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INVESTOR BEHAVIOR, STOCK MARKET EFFICIENCY AND PUBLICLY AVAILABLE INFORMATION.
The Ohio State University, Ph.D., 1973
Accounting

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INVESTOR BEHAVIOR, STOCK MARKET EFFICIENCY
AND PUBLICLY AVAILABLE INFORMATION

DISSERTATION

Presented in Partial Fulfillment of the Requirements for
the Degree Doctor of Philosophy in the Graduate
School of The Ohio State University

By

Joseph Kazimierz Winsen, B.Com., M.Com., M.A.

* * * * *

The Ohio State University

1973

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ACKNOWLEDGEMENTS

The advice and direction of Professor Melvin N. Greenball, Chairman of my dissertation committee, were of particular value throughout the conduct of this study. Valuable advice and direction were also provided by Professors David A. Ricks and Steven C. Reimer, members of the dissertation committee, and Professor Roger K. Harvey.

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# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACKNOWLEDGEMENTS</td>
<td>ii</td>
</tr>
<tr>
<td>VITA</td>
<td>iii</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>vi</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>vii</td>
</tr>
<tr>
<td>INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>Chapter</td>
<td></td>
</tr>
<tr>
<td>I. REPORTED ASSOCIATION BETWEEN STOCK MARKET BEHAVIOR AND PUBLICLY AVAILABLE INFORMATION</td>
<td>4</td>
</tr>
<tr>
<td>Stock Market Efficiency</td>
<td></td>
</tr>
<tr>
<td>Earnings Information</td>
<td></td>
</tr>
<tr>
<td>&quot;Risk&quot; Information</td>
<td></td>
</tr>
<tr>
<td>Information Implicit in a Stock-Split</td>
<td></td>
</tr>
<tr>
<td>Dividend Information</td>
<td></td>
</tr>
<tr>
<td>Comparisons of Publicly Available Information</td>
<td></td>
</tr>
<tr>
<td>Summary</td>
<td></td>
</tr>
<tr>
<td>II. AGGREGATE STOCK MARKET BEHAVIOR AND THE INVESTOR</td>
<td>37</td>
</tr>
<tr>
<td>An Accounting Perspective</td>
<td></td>
</tr>
<tr>
<td>A Model of Stock Market Behavior</td>
<td></td>
</tr>
<tr>
<td>Interpretation of the Model</td>
<td></td>
</tr>
<tr>
<td>Statement of Hypotheses</td>
<td></td>
</tr>
<tr>
<td>Fitting the Model</td>
<td></td>
</tr>
<tr>
<td>The Data</td>
<td></td>
</tr>
<tr>
<td>Summary</td>
<td></td>
</tr>
<tr>
<td>III. THE EMPIRICAL ANALYSIS</td>
<td>61</td>
</tr>
<tr>
<td>Parameter Estimation</td>
<td></td>
</tr>
<tr>
<td>Hypothesis Testing</td>
<td></td>
</tr>
<tr>
<td>Summary</td>
<td></td>
</tr>
<tr>
<td>IV. SUMMARY AND CONCLUSIONS</td>
<td>69</td>
</tr>
</tbody>
</table>
# APPENDIX

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>74</td>
</tr>
<tr>
<td>B</td>
<td>93</td>
</tr>
<tr>
<td>BIBLIOGRAPHY</td>
<td>99</td>
</tr>
</tbody>
</table>
# LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Firms Studied</td>
<td>75</td>
</tr>
<tr>
<td>2</td>
<td>Model 1</td>
<td>76</td>
</tr>
<tr>
<td>3</td>
<td>Model 2</td>
<td>85</td>
</tr>
<tr>
<td>4</td>
<td>Model 3</td>
<td>86</td>
</tr>
<tr>
<td>5</td>
<td>General Test of a Relation Between Volume and Price Change</td>
<td>87</td>
</tr>
<tr>
<td>6</td>
<td>Test Statistics for Tests of Stock Market Efficiency</td>
<td>88</td>
</tr>
<tr>
<td>7</td>
<td>Tests Statistics for Tests of Hypotheses A</td>
<td>89</td>
</tr>
<tr>
<td>8</td>
<td>Comovements in Changes of Publicly Available Information</td>
<td>90</td>
</tr>
<tr>
<td>9</td>
<td>Comovements in Absolute Changes of Publicly Available Information</td>
<td>91</td>
</tr>
<tr>
<td>10</td>
<td>Number of Runs in Absolute Changes in Publicly Available Information</td>
<td>92</td>
</tr>
</tbody>
</table>
LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The Relationship between Volume and Price Change</td>
<td>41</td>
</tr>
<tr>
<td>2</td>
<td>The Relationship between Model 3 Residual and Publicly Available Information</td>
<td>50</td>
</tr>
<tr>
<td>3</td>
<td>The Individual Portfolio Selection Process</td>
<td>94</td>
</tr>
</tbody>
</table>
INTRODUCTION

This study is concerned with the association between investor behavior and publicly available information. In particular, the study is concerned with the efficiency of investor reaction to publicly available information. This issue is relevant to those responsible for providing investors with such information—e.g., the Accounting profession, the S.E.C., etc.

The association between investor behavior and publicly available information is determined on a firm by firm basis. Investor behavior is monitored by observing the volume of transactions in the stock of a firm. Such aggregate volume behavior is a simple addition of individual behavior with respect to a given firm.

This study makes use of the efficient-market hypothesis in its semi-strong form. The hypothesis enables movements in stock prices to be used as an indication of flow of information to the market. To check on its validity, this hypothesis is subjected to tests against broad alternatives, which can be contrasted with previous tests involving specific alternatives thus leaving open the possibility that some other alternative may invalidate the hypothesis. The tests against broad alternatives to be reported could not reject the hypothesis.

A model is built and tested that disaggregates market behavior in terms of the volume of transactions in the stock of a given firm that cannot be related to the flow of information to the market about that stock. Having isolated such behavior, the study tests for an association
between such behavior and a number of publicly available data items such as earnings per share. The empirical analysis indicates that such an association does exist and that it varies across firms and across the data items. Such an association is consistent with the hypothesis that such data items are misunderstood and/or misused by investors resulting in behavior that cannot be explained by the flow of information coming on to the stock market. The extent to which the volume of transactions in a given stock can be explained by the flow of information coming on to the market about that stock is taken as an indication of the efficiency of investor behavior in the market in contrast to the efficiency of the market as a whole.

Previous research has mainly been concerned with the association between available information and the behavior of the stock market as a whole. Such research has almost without exception been concerned with price behavior. Such a focus on price behavior is not able to make clear the patterns of investor behavior, such patterns being hidden by the aggregation process determining price. Beaver, in a study to be discussed in more detail later, did look at investor behavior via the volume of transactions in the stock of a given firm, but he did not attempt to evaluate the efficiency of such behavior. Chapter one of the present study outlines the major research to date, after discussing the efficient market hypothesis on which most of the research is based.

Chapter two contains the development and interpretation of the model that isolates investor behavior which cannot be explained by the flow of information coming on to the stock market. Chapter two also contains the statement of the hypotheses about the association between publicly
available information and investor behavior. The third chapter reports
on the estimates of the parameters of the model referred to above and
on the tests of the stated hypotheses. The final chapter presents a
summary and statement of conclusions.

The impetus for the present study was the fact that recent research
had generally ignored investor behavior in the stock market. While it
has often been speculated that some investors misunderstand and/or misuse
available information, no empirical method of evaluating such an hypothe­
sis has been constructed. The present study constructs such a method.
In this endeavor, the study is exploratory in nature.
The present study can be contrasted with recent research that has mainly been concerned with the association between the behavior of the stock market as a whole in the form of stock price fluctuations and publicly available information. The one exception is some work by Beaver in which investor behavior in the form of the volume of transactions in the stock of a given firm is considered. The major research to date is outlined below.

The desirability of association with price behavior in the stock market depends on the model of price behavior to which one subscribes. All of the studies outlined below either explicitly or implicitly rely in the following manner on the efficient-market hypothesis to establish the desirability of association with stock price behavior. In general, the efficient-market hypothesis argues that prices reflect all available information in such a way that such information cannot be used to consistently earn above normal returns. As a result, association with price behavior is consistent with the hypothesis that the particular type of information so associated is used by the market in forming price and reflects itself the "essential" aspects of the stock on the basis of which normal returns are determined, or the information reflects some other underlying event(s) which reflect(s) such aspects. Before outlining
reported associations between stock market behavior and publicly available information, stock market efficiency is discussed.

Stock Market Efficiency

A market in which prices fully reflect available information is called efficient. Capital-market efficiency is defined with respect to information sets. Three different sets of information have been identified: (1) the historical sequence of security prices, (2) all publicly available information (including information which can be purchased), and (3) all information. For a further discussion of the definition of such terms as "information" and "publicly available" see the work by Fama referenced below. Note that the first set is a subset of the second which, in turn, is a subset of the third. Market efficiency, with respect to the first set, has been called the "weak" form of market efficiency, and market efficiency with respect to the second and third sets have been called the "semi-strong" and the "strong" form, respectively.

Most of the empirical tests of market efficiency are based on the assumption that the conditions of market equilibrium can, somehow, be stated in terms of expected returns. Fama and Miller point out that,

...the assumption that the conditions of market equilibrium can be stated in terms of expected returns elevates the purely mathematical concept of expected value to a status not necessarily implied by the general notion of market efficiency. The expected value is just one of many possible summary measures of a distribution of returns, and market efficiency per se, that is, the general notion that prices fully reflect available information, does not imbue it with any special importance. Thus, the results of tests based on this assumption depend to some extent on its validity as well as on the efficiency of the market. But some such assumption is the unavoidable price that one must pay to give the theory of efficient markets empirical content. 1

The assumptions, that the conditions of market equilibrium can be stated in terms of expected returns and that equilibrium expected returns and current prices are formed on the basis of, and thus fully reflect, available information have a major testable implication - they rule out the possibility of trading schemes based only on available information that have expected returns in excess of equilibrium expected returns. Expected returns are difficult, if not impossible, to detect and it might be argued that historical performance can never completely test a relation between expected returns. Yet most tests of capital market efficiency employ such a procedure.

Fama has presented an a priori argument for the existence of market efficiency. 2 His argument involves the existence of a sufficient number of "sophisticated" investors (or rather sufficient in terms of resources) learning of any dependencies between available information and return (i.e., price change), trading on them and so eliminating them. His argument continues:

The above discussion implies, of course, that, if there are many astute traders in the market, on the average the full effects of new information on intrinsic values will be reflected nearly instantaneously in actual prices. In fact, however, because there is vagueness or uncertainty surrounding new information, "instantaneous adjustment" really has two implications. First, actual prices will initially overadjust to the new intrinsic values as often as they will underadjust. Second, the lag in the complete adjustment of actual prices to successive new intrinsic values will itself be an independent random variable, sometimes preceding the new information which is the basis of the change (i.e., when the information is anticipated by the market before it actually appears) and sometimes following. It is clear that in this case successive price changes in individual securities will be independent random variables.

In a dynamic economy there will always be new information which causes intrinsic values to change over time. As a result, people who can consistently predict the appearance of new information and evaluate its effects on intrinsic values will usually make larger profits than can people who do not have this talent. The fact that the activities of these superior analysts help to make successive price changes independent does not imply that their expected profits cannot be greater than those of the investor who follows some naive buy-and-hold policy.

It must be emphasized, however, that the comparative advantage of the superior analyst over his less talented competitors lies in his ability to predict consistently the appearance of new information and evaluate its impact on intrinsic values. If there are enough superior analysts, their existence will be sufficient to insure that actual market prices are on the basis of all available information, best estimates of intrinsic values. In this way, of course, the superior analysts make intrinsic value analysis a useless tool for both the average analyst and the average investor. 3

In order for superior analysts to make above normal gains it would seem to be necessary for them to make consistently better evaluations of available information than are implicit in market prices. Yet, elsewhere, Fama has argued this would deny market efficiency:

...disagreement among investors about the implications of given information does not in itself imply market inefficiency unless there are investors who can consistently make better evaluations of available information than are implicit in market prices. 4

But then superior analysts were argued to earn their abnormal returns from generating new information so that possibly only the strong form of market efficiency is questioned here. However, if prediction of new information is based on currently publicly available information, and new information can be used to make above average gains without contradicting the efficient-market hypothesis in its semi-strong form, at what

3. Ibid., pp. 39-40.
point do transformations (predictions) of publicly available information cease to be publicly available? That is, capital-market efficiency in its semi-strong form denies the possibility of using publicly available information to consistently make above average gains, yet allows the use of publicly available information to predict "new" information which can be used to make above average gains - at what point does "use" become "prediction of new information"? One way out of the apparent contradiction is to argue that superior analysts are the medium by which the market is efficient in the semi-strong form, and that above average returns are their reward for this function. Such an interpretation of stock market behavior would mean that comparing alternate sources of publicly available information by observing their separate associations with price behavior (e.g., the study by Beaver and Dukes outlined below) would involve catering to the needs of superior analysts - possibly at the expense of the average and below average analyst and investor. For example, if association tests suggest that highly specialized information, unintelligible to the average investor, is implicit in prices, then deciding between alternate types of information based on such association tests would not restrict the arbitrage operations of the superior analysts which lead the market to efficiency and, in fact, may increase arbitrage profits if such tests lead to discontinuation of available information which the average investor has found meaningful. It will be argued later that such a situation has traditionally been viewed as undesirable by those responsible for corporate reporting.

Some studies have indicated that the market is efficient in the weak form in that any above average gains obtainable from given investment
strategies using price movements only would necessitate so many transac-
tions, and thus transaction costs, as to make such strategies unprofit-
able. Studies have also indicated that the market may not be efficient
in the strong form in that above average gains can be made using, for
example, knowledge of the orders waiting for execution by a floor
specialist in a security\(^5\) -- i.e., price movements do not reflect all
inside information (yet possibly may reflect some inside information).

The evidence consistent with an efficient capital market would
appear to outweigh the reports that are not at first sight so consistent.
It should be noted that inconsistencies would seem to be more damaging
than consistent reports are supporting. Consistent reports are necessary
but not sufficient. That is, the absence of trading systems that earn
returns above equilibrium returns is implied by a capital market in which
prices fully reflect all available information, but the former does not
imply the latter. Trading systems which do not currently exist may yet
be devised that outperform the market.

Tests of the efficient-market hypothesis in its semi-strong form
have generally been indirect. Ball and Brown, for example, reported that
once financial-accounting data was released there were no above average
gains (as reflected by API -- an average across firms) to be made in the
market using their investment strategy, which was a function of the sign
of the earnings forecast (as specified by an OLS regression) error.
Their study is outlined in more detail below. Later in the present
study a direct test, of the efficient-market hypothesis in its semi-
strong form, is reported.

\(^5\) Ibid., pp. 391ff.
A number of reports have been suggestive of market inefficiency in the semi-strong form, although such suggestions have generally lost their credibility due to methodological problems in the reports—especially in the failure to adjust gains appropriately for risk. 6

Jones and Litzenberger reported a security-selection system based on quarterly earnings that outperformed a market portfolio. 7 Performance was determined by rate of return over a period beginning two months following the end of a quarter. Unless it is argued that quarterly reports are not available within such a period, the result would appear to contradict a semi-strong-efficient capital market. Jones and Litzenberger report that the "risk" of their portfolio was higher than that of the market portfolio, so that higher returns would be expected. 8 They adjusted their returns using Sharpe's reward-to-variability index. This index is calculated as the mean realized rate of return minus the rate of return on a risk-free asset, divided by the standard deviation of the rate of return. Unlike Ball and Brown who looked only at the sign of the earnings forecast error, Jones and Litzenberger considered the size of the error. OLS regression was applied to two years of quarterly earnings per share as a function of time. Those firms with a correlation coefficient between the two series (EPS and time) larger than .7 were identified. Predictions were made of EPS for each firm for the ninth


8. The capital-asset pricing model of Sharpe-Lintner-Mossin predicts higher returns for higher risk: See E. Fama and M. Miller, Ch. 7.
quarter by extrapolating the trend observed in the previous eight quarters. If the earnings forecast error was greater than 1.5 standard errors of the estimate, a "buy" recommendation was instituted. That is, actual earnings minus predicted earnings had to be positive and greater than one and a half times the estimated standard deviation of the EPS series about the trend line, to generate a "buy" recommendation. Beginning at the end of the second month of the tenth quarter a six-month holding period was defined and the rate of return computed (actually the price-relative was computed which is one plus the rate of return). The results were reported as follows:

The price relatives for the selected stocks are compared with the price relatives for Standard and Poor's Industrial Index over the same time periods. In the ten time periods examined, a total of 211 common stocks had quarterly earnings reports exceeding their projected quarterly earnings by 1.5 standard errors of the estimate. Of these stocks, 136 had six-month price relatives greater than the corresponding price relatives for the Standard and Poor's Industrial Index. ... The average price relatives of the stocks selected in each period exceed the price relatives for the Standard and Poor's Index in all ten of the periods examined....

The deficiency in this comparison is that the risk of each stock is not compared with that of the Standard and Poor's portfolio. Jones and Litzenberger recognized this and reported a number of measures of the relative risks involved. One was the standard deviation of the mean price relative for each period calculated across the ten periods. In comparing this with the standard deviation of the Standard and Poor's Index over the same time period, it was reported that the estimates were .100 and .058 respectively. Note that this comparison is only valid if the same stocks were selected in each of the ten periods and so formed an

9, C. Jones and R. Litzenberger, p. 145.
Another measure of risk computed was the correlation of the average six-month price relative of the stocks selected with the Standard and Poor's index. The regression coefficient was 1.40. Again this result is meaningful only if the same stocks were selected in each of the ten periods - a condition not met since the number of stocks selected in each period varied. Since there really are ten different portfolios (though possibly some stocks were common to each, or at least some, of the ten periods), the results indicate that ten different portfolios each had a higher return than the Standard and Poor's portfolio in a given period, the single given period being different for each portfolio. That is, with respect to each of the ten portfolios only one sample result is available and measures of dispersion cannot be estimated. The importance of the risk element might possibly be questioned. After all, the selection procedure produced portfolios that did perform better than the market as represented by the Standard and Poor's portfolio. If each portfolio is liquidated at the end of the six-month holding period there may be a lack of interest in its performance over many consecutive holding periods. In fact, the selection procedure may be praised for switching portfolios from period to period in order to consistently outperform the market. Even if each portfolio chosen is more risky than the market this seems at first thought of little concern as long as the selection procedure switches from risky portfolio to risky portfolio in such a way that performance in each holding period is better than the market. One reason that risk information may be asked for is that the individual investor's decision involves a tradeoff between risk and return and so the above average performance of each portfolio needs to
be compared with its risk. Again it may be argued that in effect there is no risk for although each portfolio would involve a variance of return over many holding periods, each portfolio is not held over many holding periods - it is only held for one holding period and in that period it outperforms the market. Such an argument places great faith indeed in the selection procedure. Even though it is true that in the ten periods reported each portfolio does outperform the Standard and Poor's portfolio, closer examination of the reported results raises doubts about the permanent ability of the selection procedure to so perform.\(^\text{10}\) In about half of the ten periods the number of stocks in the portfolio that outperformed the market is approximately half the number of stocks in the portfolio. That is, in a significant number of cases the selection procedure forms portfolios where half of the stocks do better than the market and the other half do worse. It involves great faith indeed to rely on such a portfolio that has its composition split into good and bad performers to consistently include good performers that more than offset the bad performers. What is required is more empirical evidence to settle the question. It is suggested here that the selection procedure will not continuously outperform the market so that the risk of portfolios chosen is of relevance. Apart from the two risk measures mentioned above Jones and Litzenberger reported the following two risk adjustments, Sharpe's reward-to-variability index, defined above, applied to all ten portfolios as a group. The standard deviation was reported above and the point made that it had little meaning since there are ten different portfolios and not ten observations on the same portfolio. The other adjustment for risk

\(^{10}\) The results are summarized in table 1, \textit{Ibid.}, p. 146.
was to "mix in" risk free assets into both the group of ten portfolios and the Standard and Poor's portfolio. The exact procedure followed is not clear, but again the point can be made that it is not meaningful to treat the group of ten portfolios as a homogeneous block. The desirable adjustment for risk would involve adjusting each stock chosen for risk by regressing its return over time on a market index (such as the Standard and Poor's index) and observing the size of the residuals in evaluating each portfolio. Such a study will not be undertaken here since it constitutes an indirect test of market efficiency in its semi-strong form in being dependent on the selection procedure devised by Jones and Litzenberger. It is interesting to note a concluding statement by the authors:

It is worthwhile to examine the value of our approach in investment selection. We are not advocating that the securities selected each period should be considered a portfolio for that period, but only as possible inclusions in an adequately diversified portfolio. Risk as well as return must be considered. What is important to note is that approaches such as this may enable an investor to achieve better results than would otherwise be possible. 11

One final issue of concern is the extent to which the higher returns claimed cover the costs involved. Construction of the portfolios involves sifting through a very large number of stocks (Jones and Litzenberger studied over 500). Computer time seems essential and the costs need to be determined and taken into account.

Shelton analyzed the performance of 18,565 entrants in the 1965-1966 Value Line contest. 12 Contestants were asked to select a portfolio of 25 stocks from 350 that Value Line had ranked in classes IV and V prior

to the contest - the higher the class, (I is higher than II) the higher
the claimed quality of the stocks. Twenty-six weeks later each contest-
ant's portfolio was evaluated by determining the mean price change of the
25 stocks, adjusted for stock-splits, stock dividends, exercising of
rights, etc. The contest involved comparing the contestants performance
with that of 25 stocks chosen by Value Line from its class I. The results
can be summarized as follows; (a) the 350 stocks from which contestants
selected portfolios sustained an average fall in market value of 5.957 per
cent, leaving 94.043 per cent of beginning value; the standard deviation
was 15.93 per cent. (b) of 18,565 randomly selected portfolios the mean
closing market value was 94.05 with a standard deviation of 3.08 per cent.
(c) the 18,565 contestants actually achieved an average ending value of
95.23 per cent of beginning value. Comparing the actual mean performance
of contestants with the mean results of random selection indicates actual
performance is approximately forty-nine standard deviations greater than
the expected mean. It should be noted that the relevant standard devia-
tion is that of the mean of 18,565 portfolios randomly selected - that is,
approximately 15.93 divided by the square root of 25 times 18,565. Thus,
it appears that the contestants performed much better than random selec-
tion from the 350 stocks available for choice. Although it is possible
that some contestants may have possessed "inside" information, Shelton
argues that in general contestants based their decisions on publicly avail-
able information, the results thus being relevant to the issue of market
efficiency in the semi-strong form.

Shelton's study suffers from the same problem referred to above in
connection with the study by Jones and Litzenberger - the failure to
adequately account for risk. A preferable reporting of the results would
have been to regress all stocks involved individually on a market index and to observe the magnitude of the residuals. Shelton's reported results do allow some insight into the effect of risk on his comparison of the 25 stocks selected by Value Line from Class I and the results of a random selection from the 350 stocks available to contestants. The mean of Value Line's portfolio was some seven standard deviations greater than the mean of a portfolio randomly selected from the 350 stocks in classes IV and V. However, a summary of the performance of all five classes reveals that, while mean performance decreased as predicted as one moved from class I to class V, the standard deviation of the class members also decreased - suggesting the lower returns could be due to lower risk. Strangely enough, while the market as a whole declined over the twenty-six weeks, the classes with the higher variances performed better than those with lower variances. This observation draws attention to another limitation of Shelton's results - their generality is restricted to the particular economic context of the period involved.

In summary, the evidence is generally consistent with the hypothesis of stock market efficiency in the semi-strong form. Further evidence on this issue is reported later in the present study. Under the hypothesis fluctuations in stock prices can be taken as indications of publicly available information coming onto the market. The present study makes use of this interpretation. Before turning to this discussion, recent research is first discussed.

The following outlines of received research are grouped under headings which indicate the type of publicly available data being considered.
Earnings Information

Ball and Brown have reported that, if the sign of actual earnings change minus predicted earnings change for a particular firm and year had been available in advance at the beginning of the year, then a significant above average gain over the year would have been made in following an investment policy of "buy" when the sign is positive and "sell" (short, if necessary) when it is negative. 13 The predicted earnings change was determined by OLS regression of past earnings changes on a market index of such changes. For each firm this market index was formed by taking the average earnings change over all other firms in the market. Thus the actual earnings change for all other firms is required for a given year to predict the earnings change for a given firm. The average gain to be obtained from investing in each firm in the market is determined by predicting from an OLS regression of the past rates of return per period from investing in the stock on an index of the rate of return on a market portfolio (i.e., an investment in every asset outstanding in proportion to its total market value). Rate of return for a period is defined as price change plus dividends per share divided by beginning price after adjusting for changes in capital structure such as stock dividends, splits, etc.

Ball and Brown used Fisher's "link relative" in forming their index of rate of return on a market portfolio. 14

Fisher's link relative is formed each period by taking a weighted average of the arithmetic and geometric means of the price relatives of all stocks in the market. A price relative is the rate of return as just

defined plus one, i.e., it is the ratio of closing price plus dividends to beginning price (allowing for stock splits, etc.). For the period 1926 to 1960 Fisher reports that, on a monthly basis, his index (ignoring dividends) is more volatile than the Standard and Poor's Composite Index and the Dow-Jones Industrial Average but that the average rate of change is nearly the same. When dividends are included the index is regarded as an "investment performance" index rather than a price index, Fisher states that:

The primary purpose of an investment performance index is the provision of a benchmark for the evaluation of the performance of any particular portfolio of stocks. The benchmark provided is one that, given the prices set by investors in the market place, assumes naive, random selection. 15

Fisher's index attempts to allow monitoring of realized rates of return between any two dates resulting from an investment of equal dollar amount in each stock. The index attempts to capture the diversity of circumstances affecting each stock such as timing and amount of subscription rights. The resulting approximation is empirical rather than analytical. Analytically, as Fisher point out, problems arise because the rate of return on a portfolio is generally not a simple average of the rates on the individual stocks in the portfolio. The rate of return per period from one stock over a number of periods is

\[ r = \left( \frac{V_t}{V_0} \right)^{1/t} - 1 \]

where, \( V_t \) = the market value of all shares held at the end, i.e., originally held shares plus those acquired through reinvestment of dividends, exercised rights and stock dividends.

\( V_0 \) = original investment

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15. ibid., p. 191.
$t \equiv \text{number of periods}$

For a portfolio

$$r = \left( \frac{\Sigma V_t}{\Sigma V_0} \right)^{1/t} - 1 \neq \frac{1}{N} \Sigma \left( \frac{V_t}{V_0} \right)^{1/t} - 1$$

where the summations are over the $N$ stocks in the portfolio. Calculation of the average or "normal" gain obtainable from investing in each firm is a critical step in the results of Ball and Brown. Consequently the index used to measure rate of return on the market portfolio is critical. It should be noted that Fisher's index does not consider an investment in every stock in proportion to its total market value - a weighting scheme used in the Standard and Poor index - yet Fisher's Index is a rate-of-return index in contrast to existing price-only indices. The choice of an index arises later in the present study and will then be further considered.

Ball and Brown summarized their results in the following "abnormal performance index":

$$\text{API}_M \equiv \frac{1}{N} \sum_{n=1}^{N} \prod_{m=M}^{M+12} (1 + \nu_{nm})$$

where, $N \equiv \text{number of firms in the sample}$

$M \equiv \text{a month relative to the annual disclosure month (defined as month zero)}$

$\nu_{nm} \equiv \text{the rate of return residual for firm } n \text{ in month } m \text{ (or its negative if the stock was sold short)}.$

The $\text{API}_M$ reflects the value, at the end of month $M$, and after filtering out market effects, of a total investment of one dollar made twelve months before the annual disclosure month and spread equally over all securities. The annual disclosure month was determined by the date of
the preliminary report appearing in the Wall Street Journal. Ball and Brown's results "... demonstrate that the information contained in the annual income number is useful in that if actual income differs from expected income, the market typically has reacted in the same direction. 16 That is, the market anticipates the annual reported earnings. The conclusion is based on the behavior of $\text{API}_M$ as $M$ varies from minus twelve to plus six. Plotting $\text{API}_M$ separately for firms with positive earnings forecast errors and with negative earnings forecast errors reveals an almost monotonic increase for the former and an almost monotonic decrease for the latter. The market anticipation of annual earnings announcements appears very effective in that no sudden movement appears in $\text{API}$ around month zero - the month of disclosure. It is to be expected that some anticipation of annual earnings figures would occur via quarterly reports and announcements by the firm's top management. Yet the degree of success of such anticipation as reflected in the results of Ball and Brown seems remarkable. However, it should be noted that their results are an average across many firms and across different years so that it is unclear what their results imply about the market reaction to the operations of any given firm. Comparing the total above normal gain obtainable from basing investment decisions on the sign of earnings forecast errors with the maximum possible above normal gain obtainable, Ball and Brown report that earnings information permits about half of the maximum possible above normal gain to be attained. 17 It should be clear, however, that this result is based on the assumption that actual firm earnings are

17. Ibid., p. 191.
available twelve months in advance of their release. That is, if the results suggest anything for investment strategy, they suggest that perfect prediction of earnings for all firms in the market can be of value. The results thus suggest that there is value in predicting earnings and only in this sense do the results suggest that earnings have value for trading purposes. Since the market appears to anticipate the actual reporting of earnings, such reporting is of little value for trading purposes.

Using the efficient-market hypothesis Ball and Brown argue that changes in security prices reflect the flow of information to the market. Since their results suggest that security prices (after abstracting from market movements) move in the same direction as earnings, Ball and Brown conclude earnings have "informational content" even though this information is actually reported too late to be of major trading value. Comparing the average monthly above normal gain for the eleven months before the earnings disclosure month, obtainable from assuming knowledge of earnings twelve months before their release, with the marginal above normal gain so obtainable in the disclosure month, Ball and Brown report that "...no more than about 10 to 15 per cent [of the above normal gain] has not been anticipated by the month of the report...." Comparing the marginal above normal gain in the disclosure month, obtained with the given investment strategy and assumed knowledge, with the maximum possible above normal gain available in the disclosure month, Ball and Brown report that "the value of information conveyed by the income number at

18. But recall again that the results represent an average across different years as well as across firms.
19. Discussed above in the present study.
the time of its release constitutes, on average, only 20 percent ... of
the value of all information coming to the market in that month." 21
While Ball and Brown speak of API as a measure of the value of informa-
tion, and this is an intuitively appealing interpretation, it should be
noted that API has some problems in this regard. As Beaver has pointed
out:

The value of information is an ex ante concept, while the API is
derived from ex post relationships. Thus, the value of informa-
tion is an expected value derived from summing over the entire
state space, while the API reflects the realization of the single
state which has occurred. 22
The work of Ball and Brown does, however, detect an association between
earnings reports and stock market behavior.

In contrast to Ball and Brown who examined the behavior of stock
price in advance of earnings announcements, Beaver, using a different
methodology, restricted his attention to the market reaction at the time
of announcement. Market reaction was defined in terms of volume and
price variability across firms. Beaver argues:

An important distinction between the price and volume
tests is that the former reflects changes in the expectations
of the market as a whole while the latter reflects changes in
the expectations of individual investors. A piece of infor-
mation may be neutral in the sense of not changing the expec-
tations of the market as a whole but it may greatly alter the
expectations of individuals. In this situation, there would
be no price reaction, but there would be shifts in portfolio
positions reflected in the volume. 23
The present study also uses the volume of transactions in the stock of a

21. Ibid., p. 176.
22. W. Beaver, "The Behavior of Security Prices and Its Implica-
tions for Accounting Research (Methods)," The Accounting Review, Supple-
ment to Vol. XLVII, 1972, p. 413n.
23. W. Beaver, "The Information Content of Annual Earnings
given firm to reflect changes in the expectations of investors in that firm. Beaver reported that the annual earnings announcement of a firm can be associated with above average volume of transactions in the stock of that firm, and with above average variability of the price of that stock. Average volume and price variability were determined over "non-announcement periods" defined as all weeks excluding the announcement weeks and the eight week periods preceding and following announcement weeks. Commenting on the results of Ball and Brown, that price behavior seems to anticipate earnings announcements, Beaver states:

Although the forecasts [of earnings] are unbiased, they are not very efficient, [i.e., do not have minimum variance] for if they were, there would be no volume or price reaction when earnings reports were released. 24

Recall that Ball and Brown did report the presence of some information (as reflected by price behavior) in the announcement month.

Ball and Brown have elsewhere reported that the degree of association between a firm's earnings and a market index of earnings is itself associated with the degree of association between the rate of return on the firm's securities and the rate of return on a market portfolio. 25 The degree of association between the rate of return on a firm's securities and the rate of return on a market portfolio has been suggested as a measure of the risk involved in investing in that firm. Specifically, the estimated slope coefficient of an OLS regression of firm rate of return on the rate of return on a market portfolio can be transformed to obtain an ex post analogue to the measure of risk used in the capital-

24. Ibid., p. 85.
asset pricing model of Sharpe-Linterner-Mossin. 26 Ball and Brown's test consisted of computing cross-sectional correlations between measures of the comovements in ex post rates of return and comovements in earnings. The results indicate that comovements in incomes explain approximately 35-40 per cent of the cross-sectional variability in (estimated) degrees of association between firm rate of return and market rate of return. 27

"Risk" Information

Beaver, Kettler, and Scholes report that a number of measures of firm performance derived in part from financial accounting reports can individually be associated with the degree of association between the rate of return on a firm's securities and the rate of return on a market portfolio, and that these measures collectively can be used to predict this latter association. 28 The motivation for the study is summarized in the following:

If accounting data can be used to form superior risk forecasts, it will be a tangible demonstration of one area where the use of accounting data can lead to an improvement in decision making, at the level of the individual decision maker. 29

As indicated above, the degree of association between the rate of return on a firm's securities and the rate of return on a market portfolio is regarded as a measure of the risk of the firm's securities. The publicly available variables used by Beaver, et al, included dividend payout as a percentage of earnings, leverage in terms of debt/total assets,

26. This model is presented in, E. Fama and M. Miller, Op Cit.
29. Ibid., p. 655.
liquidity in terms of the "current ratio," asset size (total assets), variability in earnings in terms of the standard deviation of the earnings-price ratio, and the covariability of earnings in terms of the time series rate of change of the earnings-price ratio as a function of a market index of earnings/price (the work of Ball and Brown, cited immediately above, was, in effect, concerned with the relationship between the "covariability of earnings" and the market-determined risk measure). The market index of earnings/price was defined as the average ratio across all firms in the sample. The results can be summarized as follows:

The evidence indicates that accounting risk variables can be used to select and to rank portfolios such that the ranking has a high degree of correlation with ranking the same portfolios according to the market risk measure.  

This result suggests that accounting risk measures and market risk measures move together across firms. The variables which displayed the strongest association, in decreasing order, with market behavior were, earnings variability, dividend payout, earnings covariability, and liquidity, respectively. These were the only variables that displayed a statistically significant (nonzero) correlation with the market risk measure, using Spearman's rank correlation coefficient. Since Spearman's coefficient is a test statistic only (i.e., it is unknown what parameter it estimates) it is not possible to regard the above ordering as an ordering of estimated "degrees of correlation." In any event, estimates of correlation coefficients are not required. To order the significant accounting risk measures a multiple comparisons test against ordered alternatives is required.  

In comparison with a "naive" prediction, accounting risk measures "... provided superior forecasts of the market determined risk measure for the time periods studied." 32 The forecast, using the accounting risk measures, predicted the market risk measure as an OLS regression on the variables, dividend payout, earnings variability, and growth in assets. The naïve model predicted no change in the market risk measure. The statistical significance of the reported superiority of the accounting risk measures in predicting the market risk measure, was not directly considered.

Information Implicit in a Stock-Split

Prior to Ball and Brown, Fama, Fisher, Jensen and Roll evaluated the relationship between the announcement of stock splits and stock price behavior. 33 In a manner similar to that described above and used by Ball and Brown, Fama, et al, abstracted from general market movements in returns. Again in a manner analogous to that described above for Ball and Brown, Fama, et al, traced the behavior of the above normal returns around month zero, now defined as the month of the split. The results were summarized across firms as follows:

$$ u_m = (\frac{\sum_{j=1}^{N_m} v_{jm}}{N_m} ) $$

where, $v_{jm}$ = the rate of return residual for firm $j$ in month $m$

(defined in relation to month zero)

$N_m$ = the number of splits for which data are available

in month $m$


\[ U_m = \sum_{k=-29}^{m} u_k \]

It is hypothesized that stock splits provide information to the market on future dividends which in turn provide information concerning future earnings. Specifically, it is suggested that since firms are reluctant to decrease their dividends per share in proportion to the split (i.e., total payment increases), a stock split predicts increased returns to security-holders. Consequently, the sample was divided into splits that were associated with dividend increase and splits that were associated with decreased dividends. It was expected that price increases associated with splits followed by dividend increases would be maintained, while price increases associated with splits followed by dividend decreases would be reversed. Increases and decreases in dividends were defined relative to the change in the average dividend return for the market as a whole. Fama, et al., report that the majority of splits are announced some three to four months before the split takes effect and that during this time the largest \( u_m \) occur. After the split the average residuals are randomly distributed about zero for firms with dividend increases, while the cumulative residuals for firms with dividend decreases have fallen to a level near that observed prior to announcement of the split, thus confirming prior expectations noted above. 34 While the average behavior of \( u_m \) during the few months immediately preceding month zero suggests above normal trading profits may be obtained by purchasing stocks immediately a split is announced, observation of the dispersion of individual returns about the average denies the success of such a procedure. Fama, et al., report that for "... each month before

34. ibid, pp. 11-17.
the split the mean absolute deviation of residuals is well over twice as large as the corresponding average residual, which indicates that for each month the residuals for many individual securities are negative." 35 The study thus provides an outline of the association between stock price behavior and one source of publicly available information - the information implicit in a stock split.

Dividend Information

Watts, as part of his investigation into "the information content of dividends" applied Ball and Brown's API-type analysis to dividends. 36 The results can be summarized as follows:

The ranking of the APIs is as predicted, that is, the API for positive dividend residuals is greater than the overall, and the API for negative dividend residuals is less than the overall. However, the difference between the APIs for positive and negative dividend residuals is only .005 or a cumulative monthly rate of return of .5 of 1% over 15 months. This difference is not enough to cover the transaction costs of operating on the information which might be causing it. Consequently, monopolistic access to that information would not enable one to make above normal returns and I must conclude that the information is trivial. 37

Watts predicted dividend changes using OLS estimation of the following model,

$$\Delta D_{i,t} = \beta_{1,i} D_{i,t-1} + \beta_{2,i} E_{i,t} + \beta_{3,i} E_{i,t-1} + Z_{i,t}$$

where

- $\Delta D_{i,t}$ = the difference between dividends for firm $i$ in year $t$ and dividends in year $t-1$
- $D_{i,t-1}$ = total dividends declared for firm $i$ in year $t-1$
- $E_{i,t}$ = earnings per share of firm $i$ in year $t$.

35. Ibid, p. 20.
37. Ibid, p. 207.
Comparisons of Publicly Available Information

A number of studies have compared alternative sources of publicly available information in terms of their association with market behavior. Such a comparison has been made in some of the studies mentioned above.

Ball and Brown in their API study used, in addition to earnings per share, the variables, net income, cash flow (as approximated by operating income), and net income before nonrecurring items. They reported that the net income and earnings per share variables had higher APIs, but reported no statistical tests for the significance of the difference. They also used a "naive" prediction of earnings (i.e., no change) in addition to their regression model. They report little difference in results for firms with positive forecast errors, and the naive model being best (in terms of API) for the portfolio made up of firms with negative forecast errors. 39

In the other study by Ball and Brown referred to above, results were compared for the variables, operating income, net income, and available for common (each divided by total market value of common, and again but not standardized in this manner), in the form of levels and first differences. They reported that first differences appeared as the preferable form (in terms of the association between comovements in the accounting variable and comovements in market rates of return). 40

Brown and Kennelly, using the API analysis, compared different

40. For an outline of the direct comparison between the 12 variables see tables 1 and 2, pp. 319-320, R. Ball and P. Brown, "Portfolio Theory and Accounting."
earnings forecasting rules and also compared quarterly and annual earnings per share. Quarterly and annual earnings per share are compared by comparing API as defined earlier with API where investment decisions are made at the beginning of each of the four quarters based on the sign of the earnings forecast error for that quarter. That is, unlike the Ball and Brown study which employed a buy and hold decision process executed at the beginning of the year, Brown and Kennelly permit switching portfolios on a quarterly basis. The forecast models compared were (1) earnings per share (EPS) for a given period this year (e.g., the whole year or some subset such as a quarter) will equal EPS for the same period last year, (2) EPS for a given period this year will equal EPS for the same period last year plus the average change in the given period's EPS over the available history of the data, and (3) a regression model similar to that used by Ball and Brown in their API study. Brown and Kennelly report that the "...regression models are not obviously better or worse than the naive models corrected for drift."

Both results refer to the magnitude of API.

May applied Beaver's methodology to quarterly and annual data and compared the results. Unlike Beaver, May restricted his attention to

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42. Ibid., p. 413.
43. Ibid., p. 415.
price behavior only and attempted to determine the statistical significance of the difference between responses in announcement and nonannouncement weeks. He concluded that there was a significantly greater price response in weeks of quarterly earnings announcements than in non-announcement weeks. In comparing above average price response in weeks of annual earnings announcements with above average price response in weeks of quarterly earnings announcements, May concluded that reaction to annual announcements was not significantly greater than the reaction to quarterly announcements. This conclusion was held whether the reactions in all quarters were pooled and compared with the annual reaction, or each quarter's reaction was individually compared with the annual reaction. The above results were based on a sample of calendar-year fiscal year firms and noncalendar-year fiscal year firms. Observing calendar-year fiscal year firms only, May reported that reaction to second quarter earnings was significantly less than reaction to annual earnings. When the sample was classified according to dividend paying and non-dividend paying firms, it was reported that the difference between these two groups appeared mostly in the response to third quarter earnings announcements.

Another study which could be regarded as comparing alternate kinds of publicly available information is that by Beaver, Kettler, and Scholes discussed above. There, a number of different accounting risk measures were evaluated in terms of their association with the market risk measure. As an extension of their study, the authors recommended use of such association tests in resolving financial accounting measurement controversies. As an example, they determined the association between the market risk measure and one of the better performing (in
terms of association with the market risk measure) accounting risk measures, earnings variability, when earnings were measured with interperiod tax allocation and then again when earnings were measured without interperiod tax allocation. It was reported that the "...nonallocation form of the [earnings] variable exhibits a consistently higher association [across firms] with the market determined risk measure, than does the allocation form." 45

In a later study Beaver and Dukes addressed the same earnings measurement controversy using Ball and Brown's API as a criterion to be maximized by the choice between the allocation and nonallocation forms. 46 Beaver and Dukes determined the nonallocation form, or earnings before deferral, by adding the change in the deferred tax account to deferral earnings (i.e., the allocation form, actually reported). One additional variable was introduced into the comparison - cash flow, defined as earnings before deferral plus depreciation, depletion and amortization. The results were reported as follows: "...deferral earnings has the highest degree of association, [with prices] earnings without deferral is next, with cash flows performing most poorly." 47 As was the case for Ball and Brown, the result was based on comparisons over several forms of the variables (i.e., first differences, deflated by book value of common equity, etc.) and several earnings forecast models. It should be noted that the Beaver and Dukes result contradicts that of Beaver, Kettler and Scholes.

47. Ibid., p. 413.
In the above outlines, the purpose has not been to critically evaluate each study in detail, but rather to present the main results to date to serve as a point of departure for, and standard of comparison with, the present study. Several of the studies can in fact be questioned on various matters - in particular, in connection with the absence of valid statistical tests.

Of more important concern is the fact that almost without exception the studies have related publicly available information to the net result of investor actions - price behavior. The only exception is Beaver ("Information Content"). As a result investor actions are hidden in the aggregation process involved in capital asset pricing. The results of the above studies with the exception of that by Beaver thus only apply to issues concerning the "market as a whole." Implications of various conclusions for investor behavior are not clear. Consider, for example, the following statement by Beaver and Dukes.

For example, if it were found that deferral was ignored by the market, in spite of the fact that it is the required reporting method, no change in security prices would be expected if deferral were no longer required. The value of deferral would be zero, and yet it involves nonzero costs of computation and reporting, (i.e., its value net of costs is negative). 48

It is conceivable that, while deferral may be ignored by "the market" in the sense that there is little association between "deferral earnings" and security prices, deferral may be of use to some investors in their perception of the operations of the firm. Such a statement is at this point only a conjecture. The next chapter outlines a model which attempts to provide insight into such issues.

Elsewhere, Beaver has doubted the importance of such issues. Accepting the hypothesis that the market is efficient in the sense that prices reflect publicly available information, he argues that the "naive" investor should become a price taker and thus not look for overvalued or undervalued securities. Yet the investor's task involves more than "buying at the right price" - he is faced with the task of constructing a portfolio commensurate with his personal tradeoff between risk and return. Prices provide a net result of the expectations of the rate of return distribution held by the aggregate of investors in the market. If an investor considers himself a bearer of the "average risk" in the market than he can hold the market portfolio. If he is strongly risk-averse (or a risk-lover) or deviates in any sense from the "average risk" in the market, he must conduct his own analysis in selecting a portfolio. In the process he may make errors, not only of the expectation variety but also in interpreting publicly available information. As Beaver has recognized, the investor "...may incur unnecessary transactions costs, altering his portfolio position when such an alternative was not needed."

Beaver and Dukes concern with saving costs by reporting that measure of earnings (deferral versus nondeferral) that is most closely associated with the market, is suggestive of an attempt to achieve pareto optimality in the production and consumption of information. The method of reporting may be of sufficient value to some individual investors to cover the

50. This view of the investor's task is a normative one and is outlined in E. Fama and M. Miller, Op Cit.
costs of producing the information. This possibility was ignored by Beaver and Dukes who were concerned only with the value of reporting methods to the market "as a whole," - i.e., association with price behavior. Since the method of reporting may be of sufficient value to some individual investor to cover the costs involved, the argument that "the value of deferral would be zero" to the market "as a whole" is not a sufficient basis to conclude that the reporting of deferral earnings would be non-pareto optimal. In any event, it should be noted that pareto-optimality is only a necessary, and not a sufficient, condition for maximization of "social welfare." Whereas violation of pareto-optimality permits an unqualified statement about the absence of a "social welfare maximum," the presence of pareto-optimality permits no final conclusion.

Summary

In this chapter, the major tests to date of association between publicly available information and stock market behavior have been outlined. Only some work by Beaver has considered investor behavior in the form of volume of stock transactions. The remaining research has been concerned with price behavior thus, via the aggregation procedure determining price, hiding the reactions of investors to publicly available information. Stock market price behavior has been associated with: earnings information, "risk" information, information implicit in a stock-split and dividend information. The desirability of such association is usually based upon the efficient-market hypothesis in its semi-strong form. This chapter began with a discussion of this hypothesis. To date, the evidence has generally been consistent with the hypothesis.
In the next chapter, a model of stock market behavior is developed which makes use of the efficient-market hypothesis in its semi-strong form and which enables association between publicly available information and investor behavior to be tested.
CHAPTER II
AGGREGATE STOCK MARKET BEHAVIOR AND
THE INVESTOR

Information in the stock market plays a dual role. As well as being involved with the efficiency, in a general sense, of the market as a whole, it is the means by which individuals in the market control their participation. It is not suggested here that the overall efficiency of the market is not important to the economy and every individual in it. Rather it is suggested that the association between publicly-available information and investor behavior has largely been ignored. It is further suggested that such association is of direct importance to those responsible for providing investors with publicly available information. It is important to note that the market as a whole may be operating efficiently, yet significant subsets of (i.e., individuals in) that market may not be operating efficiently with respect to publicly available information. Beaver has argued similarly.

...it is important to distinguish between the securities market and the individual investors that compose the market, because the role of (accounting) information can be vastly different in each context. To a certain extent, the distinction is artificial, in the sense that the aggregate actions of the individuals determine market behavior. However, the process of aggregation is often deceptive, and if we fail to make the distinction, we may be subject to any one of a number of fallacies of composition. 52

The importance of the investor to those responsible for the data reported

52. W. Beaver, "The Behavior of Security Prices and Its Implications for Accounting Research (Methods)," p. 408.
by firms can be detected in the literature of the Accounting profession.

An Accounting Perspective

Accountants have traditionally been concerned with the possibility that their output may serve some interests to the detriment of others. For example, consider the following discussion of "the standard of freedom from bias":

The standard of freedom from bias is advocated because of the many users accounting serves and the many uses to which it may be put. The presence of bias which may serve the needs of one set of users cannot be assumed to aid or even leave unharmed the interests of others. It is conceivable that biased information could properly be introduced if it would aid one group without injuring the position of any other, but this conclusion cannot be reached with certainty in external reporting, where all potential users must be considered. 53

Of more direct relevance to this study is the recent suggestion by a large public-accounting firm that the way accountants report may provide special information and thus an advantage to the "sophisticated" investor vis-a-vis the 'average' investor:

In recent years more and more detailed disclosures have been emphasized in financial statements and footnotes. This started with the correspondence between the AICPA and the New York Stock Exchange in 1932, which recommended disclosure of accounting methods - as though the investor was somehow to use this information and perform his own accounting. Extensive disclosures in compliance with the requirements of the Securities and Exchange Commission in the United States, compounded by disclosure constantly being added under the requirements of professional pronouncements, must be thoroughly confusing to most investors. More seriously, such disclosure may be tantamount to providing insider information since they are likely to be understood by only a sophisticated few, giving them additional advantages over other investors - precisely what financial statements should not do. 54

Such an argument is hypothetical - one of the objectives of building the model below is to enable testing of such hypotheses. Before turning to the development of this model, the following argument needs to be considered. It may be suggested that higher returns to sophisticated investors are appropriate (i.e., "normal") returns to the resource of "skill." The returns are obtained by superior analysis of information which permits arbitrage gains. Jones and Litzenberger have argued that these arbitrage operations essentially "...provide those who specialize in the stock market with the normal profit accruing to their profession." 55

Yet the above quote from the Arthur Anderson publication makes it clear that the normal return for skill is not at issue, but, rather, the possibility that the content of financial accounting statements may be such that simultaneously some users are confused while others obtain an advantage in addition to their general information processing abilities.

A Model of Stock Market Behavior

Both price and volume behavior in the market can be viewed as functions of information. The impetus for a particular transaction by a given individual is postulated to be (i) the unfolding of his time dependent consumption - investment plan and/or (ii) his perception of information which gives rise to a revision of expectations. A third possibility, change in the individual's trade off between risk and return, is postulated to be an event with a probability of zero. This does not mean that such changes in the individual's trade off between risk and return are impossible but that they are believed to be generally unlikely.

55. C. Jones and R. Litzenberger, p. 144.
One source of such changes could be significant changes in wealth as brought about, for example, by inheritance. For the group of investors in a given firm, it is assumed that the level of transaction activity due to the realization of lifetime consumption-investment plans would be stable, over a small number of years. Investors may reformulate their plans. Yet, summing over investors, there is no reason to suspect that the total level of activity, due only to the effect of passage of time on consumption plans, would vary significantly over a few years. Thus changes in transaction activity from period to period, within the space of a few years, can be used to reflect changes in investor perception of information. While aggregate volume behavior is a simple addition of individual behavior and thus represents the gross changes in perception of information by individuals in the market (given the above assumptions), price behavior reflects interactions of changes in individual perceptions of information.

The view that both volume and price behavior are related to changes in information perception suggests the possibility of a relationship between volume and price (or rate of return) changes. Yet the fact that two variables are both correlated with a common third variable is not sufficient in itself for the two variables to be correlated with each other. The relationship can be expected on the basis of the following analysis suggested by Crouch. 56 A period of time is considered over which the number of shares of stock for a given firm is fixed. For illustrative purposes a two person market is considered as represented

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Price is represented on the vertical axis and number of shares on the horizontal axis. At a given time the total number of shares of stock of the given firm (OS) are held by the two individuals in the amounts OS₁ and OS₂ where OS = OS₁ + OS₂. The initial demand situation is represented by D₁, D₂ and D, so that equilibrium price is P₁. Assume now that demand changes for each individual. Consider demand changing so that the new situation is represented by D₁', D₂' such that D remains unchanged. Equilibrium price is still P₁ yet volume has occurred. Individual changes in demand have been such that they have completely offset each other in terms of effect on price. Individual 1 now requires OS₁ and individual 2 requires OS₂. The excess demand of individual 1 (i.e., S₁ S₁') equals the excess supply of individual 2 (i.e., S₂' S₂). In a market with thousands of traders, the possibility of this situation occurring day after day would seem to be remote. Yet such a situation suggests that there may not be perfect correlation between volume and price behavior. Consider next the new demand situation as being represented by D₁' and D₂'' such that market demand shifts to D'. If it was possible for the specialist in the security to anticipate the situation price would change to P₂ and no
volume would result. The possibility of this happening would also appear to be remote on a continuing basis, yet some element of this phenomenon can be seen in that the opening price for a given trading day is not always the closing price for the previous trading day. So again a less than perfect association can be expected between price and volume behavior. With specialists being unable to anticipate perfectly, price change and volume will both take place. In the simple model outlined above the following sequence of events can be expected. With a net demand at \( P_1 \) specialists begin to accept orders as they raise price in order to attract sellers. This continues until price becomes \( P_2 \). Thus a correlation can be expected between price and volume behavior. Note that the simple model is inadequate in explaining the process in that in the last case considered there are no sellers below \( P_2 \) so that specialists will have to raise price above \( P_2 \) to cover orders at a lower price - a sequence of events denying long-run survival for the specialist. In a more realistic multi-person setting sellers and buyers exist at prices between \( P_1 \) and \( P_2 \) allowing specialists to operate as expected.

The above analysis can be stated in general for an \( n \) person market. Let \( h^i (P) \) be the \( i \)th individual's demand function. Then \( \Delta Q_i \) the change in the \( i \)th individual's demand will be a function of \( \Delta P \) the change in price - say \( \Delta Q_i = g^i (\Delta P) \). Volume can be defined as \( V = \frac{1}{n} \sum_{i=1}^{n} |\Delta Q_i| = \frac{1}{n} \sum_{i=1}^{n} |g^i (\Delta P)| \), and so volume is a function of the change in price. To analytically obtain more information on the functional relationship, assumptions must be made about the form(s) of \( h^i (P) \). The general argument, unlike figure 1, makes no assumptions about the linearity or slope of the individuals demand functions. A negative slope might be expected
in that the lower the price the higher the expected return, \textit{ceteris paribus}, so that the security becomes potentially more important to any portfolio - but it should be noted that risk also increases, in terms of variance of rate of return.

It is not difficult to develop examples which illustrate that if any relationship exists between price and volume behavior it can be expected to be of the form

\[ \text{Volume} = f (|\text{price change}|). \]

That is, volume can be expected with both an increase and a decrease in price. This is readily illustrated by returning to figure 1 and beginning the analysis with an initial demand situation represented by \( D'_1, D''_2, \) and \( D' \) so that equilibrium price is \( P_2 \) and then moving to the demand situation represented by \( D'_1, D_2 \) and \( D \) with a price decrease to \( P_1 \).

One hypothesis of this study is that the relationship \( * \) takes a linear form. Crouch tested such a hypothesis with aggregate market data on volume and price and found it confirmed when price change was measured over very short periods of time. This study evaluates a linear form for \( * \) on an individual firm basis, because ultimately association between market behavior and publicly available information unique to the individual firm is of interest.

Market behavior has been analyzed in terms of general market movements and events unique to the firm. That is, it has been recognized that security prices tend to move together and individual movements in prices are viewed as functions of changes in expectations due to market-wide events, and changes in expectations due to events unique to the
firm. Since publicly available information unique to the individual firm is of interest, later observations on the association between market behavior and publicly available information involve consideration of market behavior related to events unique to the firm. For this reason market-wide effects are removed via the following linear filters:

\[ r_{jt} = \alpha_{0j} + \alpha_{1j} M_{jt} + \varepsilon_{jt} \ldots \quad (1) \]

where,

\[ r_{jt} = \frac{\text{(change in price of firm j's stock plus dividend per share, in period t)}}{\text{(price of firm j's stock at beginning of period t)}} \]

\[ M_{jt} = \frac{\text{(S and P)}_t - \text{(S and P)}_{t-1}}{\text{(S and P)}_{t-1}} \]

\( (S \text{ and } P)_t \equiv \text{the Standard and Poor's industrial index at the end of period t.} \)

In connection with the discussion on market indices early in chapter one of the present study, it should be noted that King reports a correlation larger than .9 between the Standard and Poor's index and his "market factor" in a factor analysis of the first differences in the logarithm of price. In addition the Standard and Poor's index and

57. It is also possible to consider a third argument in the function, changes in expectations due to industry-wide events. It has been reported that this third argument has become of decreasing importance as an explanatory variable. Ball and Brown, and Fama, et al., in studies outlined in the first chapter of the present study reported that ignoring the industry factor was not a serious omission. Generally on this view of price behavior see, B. King, "Market and Industry Factors in Stock Price Behavior," The Journal of Business, January, 1966.

58. W. Beaver, "The Information Content of Annual Earnings Announcements."

59. Fama, Fisher, Jensen and Roll reported that data supported a linear hypothesis for the form of this function. E. Fama, et al., "The Adjustment of Stock Prices to New Information."

60. B. King, pp. 161-3.
Fisher's Investment Performance index can be compared from columns 5 and 2 of tables 5 and 7 respectively, in Fisher's study. Also it should be noted that the Standard and Poor's index was used by Beaver in the study outlined in the first chapter of the present study. Fama, et al, reported essentially similar results in using both Fisher's index and the Standard and Poor's index. To continue specification of the model,

\[
\hat{\epsilon}_{2it} = \hat{r}_{jt} - \hat{r}_{jt}
\]

\[
\hat{r}_{jt} = \hat{\alpha}_{10j} + \hat{\alpha}_{11j} M_{1t}
\]

\[
f_{lt} = \alpha_{20i} + \alpha_{21i} M_{2t} + \epsilon_{2it} \ldots (2)
\]

where

\[
f_{lt} = V_{it}/OS_{it}
\]

\[
V_{it} = \text{market volume of firm } i \text{ in period } t
\]

\[
OS_{it} = \text{number of outstanding shares of firm } i \text{ in period } t
\]

\[
M_{2t} = \sum_{k=1}^{N} f_{kt}, \text{ where } k \text{ runs over the firms in Standard and Poor's index}
\]

\[
\hat{\epsilon}_{2it} = f_{lt} - \hat{f}_{lt}
\]

\[
\hat{f}_{lt} = \hat{\alpha}_{20i} + \hat{\alpha}_{21i} M_{2t}
\]

Model 2 removes some of the effect on the volume of a given firm of changes in the prices of stock of other firms - i.e., a substitution effect. It would be desirable to have a more direct assessment of this effect - a research task in itself. Models (1) and (2) are not fitted over the same period t. Model (1) is fitted separately for each quarter using daily data, while model (2) is based on quarterly data and fitted


63. E. Fama et al, Op Cit.
for the whole period under study. More is stated about the data below. The form of which is tested is,

$$\hat{\varepsilon}_{2it} = \alpha_{30i} + \alpha_{31i} \frac{R_{it}}{T_t} + \varepsilon_{3it} \ldots (3)$$

where

$$R_{it} \equiv \sum_{j \neq i} |\hat{\varepsilon}_{ij}||$$

$$T_t \equiv \text{number of trading days in period } t$$

Model (3) is fitted for the entire period under study using quarterly data.

$$\hat{\varepsilon}_{3it} \equiv \hat{\varepsilon}_{2it} - \hat{\varepsilon}_{2it}$$

$$\hat{\varepsilon}_{2it} \equiv \hat{\alpha}_{30i} + \hat{\alpha}_{31i} R_{it}$$

**Interpretation of the Model**

Assuming model (3) is a correct specification of market behavior, (i.e., there would be no error term if investors perceived publicly available information appropriately) the following interpretation is possible under the efficient market hypothesis in its semi-strong form.

If prices appropriately reflect publicly available information then movements in prices reflect appropriate perception of information flows and the error term in model (3) captures, (a) volume reaction to that part of inside information not reflected in price movements and (b) inappropriate volume reaction to publicly available information. Inside information can be broken up into and is defined here in terms of at least two elements; (i) private access to data and (ii) superior use of publicly available information. That is, if the market is efficient in the semi-strong form, association between publicly available information and the error term in model (3) indicates that such information is associated with, (1) misperception and/or misuse of such information by investors (since their reaction to it is inappropriate in the sense that
it is not in line with the reaction expected given such information), and/or with, (2) private access to implications of such information secured by "superior analysts," and/or with, (3) true inside information to the extent it is not reflected in price movements. The first two of the three immediately preceding possible reasons for the error term may be inferred simultaneously and association between publicly available information and misperceptions of users and/or private interpretation of such information can be tested by relating the publicly available information of one period with the error term in the next period. To test the relationship between publicly available information and true inside information the association must be observed during the same period, since once the information becomes publicly available it is no longer true inside information. Finding an association between publicly available information covering one period (but not disclosed until the end of that period) and the error term in (3) for that same period would suggest that in fact leaks were taking place - i.e., some market participants were able to obtain the information in advance of its release. This should not be confused with the prediction of information to be disclosed at the end of the period based on other more timely publicly available information disclosed during the same period, such as reported by Ball and Brown in their API study. Such prediction is ruled out here because all such appropriate reaction to publicly available information of the period has been filtered out in model (3). An association between the error term for a given period and information about that period disclosed at its end also cannot be attributed to misperception of such information or superior analysis of it, since the volume is measured
before the information is disclosed. What is possible is that, an association between, say, earnings of quarter t and the error term for quarter t, is due to an association between earnings of quarter t-1 and the error term for quarter t and also an association between earnings of quarter t-1 and earnings of quarter t. Such dependence between data of different quarters is tested by a runs test applied to the data - the results are given in chapter III. The error term for a given period (i.e., volume not explained by publicly available information disclosed during that period and reflected in prices in a manner dictated by a semi-strong efficient market) can be unambiguously related to information disclosed at the beginning of the period. Noise will enter the process because some information will become public during the period and the error term will include (inappropriate) reaction to such information. Such noise can be minimized by observing the error term over a period following the release of the information of interest short enough to exclude release of other information unique to the firm and yet long enough to permit a reaction to take place to the information of interest. Some tradeoff seems necessary and is also influenced by data availability. Since the period used in the present study is one quarter and the main sources of publicly available information unique to the firm are released quarterly, noise due to "other" information unique to the firm would appear to be minimized. Two unavoidable sources of noise remain - reaction to true inside information and delayed reaction to information made public at the beginning of previous periods. It should be clear that such noise will not confuse the interpretation of any association found between information disclosed at the beginning of a period and the error
term for that period. The effect of noise is to make the association of interest more difficult to detect assuming it really exists. The above argument can be stated more compactly with the aid of the following diagram. Let

\[ e_{1t} = \text{error term of model (3) for quarter } t \text{ due to misperceptions by investors of publicly available information} \]

\[ e_{2t} = \text{error term of model (3) for quarter } t \text{ due to superior analysis of publicly available information not reflected by prices in a semi-strong efficient market} \]

\[ e_{3t} = \text{error term of model (3) for quarter } t \text{ due to true inside information - i.e., private access - not reflected in price movements} \]

\[ e_t = \text{the observed error term for quarter } t \text{ (i.e., } e_{31t} \text{)} \]

That is, the sum of \( e_{1t}, e_{2t} \) and \( e_{3t} \) is \( e_t \). Assume, for purposes of illustration and without loss of generality, that there are only two sources of information unique to the firm for a given quarter - earnings and dividends. Let

\[ E_t = \text{earnings for quarter } t \text{ (just completed)} \]

\[ D_t = \text{dividends for quarter } t. \]

Consider the following schematic view of consecutive quarters:

---

64. The precise statement of the hypotheses to be tested will be made shortly. The present argument is stated in general terms.
Figure 2 - The Relationship between Model 3 residual and Publicly Available Information

Attempting to relate $e_{3t}$ and $E_t$ may result in an association due to a relation between $E_{t-1}$ and $E_t$ and a relation between $e_t$ and $E_{t-1}$. Associating $e_t$ and $E_{t-1}$ suggests a relation between $e_{1t}$, and/or $e_{2t}$, and $E_{t-1}$. If this relation really does exist it may be difficult to detect since $D_{t-1}$ may also influence $e_t$ and possibly swamp the effect of $E_{t-1}$. Furthermore, movements in $e_t$ may be influenced by inside information on $E_t$ and $D_t$ and delayed effects of $E_{t-2}$ and $D_{t-2}$. Since earnings and other data are not disclosed immediately at the beginning of a quarter, later tests of independence between the error term of model (3) and publicly available information look for three unwanted influences, (i) true inside information between the beginning of the quarter and the time of release of the data not reflected in price, (ii) superior analysis of the data from its release to the end of the quarter, and, (iii) misperception and/or misuse of the data from its release to the end of the quarter. In future research use of daily volume data will permit removal of (i).

The above interpretation of the model has been based on acceptance of the efficient-market hypothesis in its semi-strong form. In Appendix B it is argued that it is quite meaningful to discuss a semi-strong
efficient market and investor information processing problems simultane-
ously. It should be noted that in a semi-strong efficient market, a
model such as model (3) can be regarded as a test of investor efficiency
in the market (i.e., in terms of appropriate reaction to information)
and a filter which outputs inefficient investor reaction. That is $e_{2it}$
is a time series influenced by the flow of information coming onto the
market. The extent of such influence reflects the sensitivity of $e_{2it}$
to information and in this sense the efficiency of investor behavior.

It was argued at the beginning of this chapter that from an account-
ing perspective association between $E_{t-1}$ and $e_{1t}$ and/or $e_{2t}$ would be
considered undesirable. This is a value judgment detected in the views
of the profession. Preferably such judgments would be based on a com-
plete model of the market for information. As Beaver states:

Essentially, what is needed is a general equilibrium theory
under uncertainty that specifies the optimal amount [and form
or quality] of the economic good information that society
should produce.

The value of accounting information cannot be left entirely at
the level of the individual investor. Rather, the value of
information must be viewed within the context of the entire
set of investors, and, in fact, must incorporate the entire
society.

...in constructing an information system for a group of inves-
tors, the issue of interpersonal comparison of preference
functions arise. ...the question of the existence and nature
of a social welfare function must be addressed. 65

Economists have not yet resolved the issue of the existence and nature
of a social welfare function 66 so it is necessary for value judgments

65. W. Beaver, "The Behavior of Security Prices and Its Implica-
tions for Accounting Research (Methods)," pp. 428, 424, and 410n, respec-
tively. Although the quotations have been somewhat out of context, it is
believed they represent Beaver's point of view - which is supported here.

66. For a discussion of the issue see, K. Arrow, Social Choice
to be made by those responsible for the preparation and dissemination of publicly available information on the basis of experience.

**Statement of Hypothesis**

The following paragraphs are a formal statement of the hypotheses tested. Each hypothesis test is of the following form:

\[
\begin{align*}
H_0: & \quad h = 0 \\
H_1: & \quad h \neq 0, \text{ where} \\
& \quad h = P(X < x \text{ and } Y < y) - P(X < x) P(Y < y)
\end{align*}
\]

X and Y are random variables and \((x, y) \in \mathbb{R}^2\). P is the probability operator.

The test of independence is due to Hoeffding, and, under mild restrictions on the nature of the underlying bivariate population, the test is consistent when \(H_0\) is false. This is an improvement on normal theory procedures which do not detect all alternatives - e.g. nonlinear dependencies. The hypothesis test is given meaning when the random variables X and Y are defined. The association between publicly available information and the residual from model (3) is tested by the following three tests:

A. \[Y := |\hat{e}_{3i}|\]

X = the absolute change in quarterly Z for firm \(i\) for the quarter before \(Y\) is measured, i.e., \(|(Z_t - Z_{t-1})|\) where \(Z\) is, in turn:

67. The conditions require continuity of the joint and marginal density functions; see W. Hoeffding "A Non-parametric Test of Independence," *The Annals of Mathematical Statistics* Vol. 19. Hoeffding's statistic estimates \(E(h^2)\) where E is the expectation operator and h is as defined above.
(i) earnings per share (net income/number of shares outstanding)
(ii) dividends per share
(iii) cash flow (available for common plus depreciation, depletion, and amortization) per share,
(iv) available for common (net income less preferred dividend requirements plus savings due to common stock equivalents as outlined in A.P.B. Opinion No. 15) per share.

All four types of publicly available information have been considered in the studies outlined in chapter one of the present study — in terms of association with price behavior. Some of the studies outlined earlier relate "unexpected" changes in publicly available information with market behavior. They argue that part of the actual change may cause no reaction since it is expected. To implement their tests such studies must assume some model of how expectations are formed and results thus become tests of joint hypotheses. It has been decided not to follow such a procedure here. The above four tests are of main concern. In addition some general tests of the efficient-market hypothesis in its semi-strong form are conducted. These tests take the following forms; *** with

B. \( X \equiv \text{the change in quarterly } Z \text{ for firm } i \text{ for the quarter before } Y \text{ is measured, i.e., } (Z_t - Z_{t-1}) \text{ where } Z \text{ is,} \)

\( \text{in turn, defined as in A.} \)

\( Y \equiv \sum_{j \in I} \hat{\epsilon}_{ij} \) (for definition see explanation of variable Ri)

The tests in group B relate the net above average return that would be made by holding the stock of firm i over a quarter with the size and sign of the publicly available information variables in the previous quarter. In the tests of group B variable Y is measured over the trading
days from the announcement date of the EPS variable to the next announce-
ment date for the EPS, cash flow and available to common variables and
from ex-div. date to ex-div. date for the dividend variable. The effi-
cient-market hypothesis in its semi-strong form predicts nonrejection of
the null in each of the tests of group B.

It should be noted that no investment strategy or expectations model
is used in the tests of group B. Thus these tests are a general (in this
sense direct) evaluation of the efficient-market hypothesis in its semi-
strong form. Earlier tests have always made some assumptions concerning
expectations and/or used specific investment strategies based on the pub-
licly available information. In a different sense, earlier tests have
been more direct than the tests proposed here. Earlier tests have
attempted to determine the amount of above average gain that publicly
available information might make it possible to capture. Such information
is important because ultimately what is of interest is whether the asso-
ciation between publicly available information and above average returns
is sufficient to earn above average returns that will cover transaction
costs. In order to achieve this ultimate goal some assumption about the
actual relationship between above average gains and publicly available
information must be made - e.g. Ball and Brown's "good" and "bad" news
(as they called their respective positive and negative earnings forecast
errors). In making such an assumption, the risk is run that, even though
results do not reject the efficient-market hypothesis, some other assumed
relation may reject the hypothesis. Previous studies have all run this
risk. The present study does not do so. A finding of a strong associa-
tion in any of the tests in group B would suggest that publicly available
information of one quarter constitute information about the distribution of above average returns in the next quarter.

Some earlier studies have made restricted tests of the kind proposed here. Ball and Brown (and other API studies) report monthly "... the chi-square statistic for a two-by-two classification of firms by the sign of the [annual] income forecast error, and the sign of the stock residual for that month." 68 The chi-square test is asymptotically consistent against all alternatives. This does not mean the presently suggested tests add nothing new to the controversy on market efficiency. Ball and Brown's chi-square test relates only the signs of above average returns to the sign of the annual forecast error - thus the form of the relation and an expectation model have been assumed.

From an accounting perspective, the importance of the tests in group A (other than that involving dividends) implies something about the purpose of financial accounting reports - presumably to supply stock market investors with information about the firm which will be useful in market trading. The purpose (or purposes) of financial accounting reports is (are) a debatable issue.

It should also be noted that the hypotheses are tested at the individual firm level. Previous studies generally average results across firms.

From an accounting perspective, hypothesis testing at the individual firm level is to be preferred. Beaver has suggested this may not be so in that investors may be able to diversify out of "errors" in accounting

data for individual firms. Yet the importance of such diversification to avoid problems with individual firm data is dependent on knowledge of the existence of such problems. Accounting has generally ignored the possibility that the optimal reporting system may vary across firms in its requirement for uniformity of reporting across firms. Averaging the results of one of the tests in group A, other than that involving dividends, or rather, restating the tests by averaging the variables X and Y across firms, would obscure, among other things, the essential role of individual judgment in accounting measurement. Sterling has reported that much more of the difference across firms, in some accounting measurements, is due to the differences in the accountant's judgment than due to differences in measurement methods. Results reported by May, and outlined earlier in the present study, suggest that when firms are selected according to different criteria (such as dividend payment or non-payment) the average association between quarterly earnings and price behavior across the sample varies - i.e., results of market association tests do vary across firms. Although not of concern in the present study, a comparison of the results of the tests in group A across the set of firms sampled would provide a preliminary evaluation of the uniformity of investor misperception (and superior analysis of reported results) across firms. It would also be informative in future research to compare reactions for the same firm to quarterly versus annual announcements. Arguments that quarterly reports are of poorer quality

than annual, and that the former tend to be misleading, would predict a 
significantly stronger association detected in test A(i) for quarterly 
reports than for annual reports. 71

It may be of interest to compare the degree to which publicly 
available information and the error term from model (3) are related 
across the different kinds of publicly available information. For any 
two of the X variables such a comparison would involve the following 
considerations. Given (1) that for both of the variables the null is 
rejected, then, (2) a test is required for the significance of the differ­
ence in the two degrees of association. Parametric tests are available 
for this procedure based on asymptotic behavior of the statistics invol­
ved. 72 Nonparametric tests have recently been developed and are out­
lined and applied in chapter three of the study. 73

Fitting the Model

The models are fitted using nonparametric regression techniques. 74

The reason for this is that Fama has reported that the distribution of 
rjt may be such that the second moment does not exist. 75 With the

71. Y would, of course, have to be redefined to cover a year in 
application of the test to annual reports. For a discussion of the qual­
ity of quarterly reports see, R. Taylor, "A Look at Published Interim 

72. Fisher's transform that provides a statistic which has an 
asymptotically normal distribution, if Pearson's product-moment sample 
correlation coefficient is used, cannot be taken advantage of since the 
measures of dependence in this case are themselves dependent. For the 
appropriate parametric tests see, O. Dunn and V. Clark, "Comparison of 
tests of the Equality of Dependent Correlation Coefficients," J.A.S.A., 
December, 1971.

73. I am indebted to Professor D. Wolfe of the Faculty of Statis­
tics at OSU for allowing access to his research and for his advice - any 
statistical errors which remain in this study are of course my own.

74. M. Hollander and D. Wolfe, Ch. 9.

75. E. Fama, "The Behavior of Stock Market Prices."
nonexistence of the second moment, the Guass-Markov theorem stating that 0.L.S. estimates are "best linear unbiased" is not applicable. Fama, et al., have reported that a similar distribution is taken by $\hat{e}_{ijt}$. There have been no reports on the distribution of $f_{it}$.

Nonparametric regression does not require that the errors of the linear model be distributed so that the second moment exist. The main requirement is that they constitute a random sample - that is, that they are (1) mutually stochastically independent and (2) identically distributed (continuously). A runs test applied to the estimated errors is used to test the assumption that the errors constitute a random sample.

There are no hypothesized values with which the parameters to be estimated might be compared. Thus no significance tests (different from zero) are conducted. Confidence intervals on the parameters are reported for completeness so that significance tests are available if the reader requires such information. The slope estimator, in terms of model (1), is as follows:

$$ \hat{\alpha}_{ij} = \text{median} \left\{ \frac{(r_{ji} - r_{jk})}{(M_{ij} - M_{ik})}; (M_{ij} - M_{ik}) \neq 0 \right\} $$

and the estimator for the intercept,

$$ \hat{\alpha}_{i0j} = \text{median} \left\{ \frac{(Z_{ji} + Z_{jk})}{2} \right\}. $$

$$ Z_{ji} = r_{ji} - \hat{\alpha}_{ij} M_{ij}. $$

The Data

Data was taken from the New York Stock Exchange. One difficulty that arises from limiting attention to one exchange is that the presence of off-exchange volume and multiple exchange listings for an equity may

76. E. Fama, et al., "The Adjustment of Stock Prices to New Information."
give rise to measurement error in the dependent variable in model (3). Multiple exchange listing can be easily avoided by sample selection criteria, but information on off-exchange volume is less readily available. Since the error involved constitutes possible understatement of volume, the consequence would appear to be a downward bias in parameter estimation for the relationship between volume and price change. The source of quarterly volume and the publicly available information variables was the "quarterly 40 industrials" tape of I.M.S. Inc. (i.e., Standard and Poor's "compustat" tapes). Report dates were taken from the Wall Street Journal Index. The period covered is the years 1966-1968 thus giving a maximum of twelve observations for parameter estimation and hypothesis testing. The number of observations used in the present study compares favorably with previous studies - Beaver and Dukes used 12 to 16 observations; Jones and Litzenberger used 8; Beaver, Kettler, and Scholes 9 and 10; Ball and Brown used 10 to 18. Eight firms were selected from those for which daily returns were readily available - they appear in table 1. While a larger sample is not necessary, since all tests are made firm by firm, it would have been preferable had the available data sources permitted. However, the quarterly "compustat" tape at O.S.U. is quite poor with few firms having continuous quarterly data for even as short a period as three years. The initial sample contained all New York Stock Exchange firms with December 31 fiscal year end that had earnings per share information for the third quarter of 1963 on the quarterly compustat tapes. A common fiscal year-end was desirable initially

77. All tables appear in Appendix A.
since the market indices $M_{1t}$ and $M_{2t}$ were to be formed as averages across the sample - this later became inadvisable because of the small size of the sample. The third quarter of 1963 was chosen since initially a longer period than three years was considered and the third quarter of 1963 is the earliest quarter covered by the tapes. The first step, outlined above, yielded 102 firms. Of these, 22 did not have "volume traded" information on the tapes for the three year period under study - no "volume traded" information was available for any firm until 1966. Of the remaining 80 firms, only 11 had twelve continuous quarters, i.e., 1966-1968, inclusive, of the information required. Of the 11 firms remaining, 3 were removed because information on daily rates of return could not be readily obtained.

**Summary**

This study is concerned with the association between publicly available information and the actions of investors in the stock market. A model has been suggested to enable such association to be tested. The model and the association tests have been interpreted using stated value judgments induced from an accounting perspective and under the efficient-market hypothesis in its semi-strong form.

What is reported in the next chapter is:

- (a) fitting and evaluation of models (1), (2) and (3),
- (b) testing of hypotheses in group A and B, and
- (c) analysis of the results.
CHAPTER III
THE EMPIRICAL ANALYSIS

Parameter Estimation

Model 1 was fitted for each company for each of the twelve quarters using daily data. The results are outlined in Table 2. The most notable aspects of the results include the following three facts: (i) the extreme instability of the slope coefficient from quarter to quarter, (ii) the stability of the intercept value at approximately zero level, and (iii) the varying values of the coefficient of determination. The coefficient of determination is reported as a measure of goodness of fit since no such nonparametric measure has been developed.

The results cannot be compared directly with other received research since no other reports have been made on Model 1 using daily data. There has been some discussion of the instability of the slope coefficient when Model 1 has been estimated using monthly data, but the instability over these longer periods does not appear to be anywhere near as severe as exhibited in Table 2. The actual slope estimates are comparable in value with results reported for monthly data. Watts reports slope estimates ranging from less than .6 to greater than 1.3. Fama, et al., report slope estimates varying in value from -.1 to 1.95.

The stability of the intercept estimate around zero is consistent

79. R. Watts, Table 6, p. 204.
80. E. Fama, L. Fisher, M. Jensen, and R. Roll, Table 1, p. 5.
with reports based on monthly data. Watts reports intercept estimates ranging from less than -.004 to greater than .005 with a mean of .001. Fama, et al., report intercept estimates varying from -.06 to .04 with a mean of .000 and a median of .001.

Varying values of the coefficient of determination have also been previously noted. King reports the proportion of variance of individual stock price changes explained by his "market factor" to vary noticeably over four periods each of approximately 100 months duration. The actual values reported by King vary from .00 to .86. Fama, et al., reported \( \hat{r} \) values ranging from near zero to .91. Watts reported \( \hat{r}^2 \) values varying from less than .192 to over .425.

The data appeared to satisfy the few assumptions made in non-parametric regression. Of the (12 x 8) 96 "company-quarters" in which model 1 was fitted, in only three cases did the errors fail to satisfy a runs test. In addition, in every case the median of the errors was practically zero.

Model 2 also appeared to satisfy the assumptions involved. The results are reported in Table 3. Model 2 is fitted using twelve quarterly observations (1966-1968) and in no case did the errors fail to satisfy a runs test. Again the median of the errors is practically zero in each case. Beaver, the only one to have previously used model 2, reported correlation coefficients varying from less than .06 to above .46. Unfortunately, Beaver did not report parameter estimates. The independent

81. B. King, Table 5, p. 177.
82. In each of the runs tests conducted in this study the level of significance is .05.
83. W. Beaver, "The Information Content of Annual Earnings Announcements," Table 4, p. 87.
variable in Model 2, the average fraction of outstanding shares traded per quarter for the firms in the Standard & Poor's Industrial Average, varied from .0488 to .0697. Data was not available for all of the Standard and Poor's firms for each of the twelve quarters, but in every case at least 315 firms affected the average.

Model 3, the model of central concern, appeared to satisfy the required assumptions quite well. As with model 2, model 3 is based on twelve quarterly observations as explained in Chapter II. The results are reported in table 4. In no case did the errors fail to satisfy a runs test, indicating that the hypothesis that they constituted a random sample could not be rejected. Again, for all practical purposes, the median of the errors in each case was zero. The coefficient of determination varied from .02 to .62, indicating that in one case as much as 62 percent of volume activity could be explained by price change.

It was stated in Chapter II that in a semi-strong efficient market, a model such as Model 3 can be regarded as a test of investor efficiency in the market in terms of appropriate reaction to information flow. It will be reported in more detail later that tests of market efficiency in the semi-strong form conducted here did not refute the hypothesis. One should be careful, however, in using the coefficient of determination of Model 3 to evaluate any relation between volume activity and price-change for a given firm's stock. Model 3 may not represent the form of such a relation. In order to cover this possibility, Hoeffding's test of independence was applied to the dependent and independent variables of Model 3 on a firm by firm basis. The results are reported in Table 5. For four of the eight firms, the null hypothesis of independence was rejected,
(all significance levels are given in the appropriate tables). It is informative to note that for these four firms, the ordering of their test statistics does not coincide with an ordering of their coefficients of determination in Model 3.

Hypothesis Testing

Before considering tests in group A, it will be useful to first consider the general tests of stock market efficiency in the semi-strong form. These relate the change in a publicly available data item for one period to the sum of the values of daily excess rates of return in the next period. The periods are defined as the days between consecutive quarterly announcement dates for the E.P.S., Cash Flow Per Share, and Available for Common Per Share variables, and the days between consecutive quarterly ex-dividend dates for the Dividend Per Share variable. Quarterly announcement dates are actually announcement dates for quarterly earnings per share as given by The Wall Street Journal Index. The dates of availability of "Available for Common" and "Depreciation, Depletion and Amortization" are not given. It is suggested here that it is extremely doubtful that such information would be available before the earnings data. If such information becomes available following the earnings release then the corresponding tests in group B are biased against the null since they would be assuming knowledge of data in advance of its release. The results are reported in Table 6. The tests are based on ten observations for the dividend variable and nine observations for the other variables - from the change in data items for the second quarter of 1966 to the third and second quarters, respectively, of 1968. Exact tables are available for Hoeffding's test up to and including nine
observations so that Table 6 reports exact results for three variables and a large sample approximation for the dividend variable.

For two firms the null was rejected, involving the variables earnings per share, available for common per share, and dividend per share. The values of the test statistics in these cases indicates that the probability that the null hypothesis of independence is true is .033, .033, and .04. Thus, at a .025 level of significance, even these exceptions would not exist. In fact, the critical value for a test at the .0258 level of significance is 67 for the first two cases, and 3.40 at a .0259 level of significance for the dividend case. It is important to recall that, as discussed earlier, rejection of the null here does not necessarily indicate that the efficient-market hypothesis, in its semi-strong form, is false. Rejection of the null indicates that knowledge of the particular data item in a given period (more specifically, the change from the previous period) provides some information about the probability distribution of rate of return (adjusted for risk) in the next period. What this information is, and, most importantly, whether it is sufficient to cover trading costs, are issues the tests do not address.

Since market efficiency in the semi-strong form cannot be rejected, interpretation of the error term in Model 3 can be considered as follows. It may be due to (i) leakage of information between the beginning of the quarter and the time of disclosure of a publicly available information variable, and/or (ii) superior analysis of publicly available information from the time of its disclosure to the end of the quarter, and/or (iii) misperception and/or misuse of publicly available information from the time of its disclosure to the end of the quarter.
This interpretation of the error term in model 3 was discussed more fully in Chapter II. The interpretation is based on the observation that if prices fully reflect publicly available information then movement in prices (reflected by the independent variable of Model 3) reflects flow of publicly available information to the market.

Association between the error term of Model 3 and a publicly available data item is consistent with the hypothesis that the data item results in one or more of the three factors outlined above. It was pointed out in Chapter II that there may be some ambiguity involved in assigning association to interpretation (i), true inside information not reflected in price, since there may be some dependencies in each data item series. To check for this possibility, a runs test was applied to the absolute value of each publicly available data series used before considering hypothesis A. The results are given in Table 10. Where dependencies do exist in a series and if an association is found between a data item and the error from Model 3, then interpretation (i) may be replaced by, "superior use of previously reported data and/or misperception of such previously reported data."

The results of the tests in group A are outlined in Table 7. The number of observations used is ten - from the change in a data item in the second quarter of 1966 to the third quarter of 1968. Since exact tables are not available for Hoeffding's test when more than nine observations are involved, a large sample approximation (which allows for "relatively small" large samples) was used. In three cases, the hypothesis of independence, between the error term in Model 3 and a change in a data item in the previous quarter, was rejected. The results clearly
demonstrate that it is misleading to conclude that if two variables are related then their relationship to a third variable must be similar, or that, if two variables are not related that they cannot have a similar relationship with a third variable. The comovements in absolute changes of publicly available data items are reported in Table 9. While for firm number 3, earnings per share and cash flow per share are related (the hypothesis of independence is rejected) their relation to the error term of Model 3 is completely different. For firm number 5, cash flow per share and dividend per share are unrelated yet their relation to the error term in Model 3 is very similar.

For firm 5, it may be asked whether there is any significant difference between the association between \( |e_3| \) and absolute change in (a) cash flow per share and (b) dividend per share. Such a question involves a test of the equality of two dependent degrees of association. Kendall's rank correlation test can be used since it tests independence of \( W \) & \( Z \) against whether

\[
\tau = 2 \cdot \text{P} \left\{ \left( (W_2 - W_1) \cdot (Z_2 - Z_1) > 0 \right) \right\} -1
\]

is not equal to zero. If the variables are defined as follows,

\begin{align*}
P &\equiv \text{the probability operator} \\
W &\equiv Y - X \\
Y &\equiv \text{absolute value of change in cash flow per share in a given quarter} \\
X &\equiv \text{absolute value of change in dividend per share in a given quarter}
\end{align*}

84. Table 8 reports comovements in changes in data items.
\[ Z = \text{absolute value of error term of Model 3 in the following quarter} \]

then \( \tau \) can be rewritten as

\[ \tau = 2 \prod \{ \left( \left( Y_2 - X_2 \right) - \left( Y_1 - X_1 \right) \right) \left( Z_2 - Z_1 \right) > 0 \} \]^{-1}

\[ = 2 \prod \{ \left( Y_2 - Y_1 \right) \left( Z_2 - Z_1 \right) > \left( X_2 - X_1 \right) \left( Z_2 - Z_1 \right) \} \]^{-1}

thus providing the required test. When the test is applied to the present comparison of interest the null is not rejected indicating that for firm 5 the absolute change in (a) cash flow per share and (b) dividend per share, are essentially the same in their relationship with \( |\hat{e}_3| \).

**Summary**

The empirical analysis has served to illustrate and confirm earlier arguments. The empirical analysis has shown that tests of stock market efficiency in the semi-strong form, against broad alternatives, have not been able to reject the hypothesis. Thus, movements in stock prices can be taken as indications of publicly available information coming onto the market. The analysis has also indicated that an association does exist between investor behavior in the form of the volume of stock transaction for a given firm and the flow of information coming onto the market about that firm. That portion of volume not explained by price movements was found for some firms to be associated with certain publicly available data about those firms. This result is consistent with the argument that such data induces investor behavior that is not appropriately based on the flow of information coming onto the market.
CHAPTER IV
SUMMARY AND CONCLUSIONS

The impetus for the present study was the fact that recent research into the association between publicly available information and stock market activity was almost exclusively concerned with the behavior of stock prices. This emphasis on stock price behavior obscures the effect of publicly available information on the investor. Such research that has been concerned with investor behavior has made no attempt to evaluate the efficiency of such behavior nor to evaluate the association between any inefficiency in such behavior and publicly available information. Recent research has investigated the association between stock price behavior and: earnings information, "risk" information, information implicit in a stock-split, and, dividend information.

Recent research and the present study make use of the efficient market hypothesis in its semi-strong form. The hypothesis claims that stock market prices reflect all publicly available information in such a way that above normal expected returns cannot be consistently attained using such information. That is, prices adjust quickly and appropriately to new information. Under the hypothesis, fluctuations in a given stock price can be taken as indications of the flow of publicly available information onto the stock market about that particular stock. It was of interest in this study whether investor behavior was associated with such a flow of information.
Investor behavior was measured on a firm-by-firm basis by the volume of transactions in the stock of a firm. While data on an individual investor by individual investor basis would be desirable, it is not as readily available as stock volume data. Volume represents a simple summation of individual actions and can be considered at least a partial disaggregation of stock market activity.

The reasons for individual investor action were considered to be (1) a change in trade-off between risk and return, (2) the unfolding of time dependent consumption plans, and (3) perception of information that changes expectations. It was argued that, in general, the first reason can be ignored, occurring at discrete and probably long intervals, and that the second reason is unlikely to have an effect over a few years on the total volume of transactions in the stock of a given firm. Thus, fluctuations in such volume were considered to reflect perception of information about the given firm by investors in that firm.

Market behavior was analyzed in terms of general market movements and market movements specific to the firm. Market-wide effects on both price changes and volume of transactions in the stock of a given firm were filtered out. This left price changes indicating the flow of, and volume indicating a reaction to, information unique to the given firm.

Perception of information about a given firm by investors, measured as indicated above, was then examined for association with the flow of information coming onto the market as indicated by fluctuations in the price of the stock of the firm net of market-wide effects. The percentage of volume of transactions in the stock of a given firm that was explained by fluctuations in the stock price was taken as a measure of
the efficiency of investor behavior with respect to the given firm. The validity of accepting this interpretation is based on the following assumptions: (1) the probability that investors demands for a given stock continually exactly offset each other in such a manner that volume occurs without price change is negligible (2) specialists in securities are unable to perfectly anticipate changes in market demand in such a manner that price changes occur without volume. The importance of investigating such efficiency is apparent in the literature of the Accounting profession - the profession responsible for the reporting of most of the publicly available information unique to a given firm. A linear model for the relation between investor behavior and fluctuations in stock price of a given firm was fitted. The association was investigated between (1) the error term representing behavior not appropriately related to information flow and (2) selected publicly available data about the firm. An association was detected that varied across firms and across publicly available data. Such a finding is consistent with the argument that for some firms certain publicly available data items are misunderstood and/or misused by investors in those firms so as to result in their behavior not being an appropriate function of the flow of information coming onto the stock market. Even though some have implied otherwise, it is argued in Appendix B that investor information processing problems still exist even though the market as a whole is efficient in the semi-strong form.

The evidence prior to the present study was generally consistent with this form of the efficient-market hypothesis. Such evidence is based on tests that involve specific alternatives. That is, these tests
assume that if the hypothesis is false, then a certain trading rule will be able to attain above normal expected returns. A finding that the given trading rule could not attain above normal expected returns using publicly available information is consistent with the efficient market hypothesis in its semi-strong form but still leaves open the possibility that some other trading rule might invalidate the hypothesis.

The present study tested for an association between publicly available information and above normal returns. A nonparametric test of independence that detected broad alternatives was used. A finding of a strong association between publicly available information and above normal returns would have implied that some trading rule must exist which could attain above normal expected returns using publicly available information. The actual findings detected very weak, if any, association between publicly available information and above normal returns. That is, tests of the efficient-market hypothesis in its semi-strong form conducted in this study could not reject the hypothesis.

This study represents the first attempt to use stock market data to evaluate investor information processing efficiency. In model building, the study was to a certain extent, exploratory in nature. It is not claimed that no other approach exists to the issue of investor information processing efficiency but the approach presented here does constitute a useful way of viewing investor behavior in the stock market.

The objectives of this study have been fulfilled. A procedure has been developed with which investor behavior can be evaluated in terms of its association with publicly available information. A means of detecting which data items may be responsible for the failure of investor
behavior to be sensitive to the flow of publicly available information about a firm has been presented. The procedure is restricted, however, to data that can be quantified so that Hoeffding's test of independence can be applied. This study considered only four data items: earnings per share; cash flow per share; dividends per share; and available for common per share. Other publicly available data items can also be readily quantified and evaluated as prospective causes of the failure of investor behavior to respond to the flow of information onto the stock market. For example, asset backing per share, measures of leverage, etc., are readily quantifiable, as are predictions of earnings made publicly by officers of firms. Some information, however, cannot be readily quantified—e.g., legal proceedings brought by a regulatory agency against a firm. Yet, the procedures developed in this study to detect which data items may be responsible for the failure of investor behavior to be sensitive to the flow of publicly available information about a firm can be used to evaluate many more data items than have been considered here.

Thus, in fulfilling its objective of constructing a methodology with which to evaluate investor behavior, this study has laid the groundwork for an ongoing research program.
Table 1
Firms Studied

1. American Seating Co.
2. Marathon Oil Co.
3. Skelly Oil Co.
5. Jones and Laughlin Steel Co.
6. Copperweld Steel
7. Midland Ross Corp.
8. Ryder Systems Inc.
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<th>Number of Observations</th>
<th>Slope Estimate</th>
<th>Intercept Estimate</th>
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Av Slope Estimate = .5062  Av Intercept Estimate = -.0003  Av $R^2$ = .0573
In the preceding and following tables for model 1, the rejection region for the null hypothesis that the errors constitute a random sample is the number of runs outside the following: (0.05 significance level)

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Av Slope Estimate = .8649  Av Intercept Estimate = -.0003  Av R² = .1400
### TABLE 2 (Continued)

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†: Due to lack of independence between predicted values and residuals.

Av Slope Estimate = 1.0850  Av Intercept Estimate = -.0009  Av $R^2$ = .2186 (Deleting qtr.3 $R^2$)
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TABLE 2 (Continued)

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Av Slope Estimate = 1.1348  Av Intercept Estimate = .0011  Av R² = .1422
TABLE 2 (Continued)
Model 1 - Company No. 7

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TABLE 2 (Continued)
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<td>-.0011</td>
<td>25</td>
</tr>
<tr>
<td>12</td>
<td>52</td>
<td>.0554</td>
<td>-.0002</td>
<td>-.0050     .0047</td>
<td>-.7928  1.4000</td>
<td>.0008</td>
<td>-.0001</td>
<td>24</td>
</tr>
</tbody>
</table>

Av Slope Estimate = .5562  
Av Intercept Estimate = -.0008  
Av R² = .0583
### Table 3

Model 2

<table>
<thead>
<tr>
<th>Company Number</th>
<th>Slope Estimate</th>
<th>Intercept Estimate</th>
<th>95% Confidence Interval on Intercept</th>
<th>95% Confidence Interval on Slope</th>
<th>$R^2$</th>
<th>Median of Errors</th>
<th>Number of Runs in Errors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4.4718</td>
<td>-.1895</td>
<td>-.2026 - .1752</td>
<td>-.3086 - .7550</td>
<td>.4809</td>
<td>.0001</td>
<td>8</td>
</tr>
<tr>
<td>2</td>
<td>.3362</td>
<td>.0533</td>
<td>.0315 - .0838</td>
<td>-5.3886 - 5.9438</td>
<td>.0230</td>
<td>-.0084</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>.1049</td>
<td>.0548</td>
<td>.0443 - .0714</td>
<td>-3.0650 - 5.2231</td>
<td>.0692</td>
<td>-.0049</td>
<td>7</td>
</tr>
<tr>
<td>4</td>
<td>.2557</td>
<td>.0119</td>
<td>.0084 - .0147</td>
<td>-.8391 - .7490</td>
<td>.0308</td>
<td>.0000</td>
<td>8</td>
</tr>
<tr>
<td>5</td>
<td>2.0377</td>
<td>-.0600</td>
<td>-.0728 - -.043</td>
<td>-1.9729 - 5.6148</td>
<td>.2523</td>
<td>.0026</td>
<td>8</td>
</tr>
<tr>
<td>6</td>
<td>9.6495</td>
<td>-.3894</td>
<td>-.4386 - -.3368</td>
<td>-4.8534 - 23.2204</td>
<td>.2783</td>
<td>-.0096</td>
<td>8</td>
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<tr>
<td>7</td>
<td>.1250</td>
<td>.0036</td>
<td>.0006 - .0073</td>
<td>-.4312 - .8953</td>
<td>.0205</td>
<td>.0000</td>
<td>7</td>
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<tr>
<td>8</td>
<td>2.0498</td>
<td>-.0877</td>
<td>-.0945 - -.0808</td>
<td>.4526 - 3.4397</td>
<td>.6141</td>
<td>.0033</td>
<td>7</td>
</tr>
</tbody>
</table>

The rejection region for the hypothesis that the errors constitute a random sample is the number of runs outside the interval [4, 10] for both Models 2 and 3, (0.05 significance level). Details of the runs tests can be found in S. Siegel, *Nonparametric Statistics for the Behavioral Sciences* (New York, McGraw-Hill, 1956), and in N. Draper, and H. Smith, *Applied Regression Analysis* (New York, John Wiley and Sons, 1966).
### TABLE 4

Model 3

<table>
<thead>
<tr>
<th>Company</th>
<th>Slope Estimate</th>
<th>Intercept Estimate</th>
<th>95% Confidence Interval on Intercept</th>
<th>95% Confidence Interval on Slope</th>
<th>R²</th>
<th>Median of Errors</th>
<th>Number of Runs in Errors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.0802</td>
<td>-.0605</td>
<td>-.0705 -.0479</td>
<td>.0011 .1494</td>
<td>.4376</td>
<td>.0050</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>.0435</td>
<td>-.0450</td>
<td>-.0590 -.0067</td>
<td>-.2023 .1604</td>
<td>.1326</td>
<td>-.0044</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>.1381</td>
<td>-.0880</td>
<td>-.0936 -.0706</td>
<td>.0660 .2492</td>
<td>.1412</td>
<td>-.0014</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td>.0092</td>
<td>-.0056</td>
<td>-.0092 -.0029</td>
<td>-.0529 .0486</td>
<td>.0216</td>
<td>.0002</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td>-.0235</td>
<td>.0192</td>
<td>.0075 .0342</td>
<td>-.1486 .1135</td>
<td>.0245</td>
<td>.0058</td>
<td>8</td>
</tr>
<tr>
<td>6</td>
<td>.4565</td>
<td>-.4719</td>
<td>-.5184 -.4257</td>
<td>.0439 .8481</td>
<td>.6211</td>
<td>-.0011</td>
<td>6</td>
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<td>7</td>
<td>.0188</td>
<td>-.0103</td>
<td>-.0128 -.0070</td>
<td>-.0112 .0378</td>
<td>.2655</td>
<td>-.0010</td>
<td>7</td>
</tr>
<tr>
<td>8</td>
<td>.0154</td>
<td>-.0113</td>
<td>-.0184 -.0037</td>
<td>-.0622 .1148</td>
<td>.0253</td>
<td>.0033</td>
<td>7</td>
</tr>
</tbody>
</table>
TABLE 5

GENERAL TEST OF A RELATION BETWEEN VOLUME AND PRICE CHANGE

<table>
<thead>
<tr>
<th>Company Number:</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Statistic:</td>
<td>3.7614*</td>
<td>2.8291</td>
<td>8.0029*</td>
<td>1.2014</td>
<td>0.7299</td>
<td>4.0111*</td>
<td>3.3136*</td>
<td>1.0572</td>
</tr>
</tbody>
</table>

The rejection region for a two-tailed test of independence between \( \hat{\varepsilon}_2 \) and \( \Sigma|\hat{\varepsilon}_1| \) (as defined in Model 3), at a .0496 level of significance, is a test statistic greater than 2.85. Rejection is denoted by *. At a .1047 level of significance the critical value is 2.25. For complete tables here and in subsequent results see M. Hollander and D. Wolfe Op Cit.
### TABLE 6

**TEST STATISTICS FOR TESTS OF STOCK MARKET EFFICIENCY**

<table>
<thead>
<tr>
<th>Company Number</th>
<th>E.P.S.</th>
<th>Cash Flow Per Share</th>
<th>Dividend Per Share</th>
<th>Available For Common Per Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-2.625</td>
<td>-3.000</td>
<td>.8942</td>
<td>-3.000</td>
</tr>
<tr>
<td>2</td>
<td>-8.499</td>
<td>-8.499</td>
<td>.0000</td>
<td>-9.501</td>
</tr>
<tr>
<td>3</td>
<td>57.999*</td>
<td>38.001</td>
<td>.0000</td>
<td>57.999*</td>
</tr>
<tr>
<td>4</td>
<td>-13.374</td>
<td>-2.001</td>
<td>3.0158*</td>
<td>-14.001</td>
</tr>
<tr>
<td>5</td>
<td>-18.999</td>
<td>-13.500</td>
<td>1.0696</td>
<td>-18.999</td>
</tr>
<tr>
<td>6</td>
<td>-5.001</td>
<td>-2.001</td>
<td>.2104</td>
<td>-2.001</td>
</tr>
<tr>
<td>7</td>
<td>-8.001</td>
<td>-17.001</td>
<td>1.6175</td>
<td>-8.001</td>
</tr>
<tr>
<td>8</td>
<td>6.000</td>
<td>6.000</td>
<td>.0000</td>
<td>6.000</td>
</tr>
</tbody>
</table>

For a two-tailed test of independence between the change in a publicly available data item one quarter and a rate of return variable in the next quarter, the rejection region for Table 6 is (i) a value of a test statistic greater than 2.85 for the dividend variable (at .0496 level of significance) and (ii) a value of a test statistic greater than 48 for the other variables (.0515 level of significance). Rejections are denoted by *. 
TABLE 7

TEST STATISTICS FOR TESTS OF HYPOTHESES A

<table>
<thead>
<tr>
<th>Company Number</th>
<th>E.P.S.</th>
<th>Cash Flow Per Share</th>
<th>Dividend Per Share</th>
<th>Available for Common Per Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.7715</td>
<td>1.2098</td>
<td>.7978</td>
<td>.9205</td>
</tr>
<tr>
<td>2</td>
<td>.8065</td>
<td>1.3282</td>
<td>.0000</td>
<td>.8065</td>
</tr>
<tr>
<td>3</td>
<td>1.7402</td>
<td>2.9544*</td>
<td>.0000</td>
<td>1.7402</td>
</tr>
<tr>
<td>4</td>
<td>.6794</td>
<td>.6926</td>
<td>.2499</td>
<td>.4734</td>
</tr>
<tr>
<td>5</td>
<td>1.4334</td>
<td>4.0459*</td>
<td>3.0158*</td>
<td>.9950</td>
</tr>
<tr>
<td>6</td>
<td>1.0433</td>
<td>.5830</td>
<td>.7715</td>
<td>1.3939</td>
</tr>
<tr>
<td>7</td>
<td>2.0646</td>
<td>.9205</td>
<td>1.2317</td>
<td>1.3808</td>
</tr>
<tr>
<td>8</td>
<td>1.2317</td>
<td>.9556</td>
<td>.0000</td>
<td>1.2317</td>
</tr>
</tbody>
</table>

The rejection region for a two-tailed test of independence between $|\bar{c}_3|$ for a given quarter and the absolute value of the change in a publicly available data item for the previous quarter, at a .0496 level of significance, is a test statistic greater than 2.85. Rejection is denoted by *. 
### TABLE 8

**COMOVEMENTS IN CHANGES OF PUBLICLY AVAILABLE INFORMATION**

<table>
<thead>
<tr>
<th>Company Number:</th>
<th>E.P.S. and Cash Flow Per Share</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Company Number:</th>
<th>E.P.S. and Dividend Per Share</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Statistic:</td>
<td></td>
<td>0.6200</td>
<td>0.0000</td>
<td>0.0000</td>
<td>2.7974</td>
<td>0.3931</td>
<td>0.3750</td>
<td>0.4627</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Company Number:</th>
<th>E.P.S. and Available for Common Per Share</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Company Number:</th>
<th>Cash Flow Per Share and Dividend Per Share</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Statistic:</td>
<td></td>
<td>0.8619</td>
<td>0.0000</td>
<td>0.0000</td>
<td>1.0252</td>
<td>0.3115</td>
<td>0.6170</td>
<td>0.2933</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Company Number:</th>
<th>Cash Flow Per Share and Available for Common Per Share</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Company Number:</th>
<th>Dividend Per Share and Available for Common Per Share</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Statistic:</td>
<td></td>
<td>0.8619</td>
<td>0.0000</td>
<td>0.0000</td>
<td>2.7127</td>
<td>0.3931</td>
<td>0.3750</td>
<td>0.4264</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

The rejection region for a two-tailed test of independence between changes in, and absolute value of changes in, the variables in tables 8 and 9, respectively, at a .0496 level of significance, is a test statistic greater than 2.85. Rejection is denoted by *.
| TABLE 9 |

COMOVEMENTS IN ABSOLUTE CHANGES OF PUBLICLY AVAILABLE INFORMATION

<table>
<thead>
<tr>
<th>E.P.S. and Cash Flow Per Share</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Company Number:</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Test Statistic:</td>
<td>11.6249*</td>
<td>7.7328*</td>
<td>5.8730*</td>
<td>2.8730*</td>
<td>4.3608*</td>
<td>6.3840*</td>
<td>.4960</td>
<td>15.4414*</td>
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</table>

<table>
<thead>
<tr>
<th>E.P.S. and Dividend Per Share</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Company Number:</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Test Statistic:</td>
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<td>.0000</td>
<td>.0000</td>
<td>3.1965*</td>
<td>1.1885</td>
<td>.4718</td>
<td>1.3034</td>
<td>.0000</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>E.P.S. and Available for Common Per Share</th>
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<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Company Number:</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cash Flow Per Share and Dividend Per Share</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Company Number:</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Test Statistic:</td>
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<td>.0000</td>
<td>.0000</td>
<td>.6925</td>
<td>.8830</td>
<td>2.5040</td>
<td>.7439</td>
<td>.0000</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Cash Flow Per Share and Available for Common Per Share</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Company Number:</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Test Statistic:</td>
<td>11.8698*</td>
<td>6.9344*</td>
<td>5.8729*</td>
<td>2.7853</td>
<td>4.0070*</td>
<td>5.3649*</td>
<td>.6442</td>
<td>13.8325*</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dividend Per Share and Available for Common Per Share</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Company Number:</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Test Statistic:</td>
<td>.4385</td>
<td>.0000</td>
<td>.0000</td>
<td>2.7127</td>
<td>1.2006</td>
<td>.4718</td>
<td>.4143</td>
<td>.0000</td>
</tr>
</tbody>
</table>
### TABLE 10
NUMBER OF RUNS IN ABSOLUTE CHANGES IN PUBLICLY AVAILABLE INFORMATION

<table>
<thead>
<tr>
<th>Company Number</th>
<th>E.P.S.</th>
<th>Cash Flow Per Share</th>
<th>Dividend Per Share</th>
<th>Available For Common Per Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6</td>
<td>6</td>
<td>2*</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
<td>8</td>
<td>1*</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>6</td>
<td>7</td>
<td>1*</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td>7</td>
<td>5</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td>7</td>
<td>6</td>
<td>2*</td>
<td>7</td>
</tr>
<tr>
<td>6</td>
<td>5</td>
<td>7</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>7</td>
<td>8</td>
<td>8</td>
<td>2*</td>
<td>9*</td>
</tr>
<tr>
<td>8</td>
<td>6</td>
<td>6</td>
<td>1*</td>
<td>6</td>
</tr>
</tbody>
</table>

The rejection region for a two-tailed test (at a .05 level of significance) of the null hypothesis that changes in a data series constitute a random sample, is a number of runs outside the set [4,8]. Rejection is denoted by *. The dependence in the dividend change series is due to the fact that dividends do not change continuously and so many zero values result.
This appendix outlines why in a semi-strong efficient market investors may be subject to information processing problems. Given unchanging tastes - specifically no change in individual's trade off between risk and return - change in demand for a stock can be related to changes in expectations. The situation can be represented geometrically as follows:

The Individual Portfolio Selection Process

Figure 3

where, \( \hat{R} \) = future rate of return, a random variable

\( E \) = expectation operator

\( \sigma \) = standard deviation operator

\( R_f \) = risk-free rate of return

The curve EMH represents the "efficient boundary" for all risky assets available in the market. That is, it represents those portfolios of risky assets such that for a given level of expected return (variance of return) there are no other portfolios with equal or higher expected return (equal or lower variance of return) that have a lower variance of return (higher expected return). The shape of EMH implies that no asset returns are perfectly (positively or negatively) correlated. Points on the line \( R_fM \) represent the best return combinations of the risk-free asset and portfolios on the efficient boundary. An individual chooses a point...
on $R_fM$ consistent with his trade off between risk and return. The curve $IND$ represents a possible indifference curve between $E(\bar{R})$ and $\sigma(\bar{R})$ for a given investor. \(^85\) If investors hold homogeneous expectations then EMH will be the same for all investors. With every investor faced with the same $R_f$, $M$ represents the market portfolio. This line of reasoning is that which is followed in establishing the capital-asset pricing model of Sharpe-Lintner-Mossin. The present study does not require that investors hold homogeneous expectations nor that they all face the same $R_f$. As each investor processes information the possibility arises that the investor's efficient boundary will change. As a result his equilibrium portfolio may change. In terms of Figure 3, as EMH changes, $R_fM$ changes and $N$ may no longer be the investor's point of equilibrium. Thus as the investor receives information and revises his expectations it may be necessary for him to rearrange his portfolio if he is to remain in equilibrium in terms of his trade off between risk, as measured by the variance of return, and expected return.

Figure 3 can be used to expand on earlier statements that argued that even in an efficient market the individual investor needs to process information. If the capital-asset pricing model of Sharpe-Linter-Mossin is accepted, then the investor who judges himself to be of "average" risk disposition can visualize his position in terms of Figure 3 as a coincidence of points $M$ and $N$. In terms of Figure 3, he must know $M$ before he can judge it to be optimal. However, Figure 3 is based on an analysis

\(^85\) The shape of $IND$ implies a number of assumptions about investor behavior, such as risk aversion, etc. For a detailed statement of these assumptions, see E. Fama and M. Miller, Op Cit. Note also that points on $R_fM$ above $M$ involve short selling of the riskless asset, i.e., borrowing.
that describes individual investor behavior as if it involved utility maximization. Thus in general terms it would be reasonable to accept the proposition that an investor could subjectively attribute the average (or market) trade off between risk and return to his own desires. If the investor does not attribute an average trade off between risk and return to himself then he must decide what portfolio other than the market he is to hold. Proponents of an efficient market have made the individual investor's task in this situation appear relatively simple. Fama has argued:

> If actual prices at any point in time are good estimates of intrinsic values, he [the investor] need not be concerned with whether individual securities are over-or-under-priced. If he decides that his portfolio requires an additional security from a given risk class, he can choose that security randomly from within the class. On the average any security so chosen will have about the same effect on the expected return and riskiness of his portfolio. 86

However, before the investor can decide that he requires an additional security from a given risk class, he must be able to (1) identify the risks of the available securities and (2) compare expected return with risk. Thus he requires information on these two variables across securities. Given the risk of each security it is possible to solve for the expected return and risk of the market portfolio (i.e., identify the location of point $M$ in Figure 3) and so determine $R_f M$ and then point $N$. Even given that $M$ is the market portfolio and its location in Figure 3, the individual needs to formally express his trade off between risk and return to solve for $N$. However, the main point being made here is that information is still required to determine the attributes of portfolios even

if the market is efficient and prices reflect intrinsic values - so the problem of specifying trade off between risk and return will not be pursued. It should also be noted that portraying the investor's task in terms of locating M in Figure 3 places faith in the capital-asset pricing model of Sharpe-Lintner-Mossin - a model developed primarily to suggest the relation between risk and return in the market rather than a basis for investor's decision. The model itself does not appear to be confirmed by the data. The evidence and various alterations to the model, many involving relaxation of its assumptions (such as homogeneous expectations among investors), have been summarized by Jensen. 87 Returning to the main point of concern, it should be noted that, even given that the task of the investor involves locating M in Figure 3, determining the risk of each security and solving for M is no effortless undertaking. Given the risk of each security, M can be located via the following relation implied by the capital-asset pricing model for each security:

\[ E(\tilde{R}) = R_f + \left[ E(\tilde{R}_m) - R_f \right] \frac{\text{cov}(\tilde{R}, \tilde{R}_m)}{\sigma^2(\tilde{R}_m)} \]

where \(\tilde{R}\) and \(R_f\) are as defined above, "cov" is the covariance operator and \(\tilde{R}_m\) is the rate of return on the market portfolio - thus M is the point \((E(\tilde{R}_m), \sigma(\tilde{R}_m))\). The risk of each security is identified with \(\text{cov}(\tilde{R}, \tilde{R}_m)/\sigma^2(\tilde{R}_m)\) - say C. Then since the return on the market portfolio is a function of all securities in the market, given C for each security (and \(R_f\)) there are N equations in N unknowns (the E(\(\tilde{R}\))s) which in principle can be solved for E(\(\tilde{R}_m\)). Similarly, since the risk of the market portfolio (in terms of its

variance) is a function of all the individual cov \((\tilde{R}, \tilde{R}_m)\) knowing \(C\) for all securities enables, in principle, the determination of \(\sigma(\tilde{R}_m)\) - the individual \(\sigma(\tilde{R})\) are irrelevant since their effect is removed via diversification, i.e., a very large \(N\), the number of securities in the market. Under certain assumptions the risk for each security can be estimated from a regression of past rates of return on a market index \(^{88}\) - this would involve \(N\) time-series regressions. So, in principle, without using any information, other than regression results, the individual investor could locate point \(M\) in figure 3. It does not seem to be unreasonable to assume that, in fact, a significant number of investors do not proceed in the manner outlined above but use available information directly to estimate the expected return and risk of various portfolios. Of concern in the present study is not whether investor behavior should be associated with publicly available information, but whether it is so associated. The point outlined above is that even in an efficient market such an association can be expected. \(^{89}\)

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\(^{88}\) For a discussion of this approximation see, Ibid, and W. Beaver, "The Behavior of Security Prices and Its Implications for Accounting Research (Methods)", pp. 433-4.

\(^{89}\) This conclusion implies the assumption that a significant number of investors possess tradeoffs between risk and return that differ from the average tradeoff in the market.
BI B L I O G R A P H Y

A Statement of Basic Accounting Theory (A.A.A., 1966)


