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THE INFORMATION CONTENT OF PUBLISHED QUARTERLY EARNINGS AND QUARTERLY DIVIDEND ANNOUNCEMENTS: AN EMPIRICAL STUDY

DISSERTATION

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

By

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For all imperfections and errors that remain, I am fully responsible.

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CHAPTER I

INTRODUCTION

The importance of information for efficient resource allocation in capital markets would seem beyond question. Although the sources of this information are varied, published quarterly earnings are one such source the dissemination of which has been encouraged by major securities exchanges in the United States.[1] Coinciding closely with the publication of quarterly earnings are announcements of quarterly dividends. Both kinds of information appear to influence capital market participants, but attempts to gauge the effects of each by assessing the capital market response to their release have left several questions unresolved. A review of several major investigations discloses that at least two research questions given below have not been adequately answered.

Purpose and Motivation of Study

When published quarterly earnings and quarterly dividend announcements are made on or about the same point in

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[1]For a survey of institutional influences on interim reporting in the United States, see Robert G. Taylor, "A Look at Published Interim Reports," The Accounting Review (January, 1965), pp. 89-96.

time, the capital market's response to the announcement of one may dampen its interest in the other. For this reason it may be difficult to isolate the independent effects of either one particularly when such effects are assessed in terms of a security price reaction to the information by the capital market. Further, each one may convey information about the same set of events pertinent to the "value" of an entity. Available evidence on these issues is unclear and sometimes contradictory.[2] The purpose of this study is to address these issues by attempting to answer two empirical research questions about information pertinent to the "value" of an entity as reflected in security prices.

1. Do published quarterly earnings and quarterly dividend announcements convey such information?

2. Do significant differences exist between the ability of published quarterly earnings and the ability of quarterly dividend announcements to convey such information?

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[2]For example, studies by Watts and Pettit have contradictory conclusions and are discussed later in this study: Ross Watts, "The Information Content of Dividends," The Journal of Business (April, 1973), pp. 191-211; and R. Richardson Pettit, "Dividend Announcements, Security Performance and Capital Market Efficiency," The Journal of Finance (December, 1972), pp. 993-1007. Another study by Kiger omits any reference to the dampening effect of dividend announcements: Jack E. Kiger, "An Empirical Investigation of NYSE Volume and Price Reactions to the Announcement of Quarterly Earnings," Journal of Accounting Research (Spring, 1972), pp. 113-128.

Three constructs, inherent in the two questions above are defined below.

First, "information pertinent to the 'value' of an entity" is a message that pertains to the uncertain properties of the components of "value" of an entity's ownership stock. For example, the distribution function of returns on an entity's ownership stock may be viewed as an uncertain component of its "value." A message about that underlying distribution function constitutes information.

Second, "information conveyed by published quarterly earnings" or "information conveyed by quarterly dividend announcements" is the difference between the published change in the earnings number or the announced change in dividends and its respective expectation conditional on past changes.

Third, "information as reflected in security prices" refers to the capital market response to such information as a change in "value" of an incorporated entity's ownership stock. The effect of the information and not the information per se is reflected in security prices. A framework for presenting each construct is introduced later in this chapter.[3]

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[3]The analytical framework for presenting each construct is based largely upon Nicholas J. Gonedes and Nicholas Dopuch, "Capital Market Equilibrium, Information Production and Selecting Accounting Techniques: Theoretical Framework and Review of Empirical Work," paper presented to the Empirical Research Conference, University of Chicago, May, 1974.

Both questions are important to an investor. If no information is conveyed to market participants about events pertinent to the "value" of an entity, then the descriptive validity of stock valuation models which utilize this information would seem in doubt. From the viewpoint of an accountant or an entity manager both questions are also important. Evidence that quarterly earnings or quarterly dividends convey no information which is pertinent to the "value" of an entity may mean that such information is not used in establishing equilibrium prices in the capital market. In other words, if market participants do not respond in any predictable manner to its release, its production and dissemination may be of little benefit in terms of the efficiency of capital market resource allocation. Both questions are therefore part of an overall research program which seeks to explain the relationship between capital market equilibrium and the nature of information reflected in security prices.

Outline of Dissertation

Chapter One--Introduction. This chapter introduces the reader to the nature and importance of this study. A literature review indicates the need for further research. With the necessary definitions and theoretical rationale, a methodology to evaluate risk information is proposed.

Chapter Two--General Hypotheses. Testable hypotheses are developed concerning the risk information conveyed by published quarterly earnings numbers and quarterly dividend announcements. An explicit theoretical relationship between risk information, capital market expectations and security prices is presented.

Chapter Three--Empirical Methodology. Each of the hypotheses of the previous chapter has testable implications. Operational definitions and statistical models are specified to test such implications. The population, the sample inclusion criteria and the data sources are identified.

Chapter Four--Analysis of Unexpected Changes in Quarterly Earnings and Quarterly Dividends. The results of the application of an autoregressive integrated moving average (ARIMA) model building procedure are presented. Each identified process for quarterly earnings or quarterly dividends is viewed as a general model of capital market expectations and provides the basis for establishing the unexpected change variables.

Chapter Five--This chapter outlines the statistical procedures to test the hypotheses and the empirical results of these tests.

Chapter Six--The concluding chapter summarizes the empirical results and analyzes their implications for research in the relationship between accounting (more generally non-market) information and security prices.

Factors Which May Affect Capital Market Response

Several factors are likely to influence the capital market response to published quarterly earnings and quarterly dividend announcements. Consider first those that relate to quarterly earnings.

Despite their widespread use, quarterly earnings are not considered as entirely satisfactory. Due to the lack of a coherent and internally consistent theory of accounting, an entity's choice of procedures from "Generally Accepted Accounting Principles" (GAAP) is sometimes arbitrary and of questionable merit.[4] The same entity can vary its procedures temporally and in addition, very nearly identical firms can differ substantially in their concurrent choice of procedures from GAAP. As a result, published earnings are likely to be incomparable within and between business entities.

Moreover, the ability of an entity's management to arbitrarily choose from GAAP can lead to the implementation of smoothing policies.[5] By this it is meant that if

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[4] A compendium of Accounting Research Bulletins, APB Opinions, and Accounting Terminology Bulletins prepared by the American Institute of Certified Public Accountants, APB Accounting Principles, Vols. I & II (Chicago: Commerce Clearing House, 1971), provides an extensive inventory of current generally accepted accounting principles.

[5] Two variations of smoothing behavior may be recognized: (1) "real" smoothing, and (2) "accounting smoothing": that is decreasing the volatility of reported earnings by the application of GAAP procedures. The text at this point refers to the latter type only. The former type is investigated in: Baruch Lev and Sergius Kunitzky, "On the Association between Smoothing Measures and the Risk on Common Stocks," The Accounting Review (April, 1974), pp. 259-270.

management perceive one of their performance dimensions to be a decreasing function of the variability of published earnings, then they may be expected to select from GAAP in order to decrease such variability. One consequence of this is that unwarranted period to period dependencies are introduced into published earnings series.[6]

Seasonality and the institutional emphasis on a one year reporting period (for example, for taxation purposes) are two further factors affecting published quarterly earnings, in addition to those which apply to longer periods for earnings measurement. In short, the combined influence of these factors may result in the same set of economic events being indicated by significantly different published quarterly earnings.[7] Given this situation, not only may market participants look to other sources of information, but also an entity's management may desire to use other means to convey information about events pertinent to the "value" of a entity. One means of providing such information is via dividend changes.

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[6]An analysis of the behavior of earnings series and the implications for smoothing is provided by William H. Beaver, "The Time Series Behavior of Earnings," Empirical Research in Accounting: Selected Studies, 1970, supplement to Volume 8 of Journal of Accounting Research, pp. 62-99.

[7]Graeme Fogelberg, "Interim Income Determination: An Examination of the Effects of Alternative Measurement Techniques," Journal of Accounting Research (Autumn, 1971), pp. 215-235.

As is the case with quarterly earnings however, the capital market response to quarterly dividend announcements may also be influenced by several factors. First, the response to dividend changes clearly depends on how much information is provided by sources already available to the capital market. Notwithstanding public statements by corporate officials about future earnings and published financial forecasts, there is evidence to suppose that much relevant information is revealed in the dividend change of an entity.[8] Second, although dividends are not directly subject to GAAP and their variability cannot be increased or decreased by the choice of procedures from GAAP, they do seem to exhibit a high degree of smoothness. In part, this smoothness appears to be due to a market preference for stable but growing dividends which causes management to "partially adapt" to change in current and/or expected earnings.[9]

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[8]Pettit, op. cit., pp. 993-1007.

[9]Lintner comments: "This policy of progressive, continuing 'partial adaptation' tends to stabilize dividend distributions and provides a consistency in the pattern action which helps minimize adverse stockholder reactions. At the same time it enables management to live more comfortably with its unavoidable uncertainties regarding future developments--and this is generally true during at least a considerable part of most cyclical declines, since the failure of dividends to reflect increasing earnings fully and promptly during the preceding upswing leaves more cushion in the cash flow position as earnings start to decline." John Lintner, "Distribution of Incomes of Corporations, Retained Earnings and Taxes," The American Economic Review (May, 1956), p. 100.

Third, there are numerous factors unrelated to an entity's current or future earnings that may affect dividend changes. Some examples are noted below: (1) Unforeseen liquidity problems coupled with the need to provide a buffer between dividend requirements and especially rich investment opportunities,[10] (2) within an industry, a "follow the leader" pattern that may be associated with dividend policy decisions, (3) changes in the dividend tax structure, and (4) alteration of bond indenture provisions.

Published quarterly earnings and quarterly dividend announcements may therefore be regarded as signals pertinent to the "value" of an entity, but subject to factors such as those mentioned above that influence their capital market impact. While they cannot be regarded as signals that constitute perfect information each should, nevertheless, have an effect on market participants' assessments of entity "value" (Question One). Since the factors which influence the capital market response differ in their orientation, there is also some justification to argue that published quarterly earnings and quarterly dividend announcements may differ in their impact on market participants' assessments of entity "value" (Question Two). Closely related to this potential differential impact of each kind of information is their combined impact on assessments of entity "value." This issue is pursued as part of Question Two.

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[10] Ibid., p. 105.

The succeeding subsection gives an explanation as to why published quarterly earnings may convey information pertinent to the "value" of an entity. This is followed by a further subsection which presents an analogous explanation for quarterly dividend announcements.

Published Quarterly Earnings

Published quarterly earnings numbers are viewed as signals (or messages) about events pertinent to the "value" of an entity. But since these signals (or messages) are conditional on a theory that identifies ideal components of "value," a standard valuation model will be presented. The model is attributable to Miller and Modigliani[11] and assumes: (1) the existence of perfect capital markets, (2) no differential taxes, (3) no "growth," and (4) rational behavior on the part of market participants. Growth is viewed in the sense of opportunities to invest in assets in the future at rates of return greater than the particular firm's cost of capital. Under these assumptions, an entity's market value is equal to permanent earnings (ex ante earnings generated in perpetuity by assets currently held) times a capitalization factor (the reciprocal of rate at which ex ante earnings are discounted). Moreover, it

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[11]Merton H. Miller and Franco Modigliani, "Some Estimates of the Cost of Capital to the Electric Utility Industry, 1954-1957," The American Economic Review (June, 1966), pp. 333-391.

follows from this valuation model that a change in entity market value is the result of either a change in permanent earnings or a change in the capitalization factor. Hence, within a capital market setting, if: (1) changes in entity market value are reflected via changes in the "value" of an incorporated entity's ownership stock, and (2) one source of information about changes in entity market value (specifically changes in permanent earnings) is published quarterly earnings, then published quarterly earnings may be expected to convey information about changes in the "value" of an incorporated entity's ownership stock. Recall that such information is defined as the difference between the actual change in published quarterly earnings and its conditional expectation.

Quarterly Dividend Announcements

Quarterly dividend announcements constitute information pertinent to the "value" of an entity that differ from quarterly earnings in at least one important respect. Given the assumptions of Miller and Modigliani's standard valuation model,[12] the market value of an entity does not depend on dividend policy. Consequently, dividend policy changes in themselves cannot be expected to convey information about changes in entity market value. Nevertheless,

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[12] *Ibid.*, pp. 335-339.

Miller and Modigliani do concede that dividends may well serve as an important surrogate for permanent earnings. This has become widely known as the "information content of dividends" hypothesis.[13] If an entity's earnings consist of permanent and transitory components, and dividends depend on the former, then dividends and dividend changes convey information about events which affect the level of permanent earnings.

Since, from one period to another, part of the change in published earnings may be random and may not be representative of change in permanent earnings, there is reason to suppose that new and significant information is revealed in dividend changes. Random variation in published quarterly earnings, if recognized as such by those who invest or contemplate investment in common stock securities, will be discounted.[14] But, if market participants are unable to discern the random variation, an entity's management that wishes to convey its expectations about changes in permanent

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[13]The hypothesized relationship was labelled by Modigliani and Miller in a series of articles which centered on whether the value of a firm depends on its dividend payout rate: Franco Modigliani and Mertin H. Miller, "The Cost of Capital, Corporation Finance, and the Theory of Investment," American Economic Review (June, 1958), pp. 261-297.

[14]This is not to say that market participants explicitly compute the transitory perturbations every decision relevant period, but that intuitively or in some unknown way they may process information recognizing the different effects of transitory and permanent changes in the underlying profitability of an entity.

earnings, may use its dividend payout as a way of providing a signal to market participants about such expectations. The "information content of dividends" hypothesis is a maintained hypothesis for this current study.

Capital Market Response Approach: Related Studies

In the broadest possible terms, the approach to this study is to evaluate the relative information conveyed by published quarterly earnings numbers and quarterly dividend announcements by examining the capital market response as a security price change induced by each kind of information individually and by both kinds together. An observed correspondence over time between the security price response and information conveyed by either published quarterly earnings or quarterly dividend announcements is the basis on which to infer that the same set of events (pertinent to the "value" of an entity) is impounded in security prices. As will be evident in the following review, several major empirical studies, based on tests of association between security prices and announcements of earnings and/or dividends, have failed to concern themselves with the questions posed in this study, and suffer from model specification and/or inappropriate conclusions.

Related Studies

No attempt is made at this stage to examine comprehensively all available evidence on the association between security prices and earnings and/or dividend information. But a brief outline and criticism of research by; May, Watts, Pettit, and Black and Scholes[15] should serve as motivation for and a departure point for the particular methodological design for this study.

May's investigation is an attempt to measure security price response to the announcement of quarterly and annual earnings numbers, holding the effects of quarterly and annual dividend announcements "constant." Holding such effects "constant" is operationally defined via a sample selection criterion: "The firm must not have had more than one dividend announcement in the week of an annual earnings announcement or more than two dividend announcements that coincide with quarterly and/or annual earnings announcements."[16] His first principal hypothesis, that

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[15]Robert G. May, "The Influence of Quarterly Earnings Announcements on Investor Decisions as Reflected in Common Stock Price Changes," Empirical Research in Accounting: Selected Studies, 1971, supplement to Volume 9, Journal of Accounting Research, pp. 119-163; Watts, op. cit.; Pettit, op. cit.; and Fischer Black and Myron Scholes, "The Effects of Dividend Yield and Dividend Policy in Common Stock Prices and Returns," Journal of Financial Economics (May, 1974), pp. 1-22.

[16]May, op. cit., p. 133.

quarterly earnings have a significant effect on investor expectations, is supported by an indication that above average abnormal security price changes exist in weeks of quarterly earnings announcement, relative to all other weeks. But May's sample of firms is biased against cash dividend paying firms and as such his conclusions are inappropriate for that class of firms. Further, by his own admission, an attempt to evaluate any differential effects that dividend information might have on security price response failed. Thus May concludes "that an examination of the interaction between specific dividend and earnings information must await a research effort specifically designed for that purpose."[17]

Watts' specific objective was to test the hypothesis that knowledge of current and past annual dividends enables a better prediction of future earnings than is possible with current and past published earnings alone. Unexpected changes in published earnings one period hence and unexpected changes in dividends for the current period were found to be positively, but weakly related to each other. But Watts was unable to reject the proposition that positive abnormal security price changes did not accompany positive unexpected dividend changes, and that negative abnormal security price changes did not accompany negative unexpected dividend changes. Unable to indicate abnormal

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[17]Ibid., p. 149.

security returns assuming monopolistic access to unexpected dividend changes, Watts concludes that the information in annual dividends over and above that contained in published annual earnings is trivial. He does, however, raise the possibility that the inability of his empirical tests to discern information in dividends was affected by the large amount of noise introduced in his "partial adjustment" model[18] and that this noise may have obviated the detection of dividend information conveyed to market participants. Since this potential misspecification of the "partial adjustment" model may have obscured the influence of additional dividend information, Watts' conclusion about the information in dividends over and above published earnings requires reexamination.

Pettit's methodology is similar to that of Watts, and is based on one's ability to make abnormal returns in the capital market given foreknowledge of changes in quarterly dividends. To hold constant the effects of reported earnings on dividend announcements, his sample is divided into negative and positive quarterly earnings performance. Although by his own admission, the performance classification is not well specified, a strong dividend effect is

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[18]The "partial adjustment" model was labelled by Lintner, and is fully discussed in Lintner, op. cit., and Eugene Fama and Harvey Babiak, "Dividend Policy: An Empirical Analysis," Journal of the American Statistical Association (December, 1968), pp. 1132-1161.

found irrespective of the favorable or unfavorable earnings performance. Pettit thus concludes that his "results imply that a dividend announcement, when forthcoming, may convey significantly more information than the information implicit in an earnings announcement."[19] This is a contrary conclusion to Watts.

The contradictory conclusions of the two writers may result given that Watts emphasizes the marginal significance of an unexpected change in annual dividend over and above current annual earnings, whereas Pettit suggests that regardless of the past earnings performance, a raw change in dividend, rather than an unexpected change, is reacted to in a manner consistent with the "information content of dividends" hypothesis. Another reason may concern Pettit's misspecification of negative and positive quarterly earnings performance. Pettit's conclusion that such misspecification was of minor importance and that the cost of respecification was too high is dubious. Correct specification is essential since the higher the probability of misspecification of firms with negative and positive (quarterly) earnings performance becomes, the more invalid the classification and thus a bias may be more likely to be created in favor of the conclusion.

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[19]Pettit, op. cit., p. 1002.

The central hypothesis of the Black and Scholes study asserts that it is not possible to demonstrate empirically that expected security returns on high dividend yield stocks differ from expected security returns on low dividend yield stocks either before or after taxes. Dividend yield was defined as annual dividend per share divided by end of period price. Twenty-five intermediate portfolios which vary in their characteristics over five classes of risk and five classes of dividend yield were constructed. Within each dividend class, five portfolios differed on the basis of risk. One interim result reported by Black and Scholes is that portfolio dividend yield does not seem able to explain differences in either portfolio risk, or average excess security return (in excess of a risk-free rate of return). Their main result goes further than this and indicates that dividend yield cannot explain differences in returns for portfolios of securities, other things (e.g., portfolio risk) being equal. Their population comprises all NYSE firms.

However, rather than the above results, or the empirical methodology, it is the authors' inference about such results that is questionable. Black and Scholes infer from such findings the following:

> Perhaps the most important implications of these findings are for corporate dividend policy. We have found that a corporation that increases its dividend can expect that this will have no definite effect on its stock price. The price

> may change temporarily in response to a change in the dividend, because the market may believe that the change indicates something about the probable future course of earnings. If it becomes clear that the change was not made because of any change in estimated future earnings, this temporary effect should disappear.[20]

Two reasons may account for such a remark. The first concerns the authors' lack of belief in the validity of the "information content of dividends" hypothesis, and the second (more plausible) relates to the authors' lack of belief about its importance and relevance to their conclusions. In either case their inferred conclusion regarding the information conveyed by dividend changes is viewed as inappropriate. Their methodology considers dividend <u>yield</u> and not dividend changes as the explanatory variable for expected portfolio returns.

In summary, the above review has identified the existence of: (1) bias against cash dividend paying firms in the first study, (2) potential misspecification of the unexpected dividend change model in the second study, (3) misspecification of positive and negative earnings performance in the third study, and (4) an inappropriate conclusion regarding the information conveyed by changes in dividends in the fourth study. Consequently, the two questions raised at the outset of this study do not appear to have been adequately researched. This study is concerned

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[20]Black and Scholes, <u>op. cit</u>., p. 21.

with cash dividend paying firms only and places considerable emphasis on selecting and testing the models to estimate unexpected earnings and unexpected dividend changes. Dividend yield per se is not viewed as conveying information about events pertinent to the "value" of an entity as reflected in security prices.

Several others studies have a bearing on the particular methodological approach of this research and are introduced into later discussion of the research design and the empirical estimation procedures. For instance, the statistical techniques used by Lev and Kunitzky[21] are similar to those used in this current study. But since their objective is the evaluation of numerous smoothing measures and not the evaluation of the information conveyed by quarterly earnings and quarterly dividends, mention is deferred to subsequent chapters.

Methodology

The current study places equal emphasis on information conveyed by published quarterly earnings and quarterly dividend announcements without attempting to "hold constant" the effects of one source of information on the other. The information content of earnings is examined in the presence of the accompanying dividend announcement and vice-versa. An examination of the combined information

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[21] Lev and Kunitzky, op. cit.

content of published quarterly earnings and quarterly dividend announcements is also made.

The relative impact of each kind of information will be assessed from the viewpoint of the "relative risk" associated with an entity's securities. Relative risk is defined as *ex ante* market systematic risk, the covariance of a security's one-period return (price appreciation or depreciation plus dividends paid) with the one-period return from the market portfolio. The market portfolio consists of all those securities in the market, each entering the portfolio with weight equal to the ratio of its total market value to the total market value of all securities.

Information, Expectations and Equilibrium

The starting point for a complete description of the methodology is a structure that links information and capital market participants' expectations to a model of capital market equilibrium. The structure to be employed is fully presented in Gonedes and Dopuch.[22] A non-mathematical outline follows commencing with the model of capital market equilibrium. First, using an extensive set of assumptions,[23] the chief implication of the two parameter capital asset

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[22]Gonedes and Dopuch, *op. cit*.

[23]The assumptions are specified in Chapter Two.

pricing model formulated by Sharpe, Lintner and Mossin[24] is that, in equilibrium, the expected one-period excess return from a risky capital asset (one-period return in excess of the one-period return from a riskless asset) is equal to the expected one-period excess return from the market portfolio of risky assets times the relative risk of the risky capital asset.

The second step is to introduce the concepts of information and capital market expectations. In order to select an optimal portfolio of capital assets, each market participant is assumed to assess distribution functions of returns for each capital asset. These distribution functions which reflect each person's knowledge about return are called capital market expectations. And since the capital market is assumed to be perfect (in which case information is costless and available to everybody), these expectations are such that, in equilibrium, they reflect all available information. Thus the prices of capital assets, established in light of all available information, are accurate signals for resource allocation: that is, for

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[24]William F. Sharpe, "Capital Asset Prices: A Theory of Market Equilibrium Under Conditions of Risk," The Journal of Finance (September, 1964), pp. 425-442; John Lintner, "The Valuation of Risk Assets and the Selection of Risky Investments in Stock Portfolios and Capital Budgets," Review of Economics and Statistics (February, 1965), pp. 13-37; Jan Mossin, "Equilibrium in a Capital Asset Market," Econometrica (October, 1966), pp. 768-782.

investment decisions which may be made by entity managers and/or shareholders-consumers. A market in which all available information is impounded in capital asset prices is called efficient.

New information, flowing to the capital market, that is not perfectly consistent with available information just prior to its release will induce a revision of expectations. But more than this, it will alter the assessed distribution functions of returns which in turn will induce a change in the capital asset's equilibrium price. The effect of this information conveyed to the capital market, therefore, can be assessed according to how much price change the signal (or message) induces prior to the reestablishment of equilibrium. Note that the earlier notion of information, "information as reflected in security prices," is identical in all respects with the notion of information presented here, since all securities are (risky) capital assets.

The third step is to introduce _risk_ information as reflected in security prices. One factor which conditions the security price change is the security's relative risk (_ex ante_ market systematic risk). It is rational then to assess the impact of risk information on capital market equilibrium not only by the level of a security's relative risk, but also by the change it induces in this variable, since only information pertaining to risk-related events should be reflected. As a result, a direct relationship between risk information conveyed to the capital market and relative risk is assumed. This relationship provides several testable implications for this study. In brief, the design of this study is to determine the risk information conveyed by published quarterly earnings and the risk information conveyed by quarterly dividend announcements and to evaluate the relative effects of each kind on the expectations of capital market participants as a degree of association with a security's relative risk.

At the empirical level, the notion of an efficient capital market which impounds all public information[25]

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[25]No definitive statement can be made regarding the exact "strength" of market efficiency, except that the present level of research on efficient securities markets indicates that the "fair game," "semi-strong" form of the hypothesis is well corroborated. Semi-strong efficiency implies that all publicly available information is reflected in the capital market equilibrium prices. Fair game efficiency uses an expected return approach and implies that the information in Φ_t (Φ_t denotes whatever set of information is assumed to be fully reflected in prices at time t) is fully utilized in determining equilibrium expected returns. The assumption that the equilibrium expected returns are formed on the basis of Φ_t (i.e., fully reflect or impound Φ_t) has a major empirical implication: ". . . it rules out the possibility of trading systems based only on information in Φ_t that have expected profits or returns in excess of equilibrium expected returns or profits." Letting $R_{j,t+1}$ denote the next period realized return on security j and $\tilde{\varepsilon}_{j,t+1}$ denote the return in excess of equilibrium expected one-period return on security j,

$$\tilde{\varepsilon}_{j,t+1} = R_{j,t+1} - E(\tilde{R}_{j,t+1}/\Phi_t)$$

If $E(\tilde{\varepsilon}_{j,t+1}/\phi_t) = 0$ and for all $s>0$, $E(\tilde{\varepsilon}_{j,t+s}/\tilde{\varepsilon}_{j,t+s-1}, \ldots, \tilde{\varepsilon}_{jo}) = 0$, the sequence $\{\tilde{\varepsilon}_{j,t}\}$ is a fair game. (~)denotes a random variable, and $E(\cdot)$ is an expectation serves as a means of evaluating risk information as reflected in security prices. If publicly available risk information is quickly and unbiasedly impounded in an entity's security price, then over a period, a significant correlation should exist between an empirical analog of such risk information and an empirical analog of that entity's relative risk.[26] Further, if for estimation purposes, an entity's relative risk is considered stable over a period, then between one such period and another a significant correlation should exist between the change in an empirical analog of that entity's relative risk and the change in risk indicated by an empirical analog of the publicly available risk information flowing to the capital market in each such period. The same set of underlying events and relationships about relative risk which are

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operator. Fair game efficiency is explained in Eugene Fama and Merton H. Miller, The Theory of Finance (New York: Holt, Rinehart and Winston, 1972), p. 337. Evidence on the semi-strong form hypothesis is summarized in David Downes and Thomas R. Dyckman, "A Critical Look at the Efficient Market Empirical Research Literature as it Relates to Accounting Information," The Accounting Review (April, 1973), pp. 300-317. But the fair game, semi-strong model may be violated in special situations: for example, Jeffrey F. Jaffe, "Special Information and Insider Trading," The Journal of Business (July, 1974), pp. 410-428.

[26]Nicholas J. Gonedes, "Evidence on the Information Content of Accounting Numbers: Accounting-Based and Market-Based Estimates of Systematic Risk," Journal of Financial and Quantitative Analysis (June, 1973), p. 407.

impounded in security prices are expected to be reflected by the publicly available risk information.[27] Prior to the definition of the empirical analogs of: (1) relative risk, (2) risk information conveyed by published quarterly earnings, and (3) risk information conveyed by quarterly dividend announcements, additional justification for this risk approach is presented.

An entity's relative risk (ex ante market systematic risk) provides an independent criterion theoretically related to the observable consequences of market behavior. It is appropriate for both aggregate and individual analyses. While aggregate behavior is emphasized in this research, if security returns are generated in a manner consistent with the capital asset pricing model, then relative risk is the only security or portfolio specific variable subject to prediction. In turn, it conditions the prediction of security or portfolio return, the (presumed) objective of a market participant, and hence provides a criterion for the evaluation of information at the individual level.

Two other considerations influence its choice. First, it enables both time series and cross-sectional analyses to be utilized. Second, the criterion of relative risk

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[27]William H. Beaver, Paul Kettler, and Myron Scholes, "The Association between Market Determined and Accounting Determined Risk Measures," The Accounting Review (October, 1970), p. 679.

may be viewed as an appropriate research method for the evaluation of information from a societal viewpoint.[28] For a risk averse capital asset market, messages about relative risk may be regarded as being consistent with the notion of Pareto optimality if their effect is to reallocate economic resources such that a reduction in the "outstanding supply of risk" is achieved (ignoring the cost of producing the information).[29] The phrase "outstanding supply of risk" refers to the risk inherent in an entity's production-investment decisions which the market value of its stock reflects. Other things being equal a reduction in the "outstanding supply of risk" should imply a rise in the market value of the entity's shares.

Operational Definitions

Recall that information conveyed by published quarterly earnings numbers and quarterly dividend announcements is defined in terms of an unexpected change. Risk information conveyed is viewed as a function of the variability of such unexpected changes and may be operationally defined for the

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[28]William H. Beaver, "The Behavior of Security Prices and Its Implications for Accounting Research (Methods)," Report of the Committee on Research Methodology in Accounting, supplement to Volume 47, The Accounting Review, 1972, p. 425.

[29]Eugene F. Fama and A. B. Laffer, "Information and Capital Markets," The Journal of Business (July, 1971), p. 292; Jack Hirschleifer, "The Private and Social Value of Information and the Reward to Inventive Activity," American Economic Review (September, 1971), pp. 561-574.

purposes of empirical analysis in two ways, for each kind of information. (1) The covariance of unexpected changes in published quarterly earnings (or quarterly dividend announcements) with an economy-wide index of unexpected changes in published quarterly earnings (or quarterly dividend announcements) standardized by dividing by the variance of each respective economy-wide index. (2) The standard deviation of unexpected changes in published quarterly earnings (or quarterly dividend announcements).

Obviously, the first of the above definitions is most symmetric with the definition of relative risk and on theoretical grounds would seem the most appropriate. But another consideration suggests the relevance of the standard deviation definition. An estimate of the covariability of unexpected changes in earnings (or dividends) represents that part of an entity's unexpected earnings (or dividend) variability which cannot be diversified out over a large number of firms whose series are available. It may, however, constitute an imperfect signal, so that a market participant's policy of diversification which is based on security returns may not entirely eliminate variability in the unexpected earnings (or unexpected dividends) that is <u>not</u> systematically related to the economy-wide index. For this reason, the standard deviation of unexpected earnings changes and the standard deviation of unexpected dividend changes may be viewed as equally appropriate empirical analogs of risk information conveyed to the capital market.

The empirical analog of an entity's relative risk is called "market beta." Market beta is a parameter estimate derived from a stochastic model based on realized security returns. The model utilized (the market model) defines market beta as the covariance of a security's realized return (realized price change plus dividends paid over a stated period) with the realized return from holding the market protfolio standardized by dividing by the variance of the market portfolio return.

In summary, the purpose of the empirical methodology of this current research is to identify and explain the individual and combined effects of risk information conveyed by quarterly earnings and quarterly dividend announcements, as reflected in an entity's relative risk. The degree of association between market beta (the empirical analog of an entity's relative risk) and measures of the variability of unexpected earnings and unexpected dividends (the empirical analogs of risk information) will be determined for two non-overlapping time periods. Furthermore, the degree of association between changes in market beta and changes in measures of the variability of unexpected earnings and dividends over the two periods will also be ascertained. Degree of association will be statistically measured via correlation, prediction and dichotomous classification tests.

Scope of this Study

While allied to research on the association between an entity's relative risk and annual financial statement information, the application of the above methodology to study the effects of quarterly earnings and quarterly dividend risk information is unique. It should be noted, however, that the precise effects of risk information which may be inherent in each particular announcement of quarterly earnings or quarterly dividends is considered outside the purview of this current research. In fact, a task of this nature would undoubtedly require more efficient estimation procedures, than are presently being utilized. (What is the change in relative risk that occurs over a one week time span due to the announcement of a single bit of risk information?) Such a task may also increase the complexity of identification (What constitutes the exact moment that the capital market receives a bit of information about risk related events?).

Methodologies which utilize the opinions of (potential) users solicited (via experimental, survey or case techniques); those based solely on implications of security trading volume; and those that use simulation techniques are rejected in favor of the "capital market response" approach. Gonedes and Dopuch ascribe importance to a similar viewpoint.[30] The question of market competition and market segmentation arising from the production and consumption of quarterly earnings or quarterly dividend information is not presently studied. Such a question however should be considered in a complete analysis which would ascertain the optimal production, distribution and consumption of information that society should require for the efficient functioning of any capital asset market.

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[30]Gonedes and Dopuch, op. cit., section 9, p. 1.

CHAPTER II

GENERAL HYPOTHESES

The purpose of this chapter is to derive general hypotheses about the risk information pertinent to the "value" of an entity conveyed by published quarterly earnings and quarterly dividend announcements. Each hypothesis is directed toward the empirically testable implications that each kind of risk information may have on the resource allocation decisions of participants in the capital market. First, a strong theoretical foundation which establishes an entity's relative risk (ex ante market systematic risk) as reflecting all risk information pertinent to the "value" of an entity, is stated. Second, a link between the risk information conveyed by published quarterly earnings (or quarterly dividend announcements) and relative risk is presented. Third, a basis for examining changes in relative risk vis-à-vis changes in risk conveyed by information flowing to the capital market is discussed. Finally, a basis with which to examine the combined effects of quarterly earnings and quarterly dividend risk information is offered. The first two sections of this chapter serve to reiterate more rigorously the framework linking risk information, capital market expectations and equilibrium introduced in Chapter One.

Capital Market Expectations and the Two Parameter Capital Asset Pricing Model

The following symbols are required. Let

$\tilde{R}_j$ = one-period return on the beginning of period market value of asset j, $\overline{P}_j$. If $\tilde{V}_j$ is the end of period market value (including dividends paid during the period) of asset j, then $\tilde{R}_j = (\tilde{V}_j - \overline{P}_j)/\overline{P}_j$.

$\tilde{R}_m$ = one-period return on the market portfolio m. (The market portfolio consists of all assets in the market each entering the portfolio with weight equal to the ratio of its total market value to the total market value of all assets.)

R_f = certain one-period return (rate of interest) on the riskless asset f.

$(\tilde{\ })$ denotes a random variable

$E(\cdot)$ denotes an expectation operator.

The two parameter capital asset pricing model[1] implies the following equilibrium "balance" equation for each asset

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[1]The two parameter capital asset pricing model is attributed to Sharpe, op. cit., Lintner, op. cit., and Mossin, op. cit. For further refinements see Fama and Miller, op. cit., Chapts. 6, 7.

j in the market,

$$E(\tilde{R}_j)-R_f = [E(\tilde{R}_m)-R_f].B_j \quad (2.1)$$

where B_j = relative risk (ex ante market systematic risk) defined as Cov $(\tilde{R}_j, \tilde{R}_m)/\sigma^2(\tilde{R}_m)$, the covariance of the one-period return from asset j with the one-period return from the market portfolio divided by the variance of the one-period return from the market portfolio.

The assumptions on which (2.1) is based are stated below. (1) Perfect capital markets exist implying that information is available to all at no cost; there are no taxes, no transaction costs and all assets are divisable; market participants can borrow or lend at the same rate of interest and have the same portfolio opportunities; no buyer or seller is large enough to affect price. (2) Market participants are risk averse and maximize the expected utility of consumption over their two-period time frame. (3) The utility function, $U(C_1, \tilde{C}_2)$, is a function of consumption in a period one C_1 (which is prespecified by the market participant) and $\tilde{C}_2$, a random variable representing consumption in period two. It is strictly concave with positive first partial derivatives. (4) The portfolios of capital assets held can be assessed solely by the expected one-period return and its standard deviation. (5) The distribution of portfolio return is of the stable-symmetric class. (6) All market participants have identical estimates of expected return and of the variability of these returns.

To motivate this further, consider the pricing equation implied by Model (2.1), where $E(\tilde{R}_j) = [E(\tilde{V}_j - \overline{P}_j)/P_j]$.

$$\overline{P}_j = \frac{E(\tilde{V}_j) - \left[\frac{E(\tilde{R}_m) - R_f}{\sigma(\tilde{R}_m)}\right] \cdot \frac{Cov(\tilde{V}_j, \tilde{V}_m)}{\sigma(\tilde{V}_m)}}{1 + R_f}$$

$$= \frac{E(\tilde{V}_j)}{1+R_f} - \frac{S_m}{1+R_f} \left[\frac{Cov(\tilde{V}_j, \tilde{V}_m)}{\sigma(\tilde{V}_m)}\right] \qquad (2.2)$$

Cov $(\tilde{V}_j, \tilde{V}_m)$ is the covariance of the end of period market value of asset j with the end of period value of the market portfolio, m, $\sigma(\tilde{V}_m)$ is the standard deviation of the end of period market value of the market portfolio, m, and $S_m = [(E(\tilde{R}_m) - R_f)/\sigma(\tilde{R}_m)]$.

The equilibrium price structure is thus established by two prices: (1) $(1 + R_f)^{-1}$, the price of one unit of expected one-period market value to all market participants, and (2) $-S_m(1 + R_f)^{-1}$, the negative price of one unit of the amount of risk, $Cov(\tilde{V}_j, \tilde{V}_m)/\sigma(\tilde{V}_m)$, associated with the expected one-period market value of asset j. The two above prices are the same for all assets and for all participants in the market. Market values of individual assets differ due to the different shapes of the $\tilde{V}_j$ and related $\tilde{R}_j$ distributions assessed by market participants, aided by information which is available to them.

Since $B_j = \text{Cov}(\tilde{V}_j, \tilde{V}_m)/[\sigma(\tilde{V}_m) \cdot \overline{P}_j]$, both (2.1) and (2.2) highlight the central role of an asset's relative risk, B_j, in determining equilibrium market values and returns. As such these equations constitute the primary justification for B_j as a representation of an asset's relative risk. B_j has two properties: (1) the relative risk of the market portfolio, B_m, is equal to one, and (2) the relative risk of a portfolio, B_p, is a linear combination of the B_j's which comprise the portfolio, where the weights are a proportion of each asset's market value to the market value of the portfolio.

Another justification, which is not necessarily tied to the theory of capital asset pricing, is furnished by portfolio theory.[2] The key assumption that underlies this approach is that market participants evaluate the risk of an asset in terms of the variability of portfolio return. Denote $\sigma^2(\tilde{R}_p)$ as the variance of portfolio return, $\tilde{R}_p$, where an equal amount is invested in each security. That is,

$$\sigma^2(\tilde{R}_p) = \frac{1}{K^2} \Sigma_{j=1}^{K} \sigma^2(\tilde{R}_j) + \frac{1}{K^2} \Sigma_{j=1}^{K} \Sigma_{\substack{i=1 \\ j \neq i}}^{K} \sigma(\tilde{R}_j \tilde{R}_i) \qquad (2.3)$$

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[2]Harry Markowitz, "Portfolio Selection," The Journal of Finance (March, 1952), pp. 77-91; Harry Markowitz, Portfolio Selection: Efficient Diversification of Investments (New York: John Wiley and Sons, 1959); Marshall E. Blume, II, "On the Assessment of Risk," The Journal of Finance (March, 1971), pp. 1-10.

By increasing the number of assets (K) in the portfolio, it may be shown that,[3]

$\frac{1}{K^2} \Sigma_{j=1}^{K} \sigma^2(\tilde{R}_j) \rightarrow 0$ and that

$$\sigma^2(\tilde{R}_p) \cong \frac{K-1}{K^2(k-1)} \Sigma_{j=1}^{K} \Sigma_{\substack{i=1 \\ i \neq j}}^{K} \sigma(\tilde{R}_j, \tilde{R}_i) = \frac{K-1}{K} \overline{\sigma(\tilde{R}_j, \tilde{R}_i)} \qquad (2.4)$$

where $\overline{\sigma(\tilde{R}_j, \tilde{R}_i)}$ is the average covariance between the returns of the assets in the portfolio p. While market participants may view risk in terms of the variability of portfolio return, expression (2.4) indicates that the only nontrivial determinant of risk for a diversified portfolio is $\overline{\sigma(\tilde{R}_j, \tilde{R}_i)}$. In essence, this result expresses the same notion inherent in B_j, which is that riskiness depends on the covariance of an asset's return with the returns from the other assets in the portfolio, and that in a portfolio context, the variability of a particular asset's return is trivial (as the number of assets in the portfolio becomes large).

Available research indicates that: (1) the capital asset pricing model presented here (or a close derivative) is descriptively valid for the New York Stock Exchange

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[3]Fama and Miller, op. cit., pp. 253-255.

(NYSE)[4], (2) estimates of B_j for different classes of market participants (investment professors, portfolio managers and non-professional investors) are consistent with what they perceive the risk dimension to be,[5] and (3) as the number of securities in a diversified portfolio exceeds about ten, most of the diversification effect has taken place.[6]

Risk Information Pertinent to the "Value" of an Entity

Since within the structure of the previous section the capital market is efficient, B_j is regarded as impounding all available risk information pertinent to the "value" of an entity's securities. New information flowing to the capital market is expected to cause market participants to revise their expectations (their assessed distribution functions of returns) which ultimately will alter equilibrium prices. Thus the effect of new information may be

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[4]Fischer Black, Michael C. Jensen and Myron Scholes, "The Capital Asset Pricing Model: Some Empirical Tests," in M. C. Jensen, ed., Studies in the Theory of Capital Markets (New York: Praeger, 1972), pp. 79-121; Eugene F. Fama and James D. McBeth, "Risk, Return and Equilibrium: Some Empirical Tests," Journal of Political Economy, 81, 1973, pp. 607-636.

[5]Arthur E. Gooding, "Investors' Evaluation of Common Stocks: Perceptions and Information Processed" (unpublished doctoral dissertation, The Ohio State University, 1973).

[6]John L. Evans and Stephen H. Archer, "Diversification and the Reduction of Dispersion: An Empirical Analysis," The Journal of Finance (1968), pp. 761-768.

assessed according to how much price change it induces prior to the reestablishment of equilibrium. Consider the difference between the realized change in the value of an entity's securities in t+1, $R_{j,t+1}$ (price change plus dividends paid over a given period), and the expected return in t+1 given all available information at t (Φ_t), $E(\tilde{R}_{j,t+1}/\Phi_t)$, to represent the effect of new information.

$$\begin{aligned} \tilde{\varepsilon}_{j,t+1} &= R_{j,t+1} - E(\tilde{R}_{j,t+1}/\Phi_t) \\ &= R_{j,t+1} - E(\tilde{R}_{j,t+1}/R_{f,t+1}, E(\tilde{R}_{m,t+1}), B_{j,t+1}) \end{aligned} \qquad (2.5)$$

where $\tilde{\varepsilon}_{j,t+1}$ is a fair game random variable,[7] and the set Φ_t is impounded completely in the triple $[R_{f,t+1}, E(\tilde{R}_{m,t+1}), B_{j,t+1}]$. While $\tilde{\varepsilon}_{j,t+1}$ is conditioned by three variables that reflect all available information at end of period t, two are common to all securities. However, the third ($B_{j,t+1}$) is security-specific and, as previously stated, impounds all available risk information.

It is logical then to assess the effect of risk information conveyed to market participants from two viewpoints--available risk information and new risk information.

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[7] $\tilde{\varepsilon}_{j,t+1}$ is defined as a fair game random variable if $E(\tilde{\varepsilon}_{j,t+1}) = 0$ and for all s>0, $E(\tilde{\varepsilon}_{j,t+s}/\tilde{\varepsilon}_{j,t+s-1},\ldots,\tilde{\varepsilon}_{j,0}) = 0$: Gonedes and Dopuch, op. cit., section 8, p. 4; Supra, Chapt. 1, footnote 25.

That is from the viewpoint of: (1) the relative level of $B_{j,t+1}$, and (2) the change in $B_{j,t+1}$ that is induced by the new risk information flowing to the market (<u>not</u> already impounded in $B_{j,t+1}$). The reasoning for the first viewpoint is as follows. Since the risk information flowing to the capital market, as reflected in the level of B_j, for a high relative risk entity is expected to differ to the level of B_j for a low relative risk entity, a positive association between such information and the level of B_j may be expected to exist.

With reference to the second viewpoint, if, <u>for estimation purposes</u>, B_j, is relatively stable for short periods of time, then the risk information disseminated in one period (in an after the fact sense assume that this is available information) and the risk information disseminated in a future period (in an after the fact sense assume that this is new information) are expected to be positively associated with the B_j of the current period and the B_j of the future period respectively. Hence, the change in risk information should be positively associated with the change in B_j that may occur. The same set of risk-related events that may cause changes in B_j should also be reflected in the risk information which flows to the capital market each period.

The hypotheses to be derived are conditional on the above structure, but also are directed at two particular kinds of risk information. That is, the risk information conveyed by published quarterly earnings and quarterly dividend announcements.

Risk Information Conveyed by Published Quarterly Earnings and Quarterly Dividend Announcements

Why do quarterly earnings and quarterly dividends convey information about risk pertinent to the "value" of an entity? In Chapter One, an analysis dependent on a standard entity valuation model was presented. It was argued that two potential sources of information about changes in permanent earnings (a component of the standard entity valuation model) are: (1) the difference between the published change in a quarterly earnings number and its conditional expectation, and (2) the difference in an announced change in quarterly dividend and its conditional expectation. Accordingly, risk information was viewed as a function of the variability of the unexpected changes defined by sources (1) and (2) above. It is the aim of this subsection to introduce a model that implies a more precise link between risk information (conveyed by quarterly earnings and quarterly dividends), changes in permanent earnings, and an entity's relative risk (*ex ante* market systematic risk).

The model is attributable to Pettit and Westerfield[8] and commences with the same standard valuation model introduced in Chapter One, which defines an entity's market value, V_j^*, as

$$V_j^* = \overline{X}_j^*/r_j, \tag{2.6}$$

where $\overline{X}_j^*$ is equal to permanent earnings (previously defined) and r_j is equal to a capitalization rate (previously defined). The first result of the Pettit and Westerfield model indicates that a small change in market value, dV_j^*, reflects two factors: (1) unexpected change in parmanent earnings, $d\overline{X}_j^*$, and (2) unexpected change in a capitalization rate dr_j.[9] It is obtained by taking the total derivative of V_j^*, i.e.,

$$dV_j^* = (d\overline{X}_j^*/r_j) - (dr_j \cdot \overline{X}_j^*/r_j{}^2). \tag{2.7}$$

Their second result indicates that the <u>realized</u> change in market value for asset j, R_j, and the <u>realized</u> change in the market portfolio one-period return, R_m, may also be regarded as functions of unexpected change in permanent earnings and unexpected change in a capitalization

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[8] R. Richardson Pettit and Randolph Westerfield, "A Model of Capital Asset Risk," Journal of Financial and Quantitative Analysis (March, 1972), pp. 1649-1668.

[9] Ibid., p. 1651.

rate.[10] A valuation model for the market of the form $V_m^* = \overline{X}_m^*/r_m$ is assumed where $\overline{X}_m^*$ and r_m are the permanent earnings and the capitalization rate associated with the market portfolio of assets. Consider

$$R_j = (dV_j^* + C_j) \ / \ V_j^*, \tag{2.8}$$

where C_j represents expected price change and dividends for the next period and is equal to $\overline{X}_j^*$, given the perfect market assumption of the standard valuation model. Substituting (2.6) and (2.7) into the expression for R_j, i.e., (2.8), yields

$$R_j = (d\overline{X}_j^*/\overline{X}_j^*) - (dr_j/r_j) + r_j. \tag{2.9}$$

Equivalently, the realized return on the market portfolio may be stated as

$$R_m = (d\overline{X}_m^*/\overline{X}_m^*) - (dr_m/r_m) + r_m. \tag{2.10}$$

Finally to obtain their third result, consider the empirical analog of an entity's relative risk, called market beta. Market beta for asset j, β_j, is defined as the covariance of an asset's realized return (price change plus dividends paid over a period) with the realized return from holding the market portfolio, standardized by dividing by the variance of the market portfolio return. Substituting the

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[10]Ibid., pp. 1651-1652.

expression (2.9) for R_j and the expression (2.10) for R_m into market beta $\beta_j = Cov(R_j, R_m)/\sigma^2(R_m)$ yields an expression for β_j as a function of two factors. The first reflects the covariability of unexpected changes in permanent earnings for an asset with unexpected changes in permanent earnings for the market portfolio. The second reflects the covariability of unexpected changes in the capitalization rate for an asset with the unexpected change in the capitalization rate for the market portfolio.[11] It is this third result that precisely links market beta (empirical analog of an entity's relative risk) to the risk information impounded in security prices (theoretically defined in terms of the covariability of permanent earnings with the permanent earnings derived from the market portfolio). Since two sources of information about unexpected changes in permanent earnings are expected to be; published quarterly earnings and quarterly dividend announcements, a logical relationship between an entity's relative risk and each kind of information is thus established.

Empirical support for the second result may be inferred from the studies of Ball and Brown (annual earnings), Brown and Kennelly (quarterly earnings) and Pettit

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[11] _Ibid._, pp. 1652-1653.

(quarterly dividends).[12] Empirical support for the third result is contained in Pettit and Westerfield (annual earnings),and may be inferred from Beaver, Kettler and Scholes (annual earnings), Beaver and Manegold (annual earnings), Gonedes (annual earnings) and Lev and Kunitzky (annual earnings and annual dividends).[13]

The reasoning thus far in this chapter leads to the first set of hypotheses:

> H.1(a)--Risk information as reflected in security prices (relative risk) is uncorrelated with risk information conveyed to market participants via published quarterly earnings.
>
> H.1(b)--Risk information as reflected in security prices (relative risk) is uncorrelated with risk information conveyed to market participants via quarterly dividend announcements.

But both published quarterly earnings and quarterly dividend announcements are messages about change in an entity's permanent earnings that are posited to contain noise. Further, there is reason to suppose that the

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[12]Ray Ball and Philip Brown, "An Empirical Evaluation of Accounting Income Numbers," Journal of Accounting Research (Autumn, 1968), pp. 159-178; Philip Brown and John W. Kennelly, "The Informational Content of Quarterly Earnings: An Extension and Some Further Evidence," The Journal of Business (July, 1972), pp. 403-415; Pettit, op. cit.

[13]Pettit and Westerfield, op. cit.; Beaver, Kettler and Scholes, op. cit.; William H. Beaver and James Manegold, "The Association between Market Determined and Accounting Determined Measures of Systematic Risk," (unpublished manuscript, Graduate School of Business, Stanford University, 1973); Gonedes, op. cit., Lev and Kunitzky, op. cit.

underlying causes of noise may not be completely identical, hence raising the possibility of a differential capital market response. Table 2.1 summarizes the discussion in Chapter One concerning this issue. The second hypothesis

TABLE 2-1

DIFFERENTIAL CAPITAL MARKET RESPONSE

Factors which may Influence Response	Published Quarterly Earnings	Quarterly Dividend Announcements
1. Criteria for measurement	GAAP	Dividend policy
2. Mode of transmission to the capital market	More direct	Less direct: via "information content of dividends" hypothesis
3. Variability	Smoothing via the choice of GAAP	Smoothing via "Partial adaptation"

to be entertained is therefore:

> H.2--Risk information conveyed by published quarterly earnings and quarterly dividend announcements are not significantly different in their correlation with risk information as reflected in security prices (relative risk).

Change in Relative Risk

The second major testable implication of the structure outlined thus far concerns the ability of risk information to explain the magnitude and direction of changes in an entity's relative risk over time. Suppose that $[t_1, t_2]$ and

$[t_2, t_3]$ represent two adjacent time intervals during which information about risk is transmitted to the capital market. Suppose further that as of point in time t_2, all available risk information pertinent to period $[t_1, t_2]$ is impounded in security prices and that only new risk information is conveyed to market participants during $[t_2, t_3]$. Since new risk information is quickly and unbiasedly impounded into capital market expectations, there is reason to suggest a third hypothesis:

> H.3--The change in relative risk as indicated by published quarterly earnings and/or quarterly dividend announcements is uncorrelated with the change in relative risk as reflected in security prices.

But if this relationship is to be empirically tested, some statement about the underlying behavior of an entity's relative risk over time is required.

The most common assumption about the underlying behavior of an asset's relative risk is that over time it is constant. Such an assumption is usually implicit in research that utilizes an ordinary least squares regression to estimate parameters associated with an *ex post* version of Equation (2.5). The assumption to be made in this research is that, *for estimation purposes*, an entity's relative risk may be safely considered to be constant. This is consistent with many major works which investigate the effect of information on security price behavior. Archibald, Kaplan and Roll, and Sunder studied the effects of accounting changes;[14] Beaver, and Ball and Brown studied the impact of annual earnings announcements; Beaver, Kettler and Scholes, and Gonedes studied the association between relative risk and annual accounting information;[15] Lev and Kunitzky studied the association between relative risk and smoothing measures;[16] Fama, Fisher, Jensen and Roll[17] studied the effect of stock split announcements; and Watts and Pettit[18] studied the effect of dividend announcements. In addition, Abdel-khalik[19] studied the

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[14]T. Ross Archibald, "Stock Market Reaction to the Depreciation Switchback-Rule," The Accounting Review (January, 1972), pp. 22-30; Robert Kaplan and Richard Roll, "Investor Evaluation of Accounting Information: Some Empirical Evidence," The Journal of Business (April, 1972), pp. 225-257; Shyam Sunder, "Relationship between Accounting Changes and Stock Prices: Problems of Measurement and Some Empirical Evidence" (paper presented to the Empirical Research Conference, University of Chicago, May, 1973).

[15]William H. Beaver, "The Information Content of Annual Earnings Announcements," Empirical Research in Accounting: Selected Studies, 1968, supplement to Volume 6 of Journal of Accounting Research, pp. 67-92; Ray Ball and Philip Brown, "Portfolio Theory and Accounting," Journal of Accounting Research (Autumn, 1969), pp. 300-323; Beaver, Kettler and Scholes, op. cit.; Gonedes, op. cit.

[16]Lev and Kunitzky, op. cit.

[17]Eugene Fama, Lawrence Fisher, Michael Jensen and Richard Roll, "The Adjustment of Stock Prices to New Information," International Economic Review (February, 1969), pp. 1-21.

[18]Watts, op. cit.; Pettit, op. cit.

[19]A. Rashad Abdel-khalik, "The Stability of the Market Model Parameters" (Research paper No. 62, Graduate School of Business, Columbia University, June 1974).

stability of market beta (empirical analog of relative risk) assuming its constancy for estimation purposes within specified time intervals.

A second representation of the behavior of relative risk is that of a stationary first order autoregressive time series. Bogue[20] hypothesizes, using an investment model which assumes: (1) constant growth in assets, (2) depletion of assets over time, (3) constant serial correlation of the riskiness of new projects selected, and (4) a constant debt:equity ratio; that the relative risk of an individual entity should follow a stationary first order autoregressive process. In testing this model he found that the average relative risks for market beta ranked portfolios regressed toward the market average and the spread between the groups diminished over time. These results are consistent with stationary autoregressive behavior. Blume[21] also found evidence of a tendency for the ordinary least squares regression estimates of relative risk to regress slightly towards the market average over time. But despite such postulated behavior, both authors initially assume the constancy of relative risk <u>for</u>

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[20]Marcus C. Bogue, "The Estimation and Behavior of Systematic Risk" (unpublished doctoral dissertation, Graduate School of Business, Stanford University, 1973).

[21]Blume, <u>op. cit</u>.

estimation purposes. Bogue[22] assumes constancy over sixty months to test in aggregate the time series behavior of relative risk; Blume[23] assumes constancy over eighty-four months in order to establish his empirical adjustment procedure.

Suppose that the underlying behavior for some entities is stationary first order autoregressive with mean equal to one (the market average). In the long run such a process will always be mean reverting since the expected level of the difference between an entity's relative risk, $B_{j,t+1}$ and its mean of one is always less in absolute value than the current level of that difference. That is $|E(B_{j,t+1}-1)| < |\phi_1(B_{jt}-1)|$ for all t, where ϕ_1 is a first order autoregressive parameter and $|\phi_1|<1$. Hence, on the average, the relative risk of an entity (minus the market average) in interval $[t_2,t_3]$ can be expected to be less in absolute value to relative risk (minus the market average) in an earlier interval, $[t_1,t_2]$. In other words, the same change which may take place in the underlying level of an entity's relative risk can be assumed to be reflected in estimates of relative risk derived using ordinary least squares procedures. Bogue[24] argues that such estimates are

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22Bogue, op. cit., p. 48.

23Blume, op. cit.

24Bogue, op. cit., pp. 48-50.

a valid measure, not of the most current level of relative risk, but of the average level for the period covered by the observations.

Another reason for change in the capital market's assessment of relative risk may be change in the information system of the entity vis-à-vis its stockholders. One may contend that not only do equilibrium prices reflect signals about events pertinent to the "value" of an entity, but also such signals are conditional upon an information system. Any affects that these changes may have on relative risk, either via the accounting system, or via management decisions regarding the use of dividend policy as a means of revealing information about an entity's prospects, are ignored. Capital market efficiency is assumed to guarantee that all available information pertinent to the "value" of an entity is reflected in security prices whether its source be earnings numbers, dividends or any other medium.

Combined Risk Information

The second research question posed in Chapter One addresses not only the possible differential capital market response, but also the combined response to published quarterly earnings and quarterly dividend announcements. The purpose of this section is to derive a testable hypothesis which is cognizant of the capital market's ability to process both messages about risk contemporaneously.

To capture the basic elements of the argument, suppose that: (1) each source of information is judged by market participants to be equally, but imperfectly, reliable, and (2) market participants act as if they are able to classify the combined signal as either "unambiguous" or "ambiguous." Although the concept of ambiguity is more generally associated with the degree of confidence that an individual may assign to the probability distribution of an unknown event, for present purposes an *a priori* and operational notion is presented in the following two definitions. An unambiguous signal occurs when the risk information conveyed by published quarterly earnings and the risk information conveyed by quarterly dividend announcements coincide. An ambiguous signal is one where the risk information from each source differs. Moreover, an unambiguous signal about risk is viewed as more reliable than an ambiguous one.

Becker and Brownson[25] lend support to the link between reliability and ambiguity. They found that some experimental subjects, in violation of the Savage axioms,

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[25]S. W. Becker and F. O. Brownson, "What Price Ambiguity? Or the Role of Ambiguity in Decision Making," *Journal of Political Economy*, 72, 1964, pp. 62-73.

expressed an aversion to ambiguity, and under conditions of monetary payoff sought to avoid it. Further they found that, not only was ambiguity related to the distributions on probability, but that amounts paid to avoid ambiguity and the degree of ambiguity were related. Their results, however, pertain to individual decision-making and as such should not be directly inferred as characteristic of the behavior of capital markets. A complete analysis of the effects of unambiguous versus ambiguous information must await empirical research designed specifically for that purpose.

Hofstedt[26] deals with the notion of inconsistency as related to individual information processing of accounting messages. One of Hofstedt's research questions addresses the effect on an investor of conflicting signals, where one signal pertains to the accounting statements while the other relates to the president's letter. Although he indicates that, on the average, subjects were _more_ confident given _inconsistent_ signals, some difficulty is expressed in placing an interpretation on the result. Hofstedt[27] comments:

> Based on the subjects' reactions and comments, it was clear that the inconsistency was worrisome

[26]Thomas R. Hofstedt, "Some Behavioral Parameters of Financial Analysis," _The Accounting Review_ (October, 1972), pp. 679-692.

[27]_Ibid._, p. 690.

> for many subjects, so that the basic manipulation was successful. Curiously, subjects became more confident of their predictions as inconsistency was introduced into the report. . . . the perceived inconsistency may not translate into wholesale distrust of the report, simply because the reader <u>expects</u> to find inconsistencies in annual reports, particularly unwarranted optimism on the part of corporate officers.

The results of Hofstedt and the results of Becker and Brownson are of course not directly comparable, but they do raise the possibility that if ambiguity and inconsistency reflect similar behavioral attributes, then their conclusions may be in conflict with each other. Since the present argument maintains that the more ambiguous the combined signal is, the less reliable it is as an indication of an entity's relative risk, the following hypothesis is suggested:

> H.4--Risk information conveyed by published quarterly earnings and quarterly dividend announcements, the combined signal of which is <u>unambiguous</u>; and risk information conveyed by the above two sources, the combined signal of which is <u>ambiguous</u>; do not differ in their correlation with risk information as reflected in security prices (relative risk).

<u>Summary</u>

This chapter has presented the rationale for a number of general hypotheses which concern the capital market's response to two sources of information about risk. One is conveyed by published quarterly earnings and the other is conveyed by quarterly dividend announcements. The hypotheses constitute a response to the two research questions raised at the outset and are expected to bring to bear important explanatory evidence on (1) the association between quarterly earnings risk information and an entity's relative risk, (2) the association between quarterly dividend risk information and an entity's relative risk, (3) the effect of such information on changes in an entity's relative risk, and (4) the combined effect of earnings and dividend risk information. Chapter Three, which follows, provides the methodological design for the tests of these hypotheses.

CHAPTER III

EMPIRICAL METHODOLOGY

The purpose of this chapter is to outline the estimation procedures and the sample design. In the first section the considerations influencing the choice of the relative risk criterion are reiterated and the market model representation of the relationship between relative risk and return is specified. The second section operationally defines information conveyed by published quarterly earnings and quarterly dividend announcements. Two classes of generating processes are introduced for this purpose as *a priori* models of aggregate market expectations. The third section operationally defines risk information from each source (earnings and dividends) and highlights problems of specification in the research procedures. The final section is devoted to the population and sample inclusion criteria and provides a review of the estimation procedures applied to the sample selected.

Efficient Capital Markets and Relative Risk

The structure which links capital market behavior, expectations, permanent earnings and risk information assumes the existence of a perfect capital market. This implies that: (1) information is available to all at no cost, (2) there are no taxes or transaction costs, (3) all capital assets are perfectly divisable, (4) market participants can borrow or lend at the same rate of interest and have the same portfolio opportunities, and (5) no buyer is large enough to affect price. However, the desirable implication of a perfect capital market for this research is that it is efficient, hence capital market expectations and security prices reflect all available information. For empirical purposes there are strong grounds to assume that the fair game, semi-strong version of an efficient market is descriptively valid for major securities exchanges in the United States.[1] The fair game, semi-strong version is a maintained hypothesis and serves as an empirical means to evaluate an entity's relative risk.

The information content criterion is relative risk. In part, its justification was described in Chapter Two where two theoretical relationships beteen an entity's relative risk and risk information, conveyed by published quarterly earnings and quarterly dividend announcements, were established. The first of these maintained that available risk information, assumed to be fully reflected in an entity's security price, could be assessed by the level of an entity's relative risk. The second contended that new risk

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[1] Supra, Chapt. 1, footnote 25.

information flowing to the market could be assessed by a change in the level of an entity's relative risk over time, since it is quickly and unbiasedly impounded into security prices as it becomes available.

Estimation of Relative Risk

To estimate an entity's relative risk, a model is imposed in which the realized returns from an entity's securities are viewed as single drawings from the distribution function of an entity's one-period return. The model is referred to as the market model[2] and represents a linear relationship between a security's return, R'_j and a market factor, R'_m, of the form

$$R'_{jt} = \alpha_j + \beta_j R'_{mt} + e_{jt}, \quad t = 1, T \tag{3.1}$$

where

α_j is a parameter whose value is such that the expected value of e_{jt} is zero,

β_j is a parameter appropriate to security j, called market beta.

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[2] W. F. Sharpe, "A Simplified Model for Portfolio Analysis," Management Science, (January, 1963), pp. 277-293. The market model is, however, applied to the natural logarithm of the realized return (price relative adjusted for dividends).

The random variables, e_{jt}, are assumed to be independent and unique to each security such that: (1) Cov $(e_{jt}, R'_{mt}) = 0$, and (2) Cov $(e_{jt}, e_{it}) = 0$ for i not equal to j, and (3) Cov $(e_{jt}, e_{js}) = 0$ for t not equal to s. The second assumption is tantamount to the assumption that industry effects are ignored.

With regard to the empirical validity of (3.1), Blume[3] comments that: (1) the linearity assumption is adequate, (2) industry effects, as documented by King,[4] probably account for about 10% of variation in returns, and as a first approximation the Cov (e_{jt}, e_{it}) may be assumed to equal zero, for i not equal to j, and (3) the distribution of e_{jt} may correspond more closely to a non-normal stable Paretian distribution.[5]

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[3]Blume, op. cit., p. 2.

[4]Benjamin F. King, "Market and Industry Factors in Stock Price Behavior," The Journal of Business (Supplement, January, 1966), pp. 139-190.

[5]The implications of this point are varied: Kaplan and Roll, op. cit., employed the more general assumption of stable Paretian distributions for the purposes of market model parameter estimation. Press argued that the estimated residuals from the market model may be the result of non-stationarities in the price changes over time. Fama and Babiak, op. cit., indicated that OLS procedures are not inappropriate in the presence of stable Paretian distributions. Wise has shown that, for estimation purposes, an ordinary least squares regression may be appropriate: James S. Press, "A Compound Events Model for Security Prices," The Journal of Business (July, 1967), pp. 317-337; and John Wise, "Linear Estimation for Linear Regression Systems Having Infinite Variances" (unpublished paper presented at Berkeley-Stanford Mathematical Economics Seminar, October, 1963).

Market beta, β_j, is justified as an empirical analog of an entity's relative risk for at least two reasons. The first reason relates to the simplifying assumptions[6] which, when imposed upon the capital asset pricing model, imply that an entity's relative risk, B_j, approximates market beta, β_j. The second reason holds regardless of the stature of the capital asset pricing model. It can be shown that as the number of securities in a diversified portfolio increases, the variance of realized portfolio return will only be trivially influenced by the variance of a particular security within that portfolio. Instead, the variance of the market factor, common to all securities, will dominate as the explanatory factor.[7] A further justification is provided by Babcock.[8]

The operational definition of R'_{jt} where j refers to security j and t = 1, T is of the form

$$R'_{jt} = \ln[(\text{price}_t + \text{dividends paid}_t)/\text{price (adj for splits)}_{t-1}]$$

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[6]These assumptions are: (1) the proportionate value of asset j in the market portfolio, m, is small, (2) the variance of the one-period return from holding the market portfolio $\sigma^2(\tilde{R}_{mt})$ is equal to the variance of the market factor, $\sigma^2(R'_{mt})$, (3) $\sigma^2(\tilde{R}_{mt})$ is of the same order of magnitude as the variance of the individual disturbance terms, and (4) relative risk, B_j and the risk free rate, R_f, are constant over time.

[7]Blume, op. cit., p. 3.

[8]Guilford C. Babcock, "A Note of Justifying Beta as a Measure of Risk," The Journal of Finance (June, 1972), pp. 699-702.

R'_{jt} is regarded as the capital market's one-period rate of return, or rate of price change (incorporating dividends), assuming continuous compounding. R'_{mt} is operationally defined with respect to Fisher's monthly market index with reinvestment of dividends, M_t, for t = 1, T.[9] That is

$$R'_{mt} = \ln [M_t / M_{t-1}]$$

R'_{mt} is viewed as a valid proxy for the realized one-period rate of return from holding the market portfolio of risky assets defined within the capital asset pricing model as m. Estimates of α_j, β_j and e_{jt} may be obtained under ordinary least squares (OLS) times series regression procedures for t = 1, T. Model (3.1) thus assumes that the α_j and the β_j coefficients are constants over the period for which the model is specified. If an entity's relative risk, which for estimation purposes is defined by β_j, varies over time, OLS techniques may not be appropriate. The estimates may safely be regarded as reasonable estimates of average relative risk for the period from which the observations are taken, but as current estimates or predictors the OLS estimates will be biased.[10] A discussion of the time base to which the market model (3.1) may be applied follows.

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[9] Lawrence Fisher, "Some New Stock Market Indices," The Journal of Business (Supplement, January, 1966), pp. 191-225.

[10] Bogue, *op. cit.*, pp. 45-47.

A seven year time base for estimation of market beta consisting of 84 monthly observations on R'_{jt} and R'_{mt} is expected to provide the best balance in terms of the inherent trade-off between (1) the possibility of introducing data generated by different structural conditions, and (2) the size of the standard error of the estimates. Applying this trade-off approach to the market model, Gonedes[11] found that with monthly observations a seven year time series regression provided the greatest predictive efficiency. His time bases were not, however, identical to those to be specified for this research. Predictive efficiency was measured by Gonedes in terms of mean square error and mean absolute error. Abdel-khalik,[12] using a Chow test of parameter stability, indicated that the stability of market beta could not be rejected for 81% of his sample for different partitionings of a seven year period (July, 1962 - August, 1969) assuming monthly observations. Hence, the choice of the 84 observation time base appears well founded. In short, the market model provides a procedure which empirically defines market beta as an empirical analog of an entity's relative risk, B_j (<u>ex ante</u> systematic risk).

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[11]Gonedes, <u>op. cit</u>.

[12]Abdel-khalik, <u>op. cit</u>.

Unexpected Changes in Quarterly Earnings and Quarterly Dividends

For an entity's securities, capital market expectations about events pertaining to risk are assumed to be reflected in relative risk, B_j. New information about relative risk may be expected to induce changes in B_j. But the capital asset pricing model makes no explicit statements about the nature of the revisionary responses of the capital market in aggregate, or, more specifically, makes no statements about the nature of changes in the probability distributions of one-period returns, given new information. The purpose of this section is to introduce *a priori* models of aggregate investor expectations about information to be disseminated in the capital market, so as to capture the response by participants to published quarterly earnings and quarterly dividend announcements that they did *not* expect.

The approach is to model expectations about publicly forthcoming information in terms of *ex post* generating processes. It presupposes that: (1) market participants respond to the magnitude and the direction of changes in earnings numbers or dividend announcements that they did not anticipate, and (2) that when the magnitude and the direction of changes are fully anticipated, there is no response by market participants. The usual interpretation of the latter presupposition is that "confirmation effects" of new information are ignored. Note that neither presupposition (1) nor (2) contradict the notion of an unambiguous or an ambiguous message defined in Chapter Two, since ambiguity in this case refers to the consistency between two kinds of new information conveyed to the market on or about the same point in time.

To reiterate, information, the source of which is either a published quarterly earnings number, or a quarterly dividend announcement, is defined as the difference between the published change or the announced change and its respective expectation conditional on past changes. Such differences are viewed as proxies of the change in permanent earnings pertaining to an entity at a particular point in time. If $Z_{jt} - Z_{j,t-1}$ is the actual change in some number and $E(Z_{jt} / Z_{j,t-1}, Z_{j,t-2}, \ldots) - Z_{j,t-1}$ is its expectation conditional on past changes, then the information conveyed to participants in the capital market is defined as

$$a_{jt} = [Z_{jt} - Z_{j,t-1}] - [E(Z_{jt}/Z_{jt-1}, Z_{j,t-2}, \ldots) - Z_{j,t-1}]$$
$$= Z_{jt} - E(Z_{jt}/Z_{j,t-1}, Z_{j,t-2}, \ldots) \qquad (3.2)$$

The next step is to consider the interpretation and specification of $E(Z_{jt}/Z_{j,t-1}, Z_{j,t-2}, \ldots)$ or, in shortened form, simply $E(Z_{jt} / \cdot)$ for published quarterly earnings and quarterly dividend announcements. The generating processes described attribute unique mathematical representations to each number series, that is for earnings and dividends.

They are not presumed to correspond isomorphically with the way the market as a whole formulates expectations about forthcoming information. Nevertheless, if the generating processes selected are: (1) unique for each entity and unique for each number series, (2) not arbitrarily imposed, and (3) not ascribed to entities whose environmental variables (e.g., input prices, product demand, interest rates, management responses to environment) are unpredictably unstable, then they may be safely expected to capture important elements of the formation of expectations on the part of the capital market.

A brief review of relevant literature suggests that a number of alternative generating processes have been applied. For abnormal performance index (API) analysis, Ball and Brown, and Brown and Kennelly defined $E(Z_{jt}/.)$ for earnings as a function of the change in an economy-wide index;[13] and Beaver and Dukes defined $E(Z_{jt}/.)$ for earnings as a function of change in an economy-wide index similar to Ball and Brown, etc., and as a deterministic function of past earnings--several forms were used.[14] For

[13]Ball and Brown, op. cit., Brown and Kennelly, op. cit.

[14]William H. Beaver and Roland E. Dukes, "Interperiod Tax Allocation, Earnings Expectations and the Behavior of Security Prices," The Accounting Review (April, 1972), pp. 320-332; William H. Beaver and Roland E. Dukes, "Interperiod Tax Allocation and δ-Depreciation Methods: Some Empirical Results," The Accounting Review (July, 1973), pp. 549-559.

analyses of the association between market beta and annual earnings numbers, Ball and Brown, Beaver, Kettler and Scholes and Gonedes defined $E(Z_{jt}/.)$ as equal to earnings of the previous period;[15] and Beaver and Manegold defined $E(Z_{jt}/.)$ as equal to earnings of the previous period and as the expected value of an first order autoregressive earnings process (Durbin's procedure)[16]. For the analysis of dividends, Pettit defined $E(Z_{jt}/.)$ as equal to the dividend of the previous period; while Lev and Kunitzky defined $E(Z_{jt}/.)$ in terms of an average change over past period's dividends.[17]

Two classes of generating processes are utilized in this research. The first class is called a "no forecast" model. In specifying this model, a further subscript is introduced. The second subscript, in the symbol $E\ (Z_{jkt}/.)$, $k = 1$, refers to the "no forecast" model defined for earnings and dividends below.

$E\ (Z_{j1t}/.) = Z_{j,t-1}$ for both published quarterly earnings and quarterly dividend announcements

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[15]Ray Ball and Philip Brown, "Porftolio Theory and Accounting," Journal of Accounting Research (Augumn, 1969), pp. 3oo-323; Beaver, Kettler and Scholes, op. cit.; Gonedes, op. cit.

[16]Beaver and Manegold, op. cit.

[17]Pettit, op. cit.,; Lev and Kunitzky, op. cit.

The second class of models constitutes the broad class of autoregressive integrated moving average (ARIMA) processes, the general model form of which is specified in Equation (4.2) in Chapter Four. Since its definition is elaborate, it will not be introduced into the text at this stage. Instead it is denoted by

$E(Z_{j2t}/.)$ for <u>both</u> published quarterly earnings numbers and quarterly dividend announcements.

The second subscript in $E(Z_{j2t}/.)$, that is $k = 2$, refers to the broad class of ARIMA models.

To indicate whether the series refers to earnings (E) or dividends (D), superscripts E and D will be incorporated into the more general symbols used thus far. Published quarterly earnings defined specifically as "quarterly earnings available for common" is denoted as Z_{jt}^{E}, and quarterly dividends defined as quarterly cash dividends per share (regular plus extra) adjusted for stock splits and stock dividends is denoted as Z_{jt}^{D}. Dividend per share rather than total dividend is used because it is viewed as the appropriate decision variable of management when considering an increase or decrease in the dividend payout.[18] The change

[18] Lintner, "Distributions of Incomes of Corporations," <u>op. cit.</u>, pp. 99-103.

in quarterly earnings available for common is viewed as an appropriate GAAP counterpart of a change in an entity's permanent earnings.

Generating process one (i.e., k = 1) is introduced primarily to act as a naive (perhaps lower bound) comparison to generating process two (i.e., k = 2). Although not explicitly identified as such, it has been incorporated into most studies dealing with the relationship between market beta and accounting-determined risk measures based on annual earnings including those mentioned above. The earnings specification and the dividend specification of generating process one are expected to be influenced significantly by seasonality. However, the effects of seasonality may be less in the case of dividends than in the case of earnings.

One overriding factor dictated the choice of generating process two. The procedures by which the ARIMA process is defined ensure that, for each series, for each firm, a unique and potentially optimal model is selected from a broad class of alternatives. Further, each model, if properly selected, will reflect both the seasonality and the nonstationarity that may be present and will produce residuals, a_{jt}, that are deseasonalized and stationary. As noted by Beaver and Manegold the issue of seasonality is not a trivial one:

> Analysis of the data indicates that substantial additional specification problems are encountered when moving [from annual] to quarterly data (e.g., seasonality, among others), and that an extensive amount of additional effort will be required to make any sense out of quarterly data.[19]

By means of tests of model adequacy (refer to Chapter Four for details), the a_{jt} variable is designed to be normally distributed with mean zero and independent over time. In other words it may be considered as a statistically unbiased indicator of the unexpected change in either published quarterly earnings or quarterly dividend announcements. However, in a descriptive sense this may not necessarily be so. Part of the a_{jt} variable, no matter what its statistical properties, may not be associated with events pertinent to the "value" of an entity (for example; change in the measurement rules for either earnings or dividends without a concomitant change in the underlying circumstances). Moreover, the a_{jt} are posited to contain noise as messages about an entity's permanent earnings. Nevertheless, if the events which contribute to the noise or the effects of misspecification (if any) occur randomly both in a cross-sectional and temporal sense, then the a_{jt} may be expected to be an unbiased indicator of information about events pertinent to the "value" of an entity flowing to the capital market.

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[19]Beaver and Manegold, op. cit., p. 44 (the parenthetical remark [.] is added for clarification).

If the a_{jt}'s derived via the ARIMA procedure (generating process two) are internally consistent relative to generating process one, then there is reason to believe that this should also be brought out in improved descriptive validity. Such a contention will be examined as part of the empirical results.

Using the subscript k to denote a particular generating process, the a_{jt} of (3.2) for earnings and dividends may be denoted

a^E_{jkt} = unexpected change in quarterly earnings available for common for firm j, using generating process k, at time t,

and

a^D_{jkt} = unexpected change in quarterly dividend per share for firm j, using generating process k, at time t.

To adjust for firm size, growth, leverage and capital changes, a^E_{jkt} may be deflated by the book value of common equity as of the end of period t-1, $k_{j,t-1}$. The deflated variable is denoted

$$x_{jkt} = a_{jkt} / k_{j,t-1} \qquad (3.3)$$

The book value of common equity, k_{jt}, is observable when t coincides with the fiscal year end and may be interpolated in other cases by allocating the annual change in common equity to each quarter of a fiscal year on the basis of the number of shares outstanding as of the end of each quarter.

Alternative deflators such as total assets, or sales are rejected on the basis that they do not adjust for differences in leverage between firms. A market value of common stock deflator is also rejected since it may introduce spurious correlations into the later tests.[20] For dividends per share, to adjust for firm size and differences in the payout ratio between entities, a^D_{jkt} may be deflated by the dividend per share paid during t-1. The deflated variable is denoted

$$d_{jkt} = a^D_{jkt} \;/\; Z^D_{j,t-1} \tag{3.4}$$

The variables x_{jkt} and d_{jkt} thus constitute the deflated unexpected changes in earnings and dividends respectively and are the basis for the definitions of risk information presented in the next section.

Risk Information Content of Unexpected Quarterly Earnings and Quarterly Dividend Changes

As stated in Chapter One, risk information conveyed by either published quarterly earnings or quarterly dividend announcements is operationally defined in terms of the variability of unexpected changes. Two magnitudes are defined below.

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[20]A debate over this point can be traced in the following studies: Beaver, Kettler and Scholes, *op. cit.*; Gonedes, *op. cit.*, Beaver and Manegold, *op. cit.*, and Nicholas J. Gonedes, "A Note on Accounting-Based and Market-Based Estimates of Systematic Risk (unpublished paper, University of Chicago, September, 1973).

Risk Information Conveyed by Published Quarterly Earnings

1. $\omega^E_{jk} = \text{Cov}\ (x_{jkt}, x_{mkt})\ /\ \sigma^2(x_{mkt})$

$$= \Sigma^T_{t=1}(x_{jkt}-\overline{x}_{jk})\cdot(x_{mkt}-\overline{x}_{mk})/\Sigma^T_{t=1}(x_{mkt}-\overline{x}_{mk})^2 \qquad (3.5)$$

where $x_{mkt} = \Sigma^N_{j=1} x_{jkt}\ /\ N$, (N equals the sample size), $\overline{x}_{jk} = \Sigma^T_{t=1} x_{jkt}\ /\ T$, (T equals the number of observations), and $\overline{x}_{mk} = \Sigma^T_{t=1}\ x_{mkt}\ /\ T$. x_{mkt} is regarded as an economy-wide index of unexpected earnings for period t given generating process k.

In constructing the economy-wide indexes, x_{mkt} and d_{mkt}, it is not immediately obvious how they might be defined for entities whose quarter-end dates do not coincide with the "natural" quarter-end dates of December 31, March 31, June 30, and September 30. Rather than create separate indexes for such entities, the following steps may be taken: (1) For firms with quarter-ends of 1/31, 4/30, 7/31, and 10/31, shift the quarter-end dates back to 12/31, 3/31, 6/30, and 9/30 respectively. (2) For firms with quarter-end dates of 2/28, 5/31, 8/31, and 11/30, shift the quarter-end dates forward to 3/31, 6/30, 9/30 and 12/31. In other words, a maximum of one month may be used to interpolate all quarter-end dates to the "natural" dates of December 31, March 31, June 30 and September 30.

Alternatively, ω^E_{jk} may be viewed as the slope parameter in the linear regression equation (the usual OLS assumptions would be invoked)

$$x_{jkt} = \gamma^E_{jk} + \omega^E_{jk} \cdot x_{mkt} + u_{jkt}, \; t = 1,T \quad (3.6)$$

2. $$\sigma_{jk}(E) = \sqrt{\Sigma^T_{t=1} (x_{jkt} - \bar{x}_{jk})^2 / T} \quad (3.7)$$

where $\bar{x}_{jk}$ is defined in (3.5) above.

Risk Information Conveyed by Quarterly Dividend Announcements

1. $$\omega^D_{jk} = \text{Cov}\ (d_{jkt}, d_{mkt}) / \sigma^2(d_{mkt}) \quad (3.8)$$

where Cov (.,.) is equivalent to the definition given in (3.5) except that d_{jkt} replaces x_{jkt}, and d_{mkt} replaces x_{mkt}. Analogously, d_{mkt} is regarded as an economy-wide index of unexpected dividend changes for period t given generating process k. Further, ω^D_{jk} may be viewed as the slope parameter in the linear regression equation (the usual OLS assumptions would be invoked).

$$d_{jkt} = \gamma^D_{jk} + \omega^D_{jk} \cdot d_{mkt} + v_{jkt}, \; t = 1, T. \quad (3.9)$$

2. $$\sigma_{jk}(D) = \sqrt{\Sigma^T_{t=1} (d_{jkt} - \bar{d}_{jk})^2 / T} \quad (3.10)$$

Definitions (3.5) and (3.8) are justified not only on the basis of their symmetry with the definition of market beta, but also as surrogates of one component of the Pettit and Westerfield model of capital asset risk outlined in Chapter Two. Definitions (3.7) and (3.10) are motivated by another consideration. Suppose that $\hat{\omega}^E_{jk}$ and $\hat{\omega}^D_{jk}$ are imperfect and possibly downward biased estimates of an entity's relative risk exhibiting greater standard error than estimated market beta, $\hat{\beta}_j$ (^denotes an estimate). In this case a market participant's policy of diversification based on either of these signals may do no better than a policy based on market beta. This implies that, in an ex post sense, diversification that attempts to minimize the variability of security return may not entirely eliminate variability in the unexpected earnings (or dividend changes) that is not systematically related to the economy-wide index of unexpected earnings (or dividend changes). Moreover, by virtue of its construction, an economy-wide index of unexpected earnings (or dividend changes) may contain relatively more measurement error than the market factor defined for security returns. It may therefore contribute more to the potential downward bias of $\hat{\omega}^E_{jk}$ and $\hat{\omega}^D_{jk}$ than may the error inherent in the market factor as it effects the estimation of β_j. For this reason the standard deviation definitions are viewed as equally appropriate operational definitions of risk information conveyed by earnings and dividends.

In the preceding paragraph, measurement error associated with market beta was alluded to. Another probable implication of error in these estimates is that correlations between $\hat{\beta}_j$, $\hat{\omega}^E_{jk}$ and $\hat{\omega}^D_{jk}$ are downward biased.[21] In addition the bias does not disappear as the sample size increases. Several approaches may be used to deal with this problem. One approach is to recognize for estimation purposes, different assumptions about the behavior of an entity's relative risk over time. Its aim is to produce estimates of β_j, ω^E_{jk} and ω^D_{jk} with either less bias or smaller variance. Beaver and Manegold[22] applied an adjustment procedure that incorporates cross-sectional information as a prior estimate of the mean of an entity's relative risk. They comment, however, that even having applied such a procedure there still appeared to remain more error in the accounting determined estimates of relative risk compared to the error inherent in market beta. However, part of the difference may be due to the lower efficiency that results from using annual observations for accounting-determined estimates, rather than monthly observations.

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[21]In general, consider two variables a_1 and a_2 that are subject to error h_1 and h_2 respectively. Let

$$a_1 = a_1^* + h_1 \quad \text{and}$$
$$a_2 = a_2^* + h_2 \quad \text{where}$$

a_1^* and a_2^* are the underlying theoretical variables, with $Cov(h_2, a_1^*)$, $Cov(h_1, a_2^*)$ and $Cov(h_1, h_2)$ equal to zero. In this case it may be shown that

$$Corr(a_1, a_2) = Corr(a_1^*, a_2^*) . Corr(a_1, a_1)^{1/2} . Corr(a_2, a_2)^{1/2} .$$

Refer for example to Quinn McNemar, Psychological Statistics (4th ed., rev.; New York: John Wiley and Sons, Inc., 1969), p. 171.

[22]Beaver and Manegold, *op. cit.*

To contend with measurement error, the technique of this study is to group individual risk estimates to form portfolio estimates. This technique is used in Black, Jensen and Scholes, Fama and McBeth and Beaver and Manegold.[23] The aim is to construct portfolios on the basis of a ranking of the underlying relative risk so that the group variance of relative risk between the portfolios is maximized relative to the group variance within the portfolios. The ranking must, however, utilize a measured variable which is: (1) uncorrelated with the measurement error associated with the individual risk estimates and (2) correlated with underlying relative risk. The ensuing section specifies the study period, the sample selection, the data sources and the estimation procedures applied.

Study Period, Sample Selection, Data Sources and Estimation Procedures

Study Period

The choice of a study period, which extended from 1958 through 1971, was largely influenced by two considerations. First, the period under review should provide a wide variety of behavior in the market index and should be relatively recent so as to be applicable to present and future market behavior. Second, it should be of sufficient

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[23] Black, Jensen and Scholes, op. cit.; Fama and McBeth, op. cit., and Beaver and Manegold, op. cit.

length to enable an entity's relative risk and the risk information conveyed by published quarterly earnings numbers and quarterly dividend announcements to be estimated over two non-overlapping subperiods. The subperiods should be such that if change in relative risk has occurred, it should be reflected in the risk estimates derived with respect to these subperiods.

Sample Selection

The sample was drawn from large corporations listed on NYSE whose data were available for the period under study, 1958-1971. The large corporation emphasis was meant to provide some degree of certainty that management and stockholders were reasonably distinct groups, therefore ensuring that management's desire to convey information about permanent earnings, not only via published quarterly earnings, but also via the hypothesized medium of quarterly dividend announcements, was strengthened. A large corporation was defined in terms of its net sales revenue: whether this was above $50 million during the first quarter of 1964 (an arbitrarily selected date).

Ninety-four entities were randomly selected from such large corporations each of which had to meet the following sample inclusion criteria.

1. Quarterly cash dividends per share must have been positive and available for 56 consecutive quarters with no payments missed.

2. Quarterly earnings available for common stockholders must have been available for 56 consecutive quarters.

3. Each corporation must have been listed on NYSE during the period 1958-1971.

4. During the period 1958-1963, each corporation must not have had preference stock outstanding on which divident payments were required. The fourth criterion was instituted to preserve consistency between the published quarterly earnings numbers defined as earnings available for common and extracted mainly from the COMPUSTAT Industrial (40 quarter) tape, and the quarterly earnings numbers, extracted from The Wall Street Journal Index,[24] during the period 1958-1963.

A list of the 94 companies in the random sample and a list of the industrial groupings represented in the sample appear in Appendix A. On examination it is evident that a cross-section of the United States corporate economy is reflected. The large and successful firm orientation of the sample also ensures that a substantial portion of U.S. industrial output is represented. Hence, the sample is not only expected to depict the relationships between information and capital market behavior for large and successful

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[24] The Wall Street Journal Index (New York: Dow Jones and Co., Inc.).

NYSE firms, which are important in themselves, but seemingly, the sample may also provide insight into the relationship between information and capital market behavior of other NYSE firms particularly those that are generally able to be characterized by distinct management and stockholders groups.

Data Sources

1. R'_{jt} may be obtained from the Center for Research in Security Prices (CRSP) master file tape, developed at the University of Chicago and made available through Standard and Poor's Corporation. The tape contains monthly price and dividend data for all NYSE firms from January, 1926 to June, 1972. The market factor, M_t, may be obtained from the University of Chicago, updated to December, 1971.

2. Published quarterly earnings available for common, Z_{jt}^E, may be obtained from (a) The Wall Street Journal Index, 1958-1963, and from (b) the COMPUSTAT Quarterly Industrial tape (40 quarters), Item #10.

3. Common Equity as of fiscal year end, $k_{j,\tau-1}$, may be obtained from the COMPUSTAT Quarterly Tape (20 years), Item #11.

4. Common shares outstanding as of the end of each quarter may be obtained from Moody's Handbook of Common Stocks[25] (which may be an average for the quarter) and from

[25] Handbook of Common Stocks (New York: Moody's Investor Services, Inc.).

(b) the COMPUSTAT Quarterly Industrial Tape (40 quarters), Item #15.

5. Quarterly cash dividends per share may be obtained from (a) Standard and Poor's Annual Dividend Record,[26] 1958-1963, and from (b) the COMPUSTAT Quarterly Industrial tape (40 quarters), Item #16 and Item #17 (adjustment factor). The adjustment factor for the period not covered by the COMPUSTAT quarterly tape may be derived using the factor taken from the Annual tape together with the common shares outstanding data referred above.

Validation checks of the above data sources against analogous fiscal year data extracted from the annual tape revealed the following: (1) missing items in the COMPUSTAT Quarterly Industrial (40 quarter) tape which had to be obtained by other means (e.g., current issues of The Wall Street Journal Index), (2) small differences between the quarterly earnings per The Wall Street Journal Index and the COMPUSTAT Quarterly Industrial (40 quarter) tape, and (3) a small number of cases for which only a per share earnings number was announced in The Wall Street Journal Index. In this last situation it was necessary to multiply per share earnings (as published) times the number of common shares outstanding (which may be an average). Overall, the impact of these errors did not appear to be material

[26]Annual Dividend Record (New York: Standard and Poor's Corporation).

and thus it seems unlikely that the results would have been significantly affected in any way.

Estimation Procedures

1. The unexpected change in published quarterly earnings, a_{jkt}^{E}, and the unexpected change in quarterly dividends, a_{jkt}^{D}, were estimated for each of the 94 entities, for each of the generating processes, and for each of the 56 quarters within the study period, 1958-1971. Generating process one, when applied, necessitated a loss of one observation due to differencing. Generating process two necessitated a loss of observations in two respects: one due to differencing required to attain a stationary series, and the other due to the number of parameters requiring estimation in the specified model. A complete analysis of generating process two is contained in Chapter Four. Overall, 28 estimates of a_{jkt}^{E} and a_{jkt}^{D} were always available for the second subperiod, and 27 or less were available for the first subperiod. Having determined estimates $\hat{a}_{jkt}^{E}$ and $\hat{a}_{jkt}^{D}$, the deflated estimates of unexpected changes were then derived, that is $\hat{x}_{jkt}$ and $\hat{d}_{jkt}$. The market indexes $\hat{x}_{mkt}$ and $\hat{d}_{mkt}$ were computed as an equally weighted average of the $\hat{x}_{jkt}$ and $\hat{d}_{jkt}$ respectively.

2. The next step was to estimate market beta, β_j, for each of the two subperiods which covered 84 monthly observations on R'_{jt} and R'_{mt}. For each entity j, market beta was

estimated for

(a) Subperiod one (1958-1964)

(b) Subperiod two (1965-1971)

In addition, two market betas were estimated for 19 portfolios and denoted similarly but with p replacing j. Eighteen portfolio betas consisted of the mean market beta for groups of five entities and one consisted of the mean market beta for a group of four. This last group was made up of those entities ranked as having the highest betas. The basis for the ranking was the market beta pertaining to <u>subperiod one</u>. The portfolio size was set arbitrarily at five.

3. The third step was to compute the risk information conveyed by published quarterly earnings and quarterly dividend announcements for each firm, for each generating process, for each type of definition, for each of the two subperiods. In all, a total of 16 risk estimates were computed for each firm.

(a) Subperiod one (1958-1964)

... $\hat{\omega}^E_{jk}$, $\hat{\omega}^D_{jk}$, $\hat{\sigma}_{jk}(E)$, $\hat{\sigma}_{jk}(D)$ for $k = 1, 2$.

(b) Subperiod two (1965-1971)

... $\hat{\omega}^E_{jk}$, $\hat{\omega}^D_{jk}$, $\hat{\sigma}_{jk}(E)\hat{\sigma}_{jk}(D)$ for $k = 1, 2$.

Also, 16 risk estimates were computed for each of the 19 portfolios referred to above using the same ranking based on subperiod one market beta.

The succeeding chapter provides a complete analysis of the ARIMA procedure applied to the series for quarterly earnings available for common and to quarterly dividends per share. A reader who wishes to pursue the main results of the study may proceed directly to Chapter Five.

CHAPTER IV

ANALYSIS OF UNEXPECTED CHANGES IN QUARTERLY EARNINGS AND QUARTERLY DIVIDENDS

To generate unexpected changes in quarterly earnings and quarterly dividends, two generating processes were specified in the preceding chapter by: (1) a no forecast model, and (2) an autoregressive integrated moving average (ARIMA) model. Each generating process was viewed as a general model of expectations behavior in the capital market and provided the basis for establishing the unexpected change variables for published quarterly earnings (E) and quarterly dividends (D). These were denoted as

$$a_{jkt}^{E} \text{ and } a_{jkt}^{D} \quad \text{for } j = 1, n; \; k = 1, 2; \text{ and } t = 1, T.$$

From this point the j and k subscripts and the E or D superscripts are omitted for simplicity.

The purpose of this chapter is to report the results of the ARIMA model applied to the published quarterly earnings series and the quarterly dividend series for each sample company. The first section specifies the general class of ARIMA models and outlines the model building procedure. An example is presented in the second section to illustrate the application of the model building procedure. The third section details the identified processes, the parameter estimates and the results of diagnostic tests for each application. A summary discussion is presented in the final section. The application of the ARIMA model is emphasized, relative to other generating processes, not only because it provides a more logical approach to the analysis of time series, but also because it has received little attention from accountants as an approach to the analysis of financial processes.

The Autoregressive Integrated Moving Average (ARIMA) Time Series Model

The ARIMA model building procedure developed by Box and Jenkins,[1] is a powerful tool for describing stationary, non-stationary, seasonal and non-seasonal processes. Although many industrial and economic processes may be stationary (a stationary process remains in equilibrium about a constant mean), others will exhibit behavior which is non-stationary, and hence may be represented as having no fixed or constant mean. Box and Jenkins comments on non-stationary series:

> Even so, they exhibit homogeniety in the sense that, apart from local level, or perhaps local level and trend, one part of the series behaves much like any other part. Models which describe

[1]G. E. P. Box and Gwilym M. Jenkins, Time Series Analysis: Forecasting and Control (San Francisco: Holden Day, Inc., 1970), chapts. 1-9.

> such homogeneous non-stationary behavior can be obtained by supposing some suitable difference of the process to be stationary.[2]

For example, consider a daily series of stock prices as a process that is homogeneous apart from local level. Since one part of the series is like any other, except for its level, taking the first difference of the series (the current observation less the immediately preceding observation) may be expected to produce stationarity. As a further example, consider a monthly series of energy consumption which reflects a strong seasonal factor. It also may exhibit homogeniety in the sense that, apart from the seasonal swings, one part of the series is much like another. In this case, stationarity can be produced by differencing every twelfth observation.

A more complex kind of non-stationary process may combine non-stationarity due to local level, trend and seasonality. It may not only be necessary to take first or second differences of consecutive observations to remove non-stationarity due to local level or trend, but also to difference periodic observations of the series to remove seasonal effects. Published quarterly earnings processes and quarterly dividend processes appear to exhibit non-stationarities of this more complex kind.

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[2] Ibid., p. 85.

The ARIMA Model

For a discrete time series, the general form of the model may be described as

$$(1 - \phi_1 B - \cdots - \phi_p B^p)(1-\phi_1' B - \cdots - \phi_{p'}' B^{p'})(1-B^s)^{d_1}(1-B)^d \dot{Z}_t = \theta_o + (1-\theta_1 B - \cdots - \theta_q B^q)(1-\theta_1' B - \cdots - \theta_{q'}' B^{q'}) a_t \quad (4.1)$$

where $\dot{Z} = Z_t$ if d or $d_1 > 0$, and $\dot{Z}_t = Z_t - \mu$ if $d = d_1 = 0$. μ represents the series mean, the a_t are assumed to be normally and independently distributed with constant variance, $a_t \sim N(0, \sigma_a^2)$ and B is a backward shift operator such that $B^k \dot{Z}_t = \dot{Z}_{t-k}$ and $B^k a_t = a_{t-k}$. $\dot{Z}_t$ denotes the time series to be modeled, which for the current study is either a quarterly earnings series or a quarterly dividend series. The parameters can arise from six different sources, from left to right in the Equation (4.1).

(1) $\phi_1, \ldots, \phi_p$ - regular autoregressive parameters

(2) $\phi_1', \ldots, \phi_{p'}'$ - seasonal autoregressive parameters

(3) μ - mean of the series

(4) θ_o - deterministic trend constant

(5) $\theta_1, \ldots, \theta_q$ - regular moving average parameters

(g) $\theta_1', \ldots, \theta_{q'}'$ - seasonal moving average parameters

The other symbols in Equation (4.1) are:

(1) d = number of regular differences, i.e., (1-B) factors,

(2) d_1 = number of seasonal differences, i.e., $(1-B^s)$ factors,

(3) s = order of seasonal difference.

A unique model for $\dot{z}_t$ from Equation (4.1) can be specified by selecting: (1) the suitable differencing d, d_1 and s, (2) the parameters from any of the six sources above, and (3) the "order" of any parameter selected, that is the power of the backward shift operator B associated with each selected parameter. For the parameters μ and θ_0, the order is zero. The next subsection describes the model building procedure (the Box and Jenkins methodology) used to determine a unique model from those represented in Equation (4.1) for each quarterly earnings and quarterly dividend process.

Identification, Estimation and Diagnostic Checking

The Box and Jenkins methodology is an iterative approach to modeling time series processes and consists of three stages: (1) Identification, (2) Estimation and (3) Diagnostic Checking. Chart 4-1 summarizes the approach.

Identification

Identification is composed of two steps. The first step is to identify the suitable differencing required to produce stationarity in the original series. It is accomplished by an inspection of the estimated autocorrelation function (ACF) for the original series, and the differenced series based on selected combinations of d, d_1 and s.

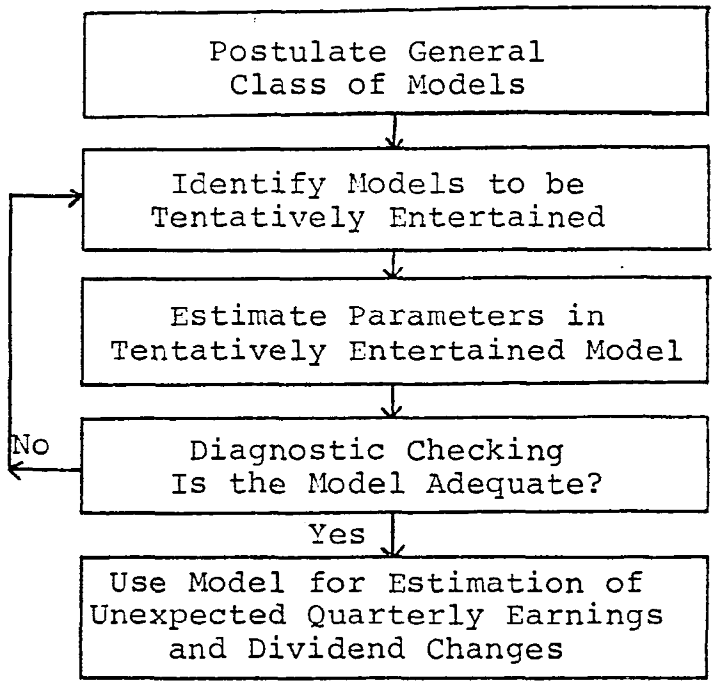

Chart 4-1. Stages in the Iterative Approach to Process Identification, Estimation and Diagnostic Checking.

Source: G. E. P. Box and Gwilym M. Jenkins, <u>Time Series Analysis: Forecasting and Control</u> (San Francisco: Holden Day, Inc., 1970), p. 19.

Box and Jenkins define the estimated autocorrelation function (ACF) for series Z_t at lag k as[3]

$$\hat{\rho}_k = \frac{\Sigma_{t=1}^{T-k} (Z_t-\overline{Z})(Z_{t+k}-\overline{Z})}{\Sigma_{t=1}^{T} (Z_t-\overline{Z})^2} \tag{4.2}$$

where $\overline{Z}$ is the mean of series Z_t and T equals the total number of observations. The theoretical autocorrelation function (ACF) at lag k for a stationary process is[4]

$$\rho_k = \frac{E[(Z_t-\mu)(Z_{t+k}-\mu)]}{\sqrt{E[(Z_t-\mu)^2]E[(Z_{t+k}-\mu)^2]}}$$

$$= \mathrm{cov}(Z_t, Z_{t+k})/\mathrm{var}(Z) \tag{4.3}$$

In most situations, d and d_1 take on values less than or equal to two and inspection of the original series suggests the seasonality, s, if any. The final choice of d, d_1 and s is based on the proposition that for a stationary process the theoretical ACF will always show a tendency to decay for moderate and large lags. Accordingly, a failure of the estimated ACF for the original series to decay is evidence of non-stationarity. Thus stationarity may be attained by choosing a particular combination of d, d_1 and s, so that the resulting differenced series exhibits this decay tendency.

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[3] *Ibid.*, p. 32.

[4] *Ibid.*, p. 28.

Having chosen d, d_1 and s so as to attain stationarity, the second step in the Identification stage is to specify the number and order of the autoregressive and moving average parameters. This is accomplished by examining the appearance of the estimated ACF and the estimated partial autocorrelation function (PACF).[5] Since each stationary ARIMA process has both unique ACF and PACF, the estimated ACF and PACF form the basis from which to infer a tentative model specification. Consequently, the primary question in specifying the number and order of the autoregressive and moving average parameters is: Which underlying stationary process most clearly adheres to the estimated ACF and PACF? In practice this is not altogether a straightforward task, since the choice procedure may be obscured by sampling variation and potential measurement

[5]The partial autocorrelation function (PACF) is obtained from the set of difference equations associated with the ACF for a specified autoregressive process. The difference equations, in matrix form, may be expressed as

$$\begin{bmatrix} 1 & \rho_1 & \rho_2 & \cdots & \rho_{k-1} \\ \rho_1 & 1 & \rho_1 & \cdots & \rho_{k-2} \\ \vdots & \vdots & \vdots & & \vdots \\ \rho_{k-1} & \rho_{k-2} & \rho_{k-3} & \cdots & 1 \end{bmatrix} \begin{bmatrix} \phi_{k1} \\ \phi_{k2} \\ \vdots \\ \phi_{kk} \end{bmatrix} = \begin{bmatrix} \rho_1 \\ \rho_2 \\ \vdots \\ \rho_k \end{bmatrix}$$

The quantity ϕ_{kk}, the last coefficient in an autoregressive process of order k, is the value of the PACF at lag k. The estimated PACF may be derived from the above by substituting $\hat{\rho}$ for ρ. Refer to Box and Jenkins, op. cit., pp. 64, 65.

error in the estimated functions. Because of this it is usual to identify a small subset of stationary processes and examine their adequacy via the subsequent Estimation and Diagnostic Checking stages of the model building procedure.

One further property of each stationary ARIMA model is that there exists a system of equations which enables the parameters of the model to be stated as functions of the ACF. Such relationships are the basis on which initial parameter estimates can be made. For example, consider a first order autoregressive process, stationary without differencing. The process is identified by $d = 0$, $d_1 = 0$, $s = 0$, one autoregressive parameter of order 1, and a mean μ. Hence, it may be denoted in the form

$$(1-\phi_1 B)(Z_t-\mu) = a_t \quad , \tag{4.4}$$

where $|\phi_1|<1$, or alternatively,

$$Z_t-\mu = \phi_1(Z_{t-1}-\mu) + a_t \ . \tag{4.5}$$

While its theoretical ACF, $\rho_k(Z_t-\mu) = \phi_1^{\ k}$, decays exponentially over k, its theoretical PACF, $\phi_{kk}(Z_t-\mu)$, is zero for all k except $\phi_{11}(Z_t-\mu) = \phi_1$. Moreover, $\phi_1 = \rho_1$ due to the relationship between the model parameters and the ACF. Thus, an initial estimate of ϕ_1 is the estimated autocorrelation coefficient for a lag of one, that is $\hat{\phi}_1 = \hat{\rho}_1(Z_t-\mu)$.

Estimation

The Estimation stage of the methodology commences by adopting preliminary estimates of the parameters to initialize a recursive, non-linear least squares algorithm. The algorithm minimizes $\Sigma_t a_t{}^2$, where $a_t = \dot{Z}_t - E(\dot{Z}_t)$, conditional on the model parameters ϕ, ϕ', μ, θ_0, θ, and θ'. For example, to estimate the parameters ϕ_1 and μ in Equation (4.5), the algorithm minimizes the sum of squares function, $\Sigma_t a_t{}^2$, of the form

$$\underset{(\mu,\phi_1)}{\text{Min}} \ \Sigma_t a_t^2 = \Sigma_t [(Z_t - \hat{\mu}) - \hat{\phi}_1 (Z_{t-1} - \hat{\mu})]^2 . \qquad (4.6)$$

Diagnostic Checking

Diagnostic Checking follows the Estimation stage and comprises a system of tests applied to the estimated residuals, $\hat{a}_t$. The objective is to determine model adequacy in terms of agreement with the assumption that they constitute independently distributed normal deviates with mean of zero and constant variance. If the tests indicate that the model is inadequate, the methodology must be iterated further. Iterations may be expected to continue until an adequate model is found on the basis of the diagnostic checks.

Three diagnostic checks are applied in this current research to the estimated residuals, $\hat{a}_t$, to ascertain model adequacy. The first, tests the autocorrelation coefficients of the estimated residuals, $\hat{\rho}_k(\hat{a}_t)$, for apparent departure from zero. In theory, because the a_t are independently and normally distributed with mean of zero and variance σ_a^2, the estimated autocorrelations, $\hat{\rho}_k(\hat{a}_t)$, are uncorrelated and distributed approximately normally about zero with variance $\frac{1}{T^*}$. T* is equal to the number of observations in the series, adjusted for differencing. Box and Jenkins,[6] however, argue that $(1/T^*)^{1/2}$, as the standard error, approximates an upper bound only. Hence $(1/T^*)^{1/2}$ may seriously underestimate the significance of apparent departures from the theoretical mean of zero, particularly for low k.

The second diagnostic, called a portmanteau lack of fit test, examines the estimated ACF as a whole for departure from zero. It can be shown[7] that if the fitted model is adequate, then

$$Q = T^*\Sigma_{k=1}^{K} \hat{\rho}_k^2(\hat{a}_t) \tag{4.7}$$

is approximately distributed as a chi-square distribution with K - (M+p+q+p'+q') degrees of freedom, where

K = number of autocorrelation coefficients estimated,

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[6] Box and Jenkins, op. cit., p. 290.

[7] G. E. P. Box and D. A. Pierce, "Distribution of Residual Autocorrelations in Autoregressive Integrated Moving Average Time Series Models," Journal of the American Statistical Association (December, 1970), pp. 1509-1526.

p,p', q and q' = number of ϕ, ϕ', θ, θ' parameters respectively,

M = 2 if μ and θ_o are included in the model,

= 1 if μ or θ_o is included in the model, and

= 0 if μ and θ_o are excluded.

The statistic Q tests whether the ACF of the estimated residuals could have resulted from a set of independently and normally distributed deviates with mean of zero and variance of σ_a^2. Large values of Q suggest model inadequacy since they lead to the rejection of the hypothesis that a set of independent and normally distributed residuals has been obtained.

The third diagnostic examines whether the standardized mean of the residuals (the mean of $\hat{a}_t$ divided by the standard error of the mean of $\hat{a}_t$) is significantly different from zero. Given the assumptions about the residuals, the standardized mean is distributed normally with mean of zero and variance of one.

In brief, these three tests constitute the system for Diagnostic Checking utilized in this research. Clearly they are not comprehensive, but no system can ever fully consider all the discrepancies that may arise. They do not, for example, test for model inadequacy that may arise when the form of the model remains the same, but the parameters change over a prolonged period. Such a test cannot be performed in this research since it requires significantly longer series than are presently available. It is believed, nevertheless, that the above checks enable a unique process to be identified for each company's quarterly series of "earnings for common" and "dividends per share" and that the estimated residuals, $\hat{a}_t$, associated with the identified earnings and dividend processes are valid analogs of the unexpected changes to which the capital market is presumed to respond.

A review of recent accounting literature revealed only one application of the ARIMA class of models to processes associated with published earnings and/or dividends series. Dopuch and Watts[8] attempted to assess the significance of a switch from straight line to accelerated depreciation accounting methods on the basis of the time series properties of annual earnings. The accounting change was viewed as significant if it significantly changed the parameters of the model of a firm's annual earnings process. Their rationale for the criterion was to presume that the time series process adequately modeled the structure of investor expectations about annual earnings numbers, and to infer that if the parameter values were significantly different before and after the accounting change, the change was significant for investors. According to their results,

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[8]Nicholas Dopuch and Ross Watts. "Using Time-Series Models to Assess the Significance of Accounting Changes," Journal of Accounting Research (Spring, 1972), pp. 180-194.

eight companies out of 11 were significantly affected by the change in depreciation methods. However, their application of the Box and Jenkins methodology raises one important question: Were diagnostic checks applied to the residuals to ensure that the identified models were adequate both before the depreciation change and after the depreciation change? Since their reported results do not mention such checks, potential model inadequacies cannot be assessed. In any procedure of this type, tests of model adequacy should be of primary concern. Not only does this current research emphasize the results of such Diagnostic Checking, but also seeks further evidence of the propriety of such methodology by external and independent empirical comparisons (see Chapter Five).

To illustrate the application of the Box and Jenkins methodology, the next section focuses on one representative series.

Example Application of Box and Jenkins Methodology

The series selected from the available earnings and dividend series was quarterly earnings available for common for Goodyear Tire and Rubber Company. It covered the period, first quarter 1958 through fourth quarter 1971 (56 observations), and as shown by a plot of the series in Figure 4-1, appears to exhibit both a trend component and a seasonality component. Further, there is some evidence

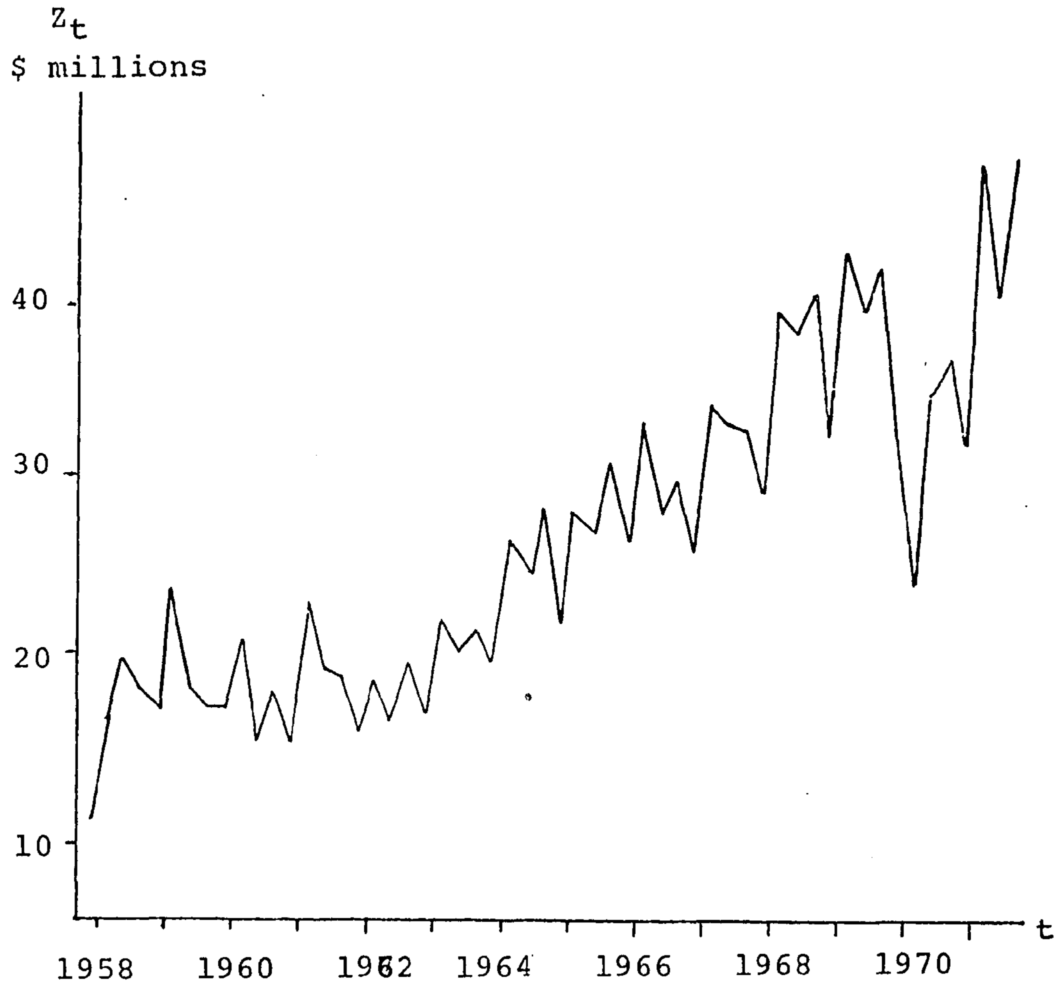

Figure 4-1. Plot of Quarterly Earnings for Common, Goodyear Tire and Rubber Co.

that the seasonal effect increases with the mean level of the series which may imply that some type of transformation on the original data is appropriate prior to differencing. One common transformation is to logarithmically transform the original series. In this particular series (and in all the series analyzed in this research) no prior transformation was made for two reasons. First, the logarithmic transformation is arbitrary and deterministic and may lead to substantial problems of over or under-transformation particularly if the trend or seasonal patterns are influenced in a non-deterministic manner. Second, identifying the "best" transformation on the original data may be costly and time consuming. Evidence on the first point is documented by Wilson[9] in his critique of Chatfield and Prothero.[10] In fact, Chatfield and Prothero, in their response to Wilson's critique, conclude that "our approach would always be to analyze the untransformed observations,

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[9]G. Tunnicliffe Wilson, "Discussion of Box-Jenkins Seasonal Forecasting: Problems in a Case-Study," Journal of the Royal Statistical Association, 136, Part 3 (1973), pp. 315-319.

[10]C. Chatfield and D. L. Prothero, "Box-Jenkins Seasonal Forecasting: Problems in a Case-Study," Journal of the Royal Statistical Association, 136, Part 3 (1973), pp. 295-315.

except in possibly exceptional circumstances which need to be determined."[11]

Within the Identification stage, the first step was to suitably difference the series. Six combinations of d, d_1 and s were entertained and the estimated ACF's examined for decay over lags one through twelve. Plots of the ACF's for each combination of d, d_1 and s (000, 100, 200, 014, 114, and 214) are presented in Figure 4-2. Upon examination of Figure 4-2 it is clear that $\hat{\rho}_k$ for combinations 000, 100, and 200 indicated in Panels A, B and C, show little sign of decay over twelve lags. But as shown in Panels D, E and F, $\hat{\rho}_k$ for the 014, 114 and 214 combinations are much more inclined to decay. The 114 combination (Panel E) was finally chosen for further analysis, since apart from the spikes at lags one and four, the ACF appears to have died substantially as early as lag six. Relative to the 114 combination (Panel E), the 214 combination (Panel F) is similar, but has larger spikes and thus was rejected. Further, the 114 combination was preferred to the 014, although the choice is less clear-cut. The posture taken towards the 014 combination was that the 014 combination would be considered in the event that the

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[11]C. Chatfield and D. L. Prothero, "Reply to Comments by G. E. P. Box and G. M. Jenkins on Box-Jenkins Seasonal Forecasting," Journal of the Royal Statistical Association, 136, Part 3 (1973), p. 347.

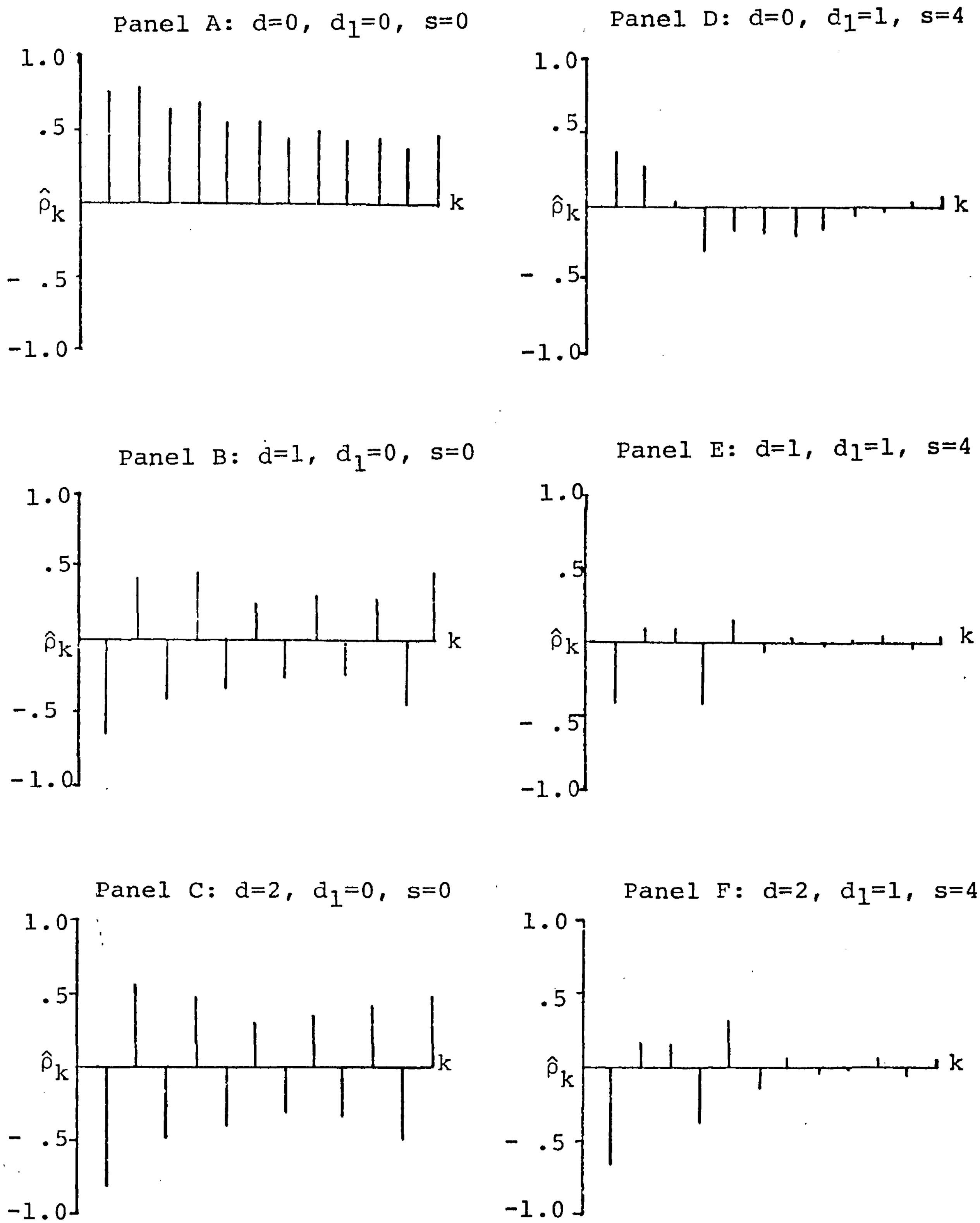

Figure 4-2. Plots of Estimated Autocorrelation Functions for Six Combinations of Differencing for Goodyear Tire and Rubber Co., Quarterly Earnings Available for Common

selected ARIMA model based on the 114 combination proved inadequate (or appeared overspecified).

The second step was to tentatively identify a model from the stationary class of ARIMA models given the 114 combination of differencing (Panel E). The theoretical properties of ACF and PACF indicated that one regular moving parameter, θ_1, and one seasonal moving-average parameter, θ'_4, were most likely appropriate. To see why this might be so, consider first the theoretical ACF and PACF for a typical first order moving average process plotted in Figure 4-3. (With reference to Equation (4.1), the process is identified by $d = 0$, $d_1 = 0$, $s = 0$ and one moving average parameter of order one.) The plots indicate the process to be characterized by a single spike ρ_k at lag $k = 1$ and ϕ_{kk} with the general appearance of a negatively decaying exponential. The same holds for a seasonal moving average process except that the single ACF spike would appear at the lag appropriate to the seasonality and PACF would decay at every seasonal lag rather than every consecutive lag.

Consider next the estimated ACF (Figure 4-2, Panel E) but this time in relation to the estimated PACF for the 114 combination which is plotted in Figure 4-4. Spikes are evident at lags $k = 1$ and $k = 4$ for the ACF, each significant with 95% confidence. Moreover, there is some evidence of decaying exponential behavior of the PACF at spikes one

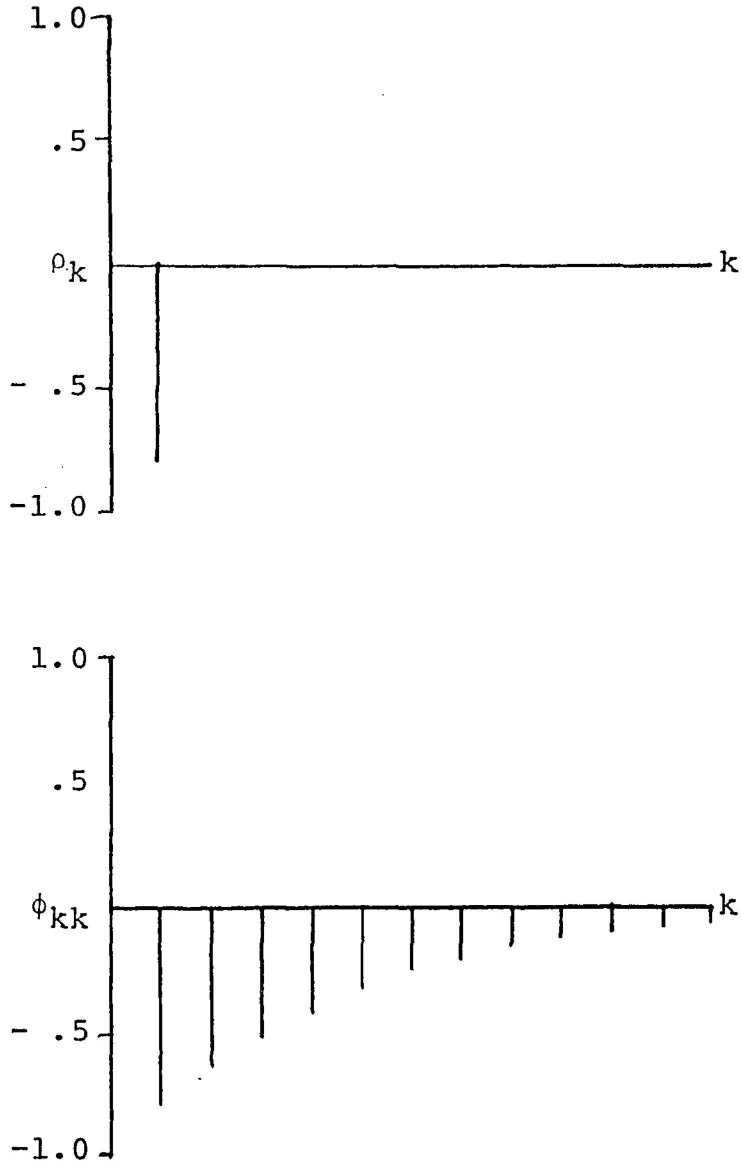

Figure 4-3. Plots of Typical Autocorrelation Function, ρ_k, and Partial Autocorrelation Function, ϕ_{kk}, for First Order Moving Average Process with Parameter $\theta_1, 0<\theta_1<1$.

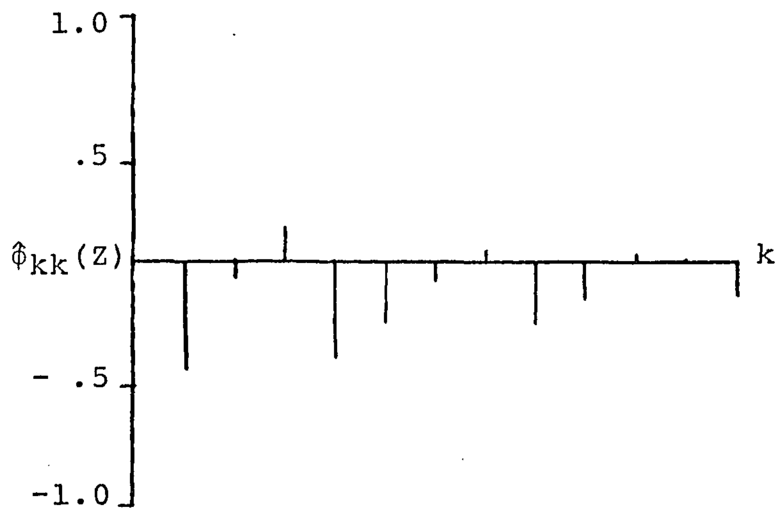

Figure 4-4. Plot of Estimated Partial Autocorrelation Function for the 114 Combination of Differencing for Goodyear Tire and Rubber Co., Quarterly Earnings Available for Common.

and two for the regular moving average and at spikes 4, 8 and 12 for the seasonal moving average process. It was these characteristics of the estimated ACF and PACF that were the principal justification for choosing a model with one regular moving average parameter, θ_1, and one seasonal moving average parameter, θ_4'. The model tentatively identified for the Goodyear Tire and Rubber quarterly "earnings available for common" process was therefore

$$(1-B)^1(1-B^4)^1 Z_t = (1-\theta_1 B)(1-\theta_4') a_t \qquad (4.8)$$

Using a program developed by Pack, et al,[12] estimates of $\theta_1 = .463$ and $\theta_4' = .763$ were obtained resulting in

$$(1-B)^1(1-B^4)^1 Z_t = (1-.463B)(1-.763B^4) a_t \qquad (4.9)$$

The mean of the $\hat{a}_t$ was -.364, with a standard error of .587. The portmanteau lack of fit statistic, Q, was 3.914.

To assist in the diagnostic checking, plots were made of the $\hat{a}_t$ and the estimated ACF and PACF for the $\hat{a}_t$. These are shown in Figures 4-5 and 4-6 respectively. Figure 4-5 indicates that the $\hat{a}_t$ are generally scattered about zero and are less than one tenth the order of magnitude of the original series (the standard error of the mean of the

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[12] D. J. Pack, M. L. Goodman and R. B. Miller, "Computer Programs for the Analysis of Univariate Time Series Using the Methods of Box and Jenkins," (Technical Report No. 296, The University of Wisconsin, April, 1972).

Graph Interval is .4615E+00

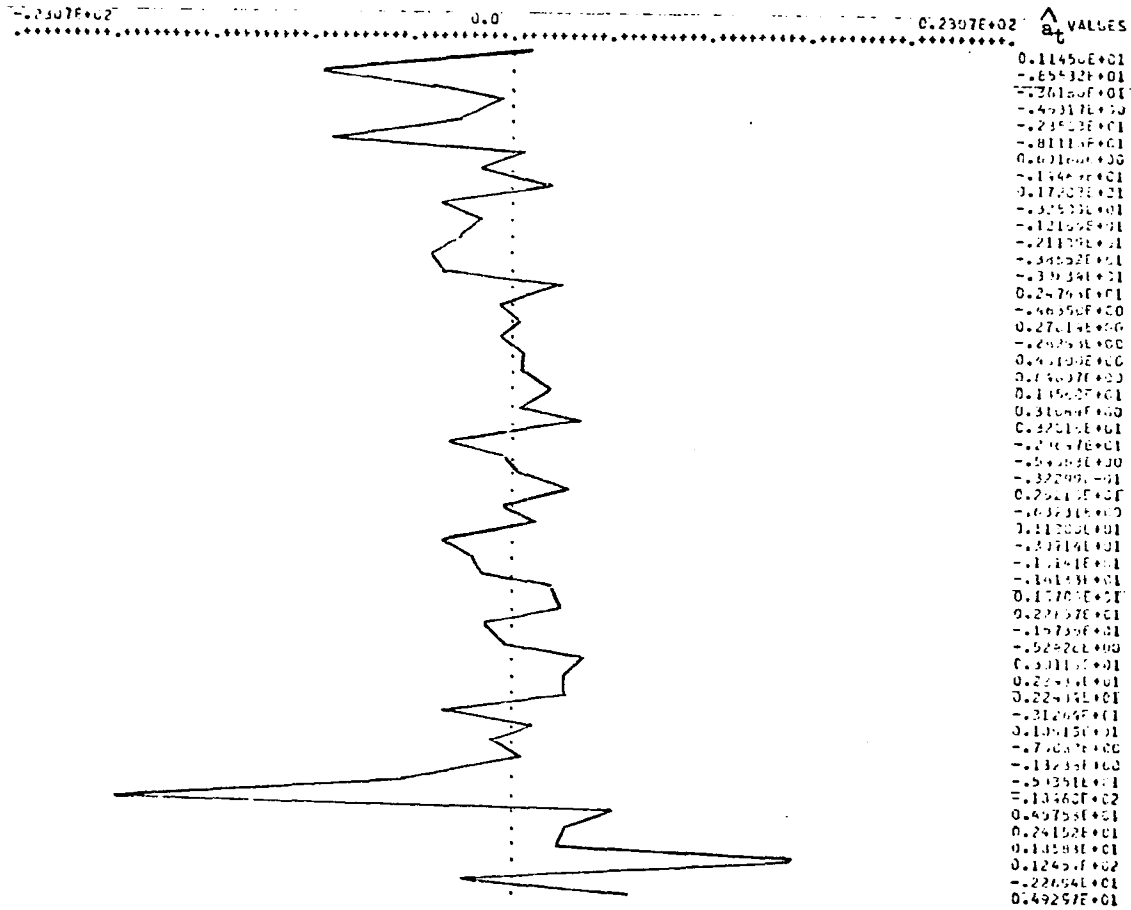

Figure 4-5. Plot of Residuals for Identified Quarterly Earnings Available for Common Process for Goodyear Tire and Rubber Co.

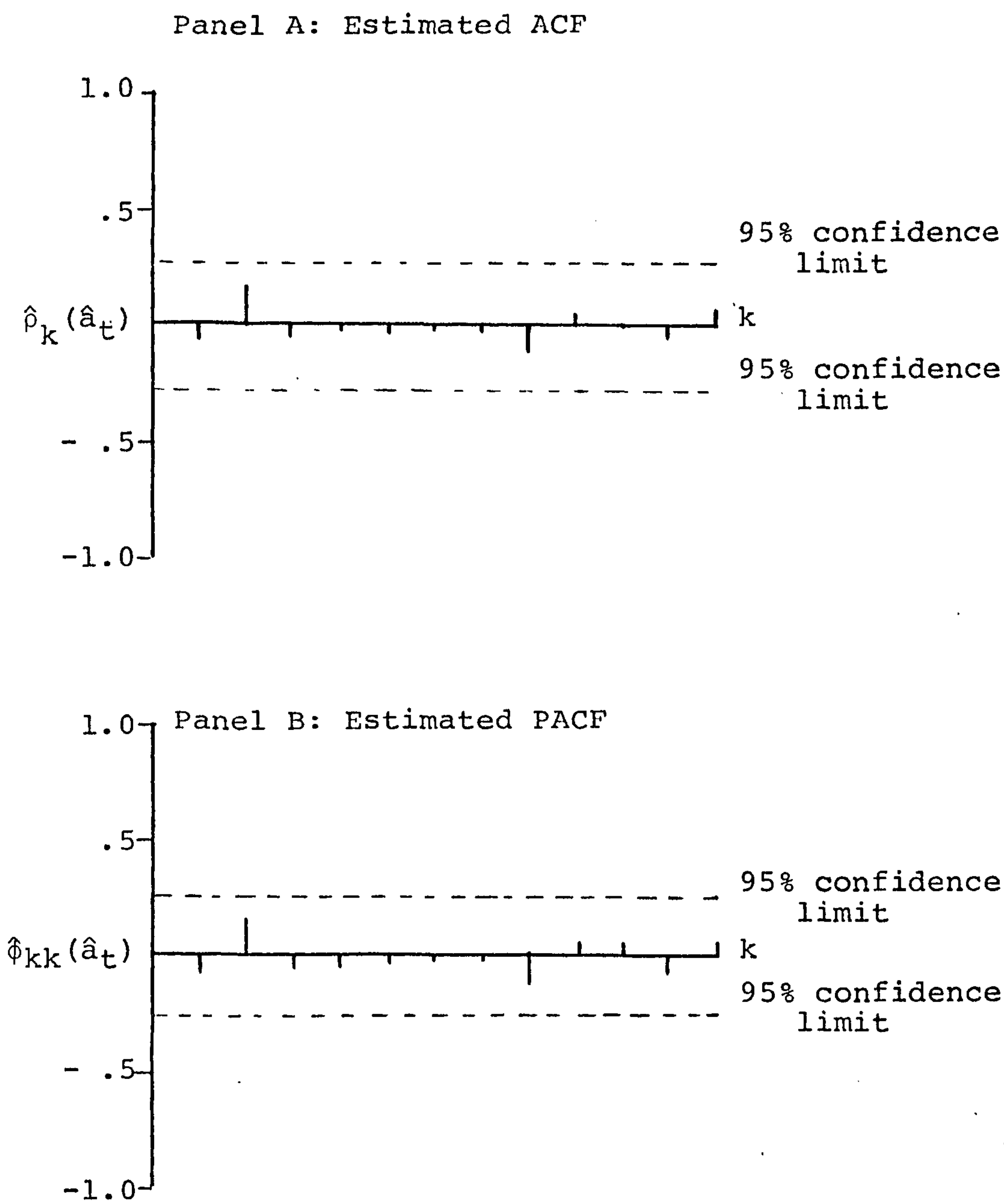

Figure 4-6. Plots of Estimated Autocorrelation Function and Partial Autocorrelation Function for Residuals of Identified Quarterly Earnings Available for Common Process for Goodyear Tire and Rubber Co.

original series is 13.819 while that for the residuals is .587). The hashed lines in Figure 4-6 indicate that the estimated residual ACF and PACF are well within the bounds of a 95% confidence interval at all lags k. Thus, according to the first diagnostic check, the model appears adequate. With regard to the portmanteau test, the critical χ^2 value with ten degrees of freedom at significance level $\alpha = .05$ is 18.307. Since $Q = 3.4914 < 18.307$, the hypothesis that Q resulted from $\hat{a}_t$ that are independently and normally distributed with mean of zero and variance of σ_a^2, could not be rejected. Thus, on the basis of this test, the model also appeared adequate. Finally, the hypothesis that the standardized mean of the distribution of $\hat{a}_t$ was distributed normally with mean of zero and variance of one could not be rejected. The sample statistic for the standardized mean of -.621 was clearly within the standard 95% confidence interval of (-1.96, 1.96).

Since each of the diagnostic checks suggested model adequacy, Equation (4.9) was accepted as a valid representation of the process generating quarterly earnings for common for the period 1956-1971 for Goodyear Tire and Rubber Company. By implication the model produced a series of deseasonalized, estimates of the unexpected change in published quarterly earnings numbers, a_t.

Thus far, the application of the Box and Jenkins methodology to earnings available for common for Goodyear

Tire and Rubber Company, 1958-1971, has identified and diagnosed the parameter estimates of only one model, i.e., model (4.8). It should be noted, however, that the methodology suggests an iterative approach. Two alternatives, model A and model B, were rejected as part of the iterative approach prior to the selection of model (4.8). They were of the form

$$(1-B)Z_t = (1-\theta_1 B-\theta_4 B^4)a_t \qquad \text{(Model A)}$$

$$(1-B)(1-B^4)Z_t = (1-\theta_1 B-\theta_4 B^4)a_t \qquad \text{(Model B)}$$

The statistics shown in Table 4.1 summarize and compare the results of diagnostic tests for each model. The value of Q, the estimate of the residual variance, and the standardized mean of the residuals, are all minimized with model 4.8 indicating that, on the basis of these criteria, it provides the best fit. However, the question arises as to whether differences in the statistics shown may be regarded as statistically significant. Box and Jenkins do not discuss the problem of comparing two different models with the same number of parameters, but it would seem that on the basis of Q, A may be rejected, since Q is greater than α = .05 critical value set for χ^2 with degrees of freedom equal to 10. Model B may be rejected [relative to model (4.8)] because it contains first order correlation coefficient, $\hat{\rho}_1$ $(\hat{a}_t)$, which borders on being significant at the 95% confidence level.

TABLE 4-1

COMPARISON OF MODEL 4.8 WITH MODELS A AND B FOR EARNINGS AVAILABLE FOR COMMON, GOODYEAR TIRE AND RUBBER CO.

Model	$\hat{\rho}_1(\hat{a}_t)$	Standard Error of $\hat{\rho}_1(\hat{a}_t)$	Value of Q[a] (dof)	Estimate of Residual Variance $\hat{\sigma}^2(\hat{a}_t)$	Standardized Means of Residuals[b]
4.8	-.08	±.13	3.491 (10)	19.454	-.621
A	-.21	±.13	34.365 (10)	25.551	1.594
B	-.26	±.13	8.223 (10)	21.619	-1.106

[a]Critical value of Q with 10 degrees of freedom, α = .05, equals 18.307.

[b]95% confidence interval [-1.96, 1.96].

The next section presents the results from the application of the Box and Jenkins methodology to the quarterly earnings and quarterly dividends series for 94 sample companies.

Results of Time Series Analysis

For each sample company, the initial data comprised 56 observations of quarterly earnings for common and 56 observations of quarterly dividends per share for the period, 1958-1971. Thus 94 processes for earnings and 94 processes for dividends were identified. No more than six iterations of the Box and Jenkins procedure were required in any particular case to identify an adequate model of each process. Tables 4-2 and 4-3 summarize these identified models by:

TABLE 4-2

PROCESSES IDENTIFIED FOR QUARTERLY EARNINGS AVAILABLE FOR COMMON FOR PERIOD 1958-1971

Company Compustat Number (1)	d (2)	d_1	S	Number of Parameters ϕ (3)	ϕ'	μ	θ_0	θ	θ'	Order[b] of Parameters (4)	Non-linear Least Squares Parameter Estimates[a] (5)	Effective Number of Observations for Estimation (6)
27465	1	1	4					3		46(10)	θ_4= .327 θ_6=-.179 θ_{10}= .508	51
29663	1	1	4					2		48	θ_4= .623 θ_8= .304	51
460056	1	0	0	2					1	235	ϕ_2=-.394 ϕ_3=-.308 θ'_5 = .459	55
209219	1	0	0		1			2		412	ϕ'_4= .987 θ_1= .614 θ_2 = .190	55
369856	0	0	0	1	1	1			1	1404	ϕ_1= .683 ϕ'_4= .998 μ =-.000 ϕ'_4= .675	56
99599	1	0	0	1	1			1		143	ϕ_1=-.437 ϕ'_4= .875 θ_1 = .244	55
751277	0	0	0	1	1	1		1		1407	ϕ_1= .827 ϕ'_4= .418 μ =10.38 θ_7=-.183	56
254723	0	1	4	1				1		11	ϕ_1=1.013 θ_1= .870	52
532202	1	0	0	1	1			1		141	ϕ_1= .231 ϕ'_4= .536 θ_1 = .896	55
718167	1	1	4	1				1		69	ϕ_6=-.276 θ_9= .336	51
761753	0	1	4	2			1			120	ϕ_1= .259 ϕ_2= .151 θ_0 =1.481	52
121691	1	0	0	1				1		11	ϕ_1=-.309 θ_1=-.195	55
860163	0	1	4	1				1	1	164	ϕ_1= .877 θ_6= .383 θ'_4 = .878	52
494368	1	0	0		1			1	1	446	ϕ'_4= .849 θ_4= .262 θ'_6 = .218	55
793453	1	0	0	1				2		417	ϕ_4= .371 θ_1= .471 θ_7 = .249	55
809877	1	1	4					1		3	θ_3= .233	51
19087	1	0	0		1				1	44	ϕ'_4= .906 θ'_4= .876	55
25321	1	1	4	1					1	16	ϕ_1=-.379 θ'_6= .363	51
150843	1	0	0				1	1		01	θ_0= .206 θ_1= .291	55
260543	1	1	4	1					1	19	ϕ_1= .630 θ'_9=-.270	51
263534	0	1	4	1					1	15	ϕ_1= .588 θ'_5= .269	52
611662	0	1	4	1				2		135	ϕ_1= .571 θ_3=-.273 θ_5 = .199	52
680665	1	1	4	1				1		18	ϕ_1=-.102 θ_8=-.253	51
905581	1	0	0					2	1	194	θ_1= .467 θ_9= .222 θ'_4 =-.222	55
775371	0	1	4	1				1	1	134	ϕ_1= .893 θ_3=-.497 θ'_4 = .405	52

TABLE 4-2 (Contd.)

Company Compustat Number (1)	d	d_1 (2)	S	ϕ	ϕ'	μ (3)	θ_0	θ	θ'	Order[b] of Parameters (4)	Non-linear Least Squares Parameter Estimates[a] (5)	Effective Number of Observations for Estimation (6)
2824	1	0	0		1				1	44	$\phi'_4 = .906$ $\theta'_4 = .447$	55
589331	1	1	4					1	1	16	$\theta_1 = .463$ $\theta'_6 = -.301$	51
717081	1	1	4	2						12	$\phi_1 = -.191$ $\phi_2 = -.268$	51
832135	0	1	4	1	1			1		141	$\phi_1 = .931$ $\phi'_4 = -.232$ $\theta_1 = .588$	52
859264	1	1	4	1				1	1	118	$\phi_1 = .072$ $\theta_1 = .711$ $\theta'_8 = .318$	51
478160	1	0	0		1			2		413	$\phi'_4 = .917$ $\theta_1 = .496$ $\theta_3 = -.087$	55
194162	0	0	0	1	1	1		1		1401	$\phi_1 = .929$ $\phi'_4 = .955$ $\mu = 9.153$ $\theta_1 = .344$	56
375766	0	1	4	2					1	12(12)	$\phi_1 = .486$ $\phi_2 = .202$ $\theta'_{12} = .407$	52
492386	0	1	4	1				1	1	114	$\phi_1 = .987$ $\theta_1 = .629$ $\theta'_4 = .481$	52
565845	1	1	4					1	1	14	$\theta_1 = .502$ $\theta'_4 = .782$	51
718507	1	1	4					3	1	1274	$\theta_1 = .187$ $\theta_2 = .065$ $\theta_7 = .289$ $\theta'_4 = .663$	51
822635	1	1	4					1	1	16	$\theta_1 = .391$ $\theta'_6 = .385$	51
830575	0	1	4	2					1	138	$\phi_1 = .438$ $\phi_3 = .534$ $\theta'_8 = -.669$	52
853700	0	1	4	1	1		1			140	$\phi_1 = .325$ $\phi'_4 = -.364$ $\theta_0 = 4.396$	52
302290	1	1	4	1				1	1	214	$\phi_2 = .003$ $\theta_1 = .406$ $\theta'_4 = .370$	51
607080	1	1	4					2	1	154	$\theta_1 = .317$ $\theta_5 = .072$ $\theta'_4 = -.025$	51
853683	1	0	0	1	1				1	14(10)	$\phi_1 = -.376$ $\phi'_4 = .322$ $\theta'_{10} = .265$	55
881694	0	1	4				1	1	1	044	$\theta_0 = 11.04$ $\theta_4 = .821$ $\theta'_4 = -.010$	52
478124	1	1	4					2	1	274	$\theta_2 = .223$ $\theta_7 = .186$ $\theta'_4 = .689$	51
318315	1	1	4					1	1	14	$\theta_1 = .516$ $\theta'_4 = .583$	51
382388	1	0	0	1				1	1	11(10)	$\phi_1 = .294$ $\theta_1 = .98$ $\theta'_{10} = .384$	55
382550	1	1	4					1	1	14	$\theta_1 = .463$ $\theta'_4 = .783$	51
42195	1	0	0		1			1	1	419	$\phi'_4 = .076$ $\theta_1 = .664$ $\theta'_9 = .319$	55
87509	0	0	0		1	1		1	1	406(12)	$\phi'_4 = .151$ $\mu = 32.56$ $\theta_6 = -.176$ $\theta'_{12} = -.213$	56
457470	0	0	0		1	1			1	404	$\phi'_4 = .805$ $\mu = 15.24$ $\theta'_4 = .631$	56
637844	1	0	0					2	1	169	$\theta_1 = .608$ $\theta_6 = -.054$ $\theta'_9 = .277$	55
760779	1	0	0					2		12	$\theta_1 = .726$ $\theta_2 = .123$	55
912656	0	0	0			1		2		046	$\mu = 55.71$ $\theta_4 = -.229$ $\theta_6 = -.269$	56
489314	0	0	0	1	1	1		1		1403	$\phi_1 = .706$ $\phi'_4 = .167$ $\mu = 24.23$ $\theta_3 = .217$	56

TABLE 4-2 (Contd.)

Company Compustat Number (1)	d	d_1	S	ϕ	ϕ'	μ	θ_0	θ	θ'	Order[b] of Parameters (4)	Non-linear Least Squares Parameter Estimates[a] (5)	Effective Number of Observations for Estimation (6)
	(2)			Number of Parameters (3)								
717265	1	0	0		1			1		43	ϕ'_4= .456 θ_3= .365	55
56147	1	0	0					2	1	134	θ_1= .401 θ_3=-.258 θ'_4=-.241	55
200273	1	0	0	1	1			1	1	2414	ϕ_2= .103 ϕ'_4= .905 θ_1= .674 θ'_4= .378	55
244199	1	1	4					1	1	14	θ_1= .374 θ'_4= .811	51
149123	1	1	4					1	1	4(11)	θ_4= .560 θ'_{11}= .585	51
181396	1	1	4					2	1	1(12)4	θ_1= .410 θ_{12}=-.352 θ'_4= .958	51
261597	1	0	0		1			2		412	ϕ'_4= .781 θ_1= .575 θ_2= .156	55
406216	1	1	4						1	4	θ'_4= .474	51
6716	1	0	0		1			1	1	419	ϕ'_4= .510 θ_1= .410 θ'_9= .396	55
122781	0	2	2		1			1	1	424	ϕ'_4=1.102 θ_2=-.482 θ'_4= .703	52
459200	1	0	0		1		1	1		401	ϕ'_4= .308 θ_0=4.028 θ_1= .521	55
635230	0	0	0	1		1			1	104	ϕ_1= .657 μ =47.56 θ'_4=-.926	56
369604	1	1	4						1	4	θ'_4= .930	51
580628	1	1	4	1					1	14	ϕ_1=-.257 θ'_4= .820	51
829302	1	1	4					1	1	14	θ_1= .334 θ'_4= .495	51
963320	1	0	0		1			2		412	ϕ'_4= .443 θ_1= .133 θ_2= .470	55
620076	0	1	4	1			1		1	106	ϕ_1= .706 θ_0= .233 θ'_6= .336	52
989399	0	0	0	1	1	1				140	ϕ_1= .696 ϕ'_4= .996 μ =7.288	56
171196	1	1	4					1	1	14	θ_1= .326 θ'_4= .778	51
345370	1	1	4					1	1	14	θ_1= .395 θ'_4= .647	51
459578	0	1	4	2					1	124	ϕ_1= .306 ϕ_2= .224 θ'_4= .509	52
81689	1	0	0		1			2		412	ϕ'_4= .663 θ_1= .127 θ_2=-.091	55
488188	1	0	0	1	1			1		161	ϕ_1= .067 ϕ'_6=-.466 θ_1= .712	55
97023	1	0	0					2		12	θ_1= .075 θ_2= .131	55
666807	1	0	0		1		1	1		401	ϕ'_4= .368 θ_0= .021 θ_1= .424	55
909296	0	0	0			1				0	μ =7.97	56
800	1	0	0					1		1	θ_1= .311	55
368838	0	0	0			1		1		01	μ =6.21 θ_1= .907	56

TABLE 4-2 (Contd.)

Company Compustat Number (1)	d (2)	d_1	S	Number of Parameters (3) ϕ	ϕ'	μ	θ_0	θ	θ'	Order[b] of Parameters (4)	Non-linear Least Squares Parameter Estimates[a] (5)	Effective Number of Observations for Estimation (6)
745791	1	1	4	1				2		147	$\phi_1 = .776$ $\theta_4 = .677$ $\theta_7 = .144$	51
277461	0	1	4	1					1	17	$\phi_1 = .955$ $\theta'_7 = .362$	52
604059	0	1	4	2			1			120	$\phi_1 = .633$ $\phi_2 = .116$ $\theta_0 = .939$	52
30177	1	0	0		1			1		41	$\phi'_4 = .326$ $\theta_1 = .292$	55
371028	1	2	2	1			1	1		201	$\phi_2 = .101$ $\theta_0 = .386$ $\theta_1 = .447$	51
45573	1	2	4		1		1	1	1	4014	$\phi'_4 = .509$ $\theta_0 = .417$ $\theta_1 = -.259$ $\theta'_4 = .163$	48
314099	0	1	4					2	1	12(10)	$\theta_1 = -.634$ $\theta_2 = -.349$ $\theta'_{10} = .183$	52
556139	0	0	0		1	1				40	$\phi'_4 = .901$ $\mu = 3.798$	56
4716	0	0	0		1	1		1	1	4017	$\phi'_4 = .212$ $\mu = 2.823$ $\theta_1 = -.342$ $\theta'_7 = .290$	56
501044	0	1	4	1						1	$\phi_1 = .262$	52
786514	0	1	4				1	1		01	$\theta_0 = 1.057$ $\theta_1 = -.684$	52
974280	1	1	4					2	1	18(10)	$\theta_1 = -.576$ $\theta_8 = .103$ $\theta_{10} = -.265$	51

[a] Parameter estimates μ and θ_0 in \$000,000's.

[b] Parameter orders greater than nine are in parentheses.

TABLE 4-3

PROCESSES IDENTIFIED FOR QUARTERLY DIVIDENDS PER SHARE FOR PERIOD 1958-1971

Company Compustat Number (1)	d (2)	d_1	S	Number of Parameters ϕ (3)	ϕ'	μ	θ_0	θ	θ'	Order of Parameters (4)	Non-linear Least Squares Parameter Estimates[a] (5)	Effective Number of Observations for Estimation (6)
27465	1	0	0				1			0	θ_0= .003	55
29663	1	0	0		1					4	ϕ'_4= .329	55
460056	0	0	0	1	1	1				140	ϕ_1= .465 ϕ'_4= .371 μ = .240	56
209219	1	0	0	1	1					14	ϕ_1=-.224 ϕ'_4= .693	55
369856	1	0	0				1			0	θ_0= .004	55
99599	1	0	0				1	1	1	014	θ_0= .003 θ_1= .754 θ_2=-.499	55
751277	1	0	0				1			0	θ_0= .002	55
254723	0	0	0		1	1				40	ϕ'_4= .808 μ = .129	56
532202	1	0	0				1			0	θ_0=-.006	55
718167	1	0	0				1			0	θ_0= .003	55
761753	1	0	0		1					8	ϕ_8= .519	55
121691	1	0	0				1			0	θ_0= .004	55
860163	1	0	0				1			0	θ_0= .001	55
494368	1	0	0				1			0	θ_0= .002	55
793453	1	0	0					1		1	θ_1= .819	55
809877	0	0	0	1		1				10	ϕ_1= .995 μ = .527	56
19087	1	0	0				1			0	θ_0=-.001	55
25321	1	0	0		1					6	ϕ'_6= .476	55
150843	1	0	0		1					8	ϕ'_8= .500	55
260543	1	0	0				1			0	θ_0= .002	55
263534	0	1	4		1					4	ϕ'_4=-.403	52
611662	1	0	0				1			0	θ_0= .004	55
680665	1	0	0				1			0	θ_0=-.002	55
905581	1	0	0				1			0	θ_0= .001	

TABLE 4-3 (Contd.)

Company Compustat Number (1)	d (2)	d_1 (2)	S (2)	Number of Parameters (3) ϕ	ϕ'	μ	θ_0	θ	θ'	Order of Parameters (4)	Non-linear Least Squares Parameter Estimates[a] (5)	Effective Number of Observations for Estimation (6)
775371	1	0	0					1		1	θ_1= .645	55
2824	0	0	0	1	1	1				140	ϕ_1= .804 ϕ'_4= .716 μ = .255	56
589331	0	0	0	1	1	1				140	ϕ_1= .227 ϕ'_4= .963 μ = .589	56
717081	0	0	0	1	1	1				140	ϕ_1= .215 ϕ'_4= .915 μ = .195	56
832135	0	0	0	1	1	1				140	ϕ_1= .158 ϕ'_4= .765 μ = .492	56
859264	1	0	0				1			0	θ_0= .001	55
478160	0	0	0	1	1	1				140	ϕ_1= .663 ϕ'_4= .101 μ =-.593	56
194162	0	0	0	1	1	1				140	ϕ_1= .149 ϕ'_4= .977 μ = .885	56
375766	0	0	0	1	1	1				140	ϕ_1= .004 ϕ'_4= .718 μ = .336	56
492386	1	0	0					1		2	θ_2= .209	55
565845	1	0	0				1			0	θ_0= .004	55
718507	1	0	0				1			0	θ_0= .002	55
822635	1	0	0		1					4	ϕ'_4= .846	55
830575	1	0	0	1						1	ϕ_1=-.488	55
853700	0	0	0		1	1				10	ϕ_1= .991 μ =1.176	56
302290	0	0	0	1	1	1				140	ϕ_1= .451 ϕ'_4= .918 μ =1.090	56
607080	0	0	0	1	1	1				140	ϕ_1= .212 ϕ'_4= .989 μ =3.188	56
853683	1	0	0		1					4	ϕ'_4= .470	55
881694	0	0	0	1	1	1				140	ϕ_1= .289 ϕ'_4= .931 μ = .570	56
478124	1	0	0				1			0	θ_0= .001	55
318315	1	0	0				1			0	θ_0= .002	55
382388	1	0	0				1			0	θ_0=-.002	55
382550	1	0	0				1			0	θ_0= .002	55
42195	1	0	0				1			0	θ_0=-.002	55
87509	1	0	0					1		1	θ_1= .416	55
457470	1	0	0					1		1	θ_1= .595	55
637844	1	0	0				1			0	θ_0= .004	55
760779	1	0	0				1			0	θ_0=-.004	55

TABLE 4-3 (Contd.)

Company Compustat Number (1)	d (2)	d_1 (2)	S (3)	ϕ (3)	ϕ' (3)	μ (3)	θ_0 (3)	θ (3)	θ' (3)	Order of Parameters (4)	Non-linear Least Squares Parameter Estimates[a] (5)	Effective Number of Observations for Estimation (6)
912656	1	0	0				1			0	θ_0=-.006	55
489314	1	0	0					1		3	θ_3=-.411	55
717265	0	0	0	1	1	1				140	ϕ_1= .188 ϕ_4'= .612 μ = .463	56
56147	1	0	0				1			0	θ_0= .000	55
200273	1	0	0				1	1		01	θ_0= .224 θ_1=-.610	55
244199	0	0	0	1	1	1				140	ϕ_1= .107 ϕ_4'= .854 μ = .272	56
149123	1	0	0				1			0	θ_0= .004	55
181396	1	0	0					1		1	θ_1= .173	55
261597	1	0	0					1		2	θ_2=-.259	55
406216	1	0	0				1			0	θ_0= .002	55
6716	1	0	0				1			0	θ_0=-.000	55
122781	1	0	0				1			0	θ_0= .001	55
459200	0	0	0	1	1	1				140	ϕ_1= .990 ϕ_4'= .357 μ = .306	56
635230	1	0	0				1			0	θ_0=-.001	55
369604	1	0	0				1			0	θ_0= .002	55
580628	0	0	0	1	1	1				140	ϕ_1= .771 ϕ_4'= .668 μ = .310	56
829302	1	0	0				1			0	θ_0= .005	55
963320	1	0	0		1					4	ϕ_4'= .407	55
620076	1	0	0					1		1	θ_1= .579	55
989399	0	0	0	1	1	1				140	ϕ_1= .244 ϕ_4'= .884 μ = .413	56
171196	1	0	0				1			0	θ_0= .001	55
345370	0	0	0	1	1	1				140	ϕ_1= .350 ϕ_4'= .603 μ = .584	56
459578	1	0	0				1			0	θ_0= .002	55
81689	1	0	0				1			0	θ_0= .002	55
488188	1	0	0				1			0	θ_0= .000	55
97023	1	0	0					1		1	θ_1= .437	55
666807	1	0	0				1			0	θ_0= .001	55
909296	1	0	0				1			0	θ_0= .003	55

TABLE 4-3 (Contd.)

Company Compustat Number (1)	d	d_1 (2)	S	ϕ	ϕ'	μ (Number of Parameters (3))	θ_0	θ	θ'	Order of Parameters (4)	Non-linear Least Squares Parameter Estimates[a] (5)	Effective Number of Observations for Estimation (6)
800	1	0	0				1			0	θ_0= .006	55
368838	1	0	0		1					4	ϕ_4= .708	55
745791	1	0	0					1		1	θ_1= .606	55
277461	0	0	0	1	1	1				140	ϕ_1= .446 ϕ_4= .951 μ =-.200	56
604059	1	1	4		1		1			10	ϕ_1= .548 θ_0= .006	51
30177	1	0	0				1			0	θ_0= .006	55
371028	1	0	0		1					4	ϕ_4= .836	55
45573	1	0	0					1		6	θ_6=-.472	55
314099	1	0	0				1			0	θ_0= .003	55
556139	1	0	0					1		1	θ_1= .491	55
4716	1	0	0				1			0	θ_0=-.000	55
501044	1	0	0						1	4	θ_4=-.846	55
786514	1	0	0					1		1	θ_1= .594	55
974280	1	0	0		1					4	ϕ_4= .368	55

[a]Parameter estimes μ and θ_0 are in $'s.

(1) COMPUSTAT company number--column 1, (2) suitable differencing--column 2, (3) the number of parameters--column 3, (4) order of parameters--column 4, (5) parameter estimates--column 5 and (6) effective number of observations used for parameter estimation--column 6.

Processes Identified for Earnings Available for Common

Several observations may be made of the processes identified and summarized in Table 4-2. First, 82 out of 94 processes were affected by seasonality either via fourth order differencing, fourth order autoregressive or fourth order moving average parameters. Hence a strong seasonal effect is present. Second, consider the frequency of firms with a given differencing combination (Column 2, Table 4-2). Table 4-4 summarizes these frequencies and indicates that none of the processes required more than one level of regular differencing and only three required more than one level of seasonal differencing. Of these three, two processes reflected seasonality as a six-monthly phenomenon.

Third, a relationship between the differencing combination and the parameters of each process is apparent from Table 4-2. Combinations 014 and 114, although dominated by θ and θ' parameters, were different with respect to autoregressive parameters. The 014 combinations contained many more θ parameters. However, this was an expected result, since the first regular differencing in the

TABLE 4-4

FREQUENCY OF IDENTIFIED PROCESSES FOR QUARTERLY EARNINGS AVAILABLE FOR COMMON FOR PARTICULAR COMBINATIONS OF d, d_1 AND s

Combination of d	d_1	s	Frequency of Process
0	0	0	13
1	0	0	30
0	1	4	19
1	1	4	29
1	2	4	1
0	2	2	1
1	2	2	1
			94

114 combination may be viewed as a special case of a first order autoregressive parameter, i.e., $\phi_1 = 1$. An expected difference between the parameters associated with 000 or 100 combinations and 014 or 114 combinations was also confirmed by Table 4-2 for much the same reason. That is, the 000 or 100 combinations contained many more autoregressive seasonal parameters, ϕ_4', since the 014 or 114 combinations may be viewed as special cases of a seasonal autoregressive parameter, i.e., $\phi_4' = 1$.

Overall there appeared to be a diversity of unique processes associated with quarterly earnings available for common. Except for a tendency for Retail Department Stores and Retail Food Chains (COMPUSTAT four-digit industrial codes 5311 and 5411) to be more affected by seasonality than other industrial groups, inter-industry differences and intra-industry similarities were not inherently obvious. For example, no COMPUSTAT four-digit industrial group consisting of three or more companies contained process structures that were identical except for parameter estimates.

Processes Identified for Dividends per Share

Table 4-3 summarizes the processes identified for dividends per share. It should be noted that only 29 out of 94 appear to be affected by seasonality either via fourth order differencing, fourth order autoregressive or fourth order moving-average parameters. Relative to the earnings available for common processes, the impact of seasonality thus appears to be smaller. Several other comments may be made: (1) All but three processes were based on either the 100 or the 000 differencing combinations. (2) The above mentioned relationship between the differencing combinations and the parameters of the earnings processes was also applicable to the dividend processes. A review of the 100 and 000 combinations clearly indicates a significantly greater number of first order autoregressive parameters in the 000 combination relative to the 100 combination. (3) In general, there appeared to be less diversity in both the number of parameters, and the order of parameters, than in the quarterly earnings for common series. Moreover, a simple first differencing of the quarterly dividend per share series appeared in some cases to perform remarkably well as a model of the process, whereas this was seldom the case with quarterly earnings.

Diagnostic Checking of Quarterly Earnings and Quarterly Dividend Processes

Three previously described diagnostic checks were utilized to test the properties of the residuals of each of the models. The first diagnostic which tested each residual autocorrelation coefficient for departure from zero is not presented. The second diagnostic, the "portmanteau test of model adequacy," is viewed as an equally comprehensive test of the properties of the ACF of the estimated residuals. Charts 4-2 and 4-3 contain frequency histograms of the χ^2 probabilities associated with portmanteau statistic Q for the quarterly earnings for common processes and the quarterly dividend per share processes, respectively. The ordinate of each histogram indicates the probability that a χ^2 value is below Q, i.e., Pr $(q<Q)$ where q approximates a chi-square with a given number of degrees of freedom. Thus, 1 - Pr $(q<Q)$ is the probability of rejecting the residuals as normally distributed deviates with zero mean and constant variance σ_a^2 when it is true that they have this property. By convention the significance level was set at .05. All identified processes were acceptable under this criterion: in fact the smallest values for 1 - Pr $(q<Q)$ were .0788 and .0542,

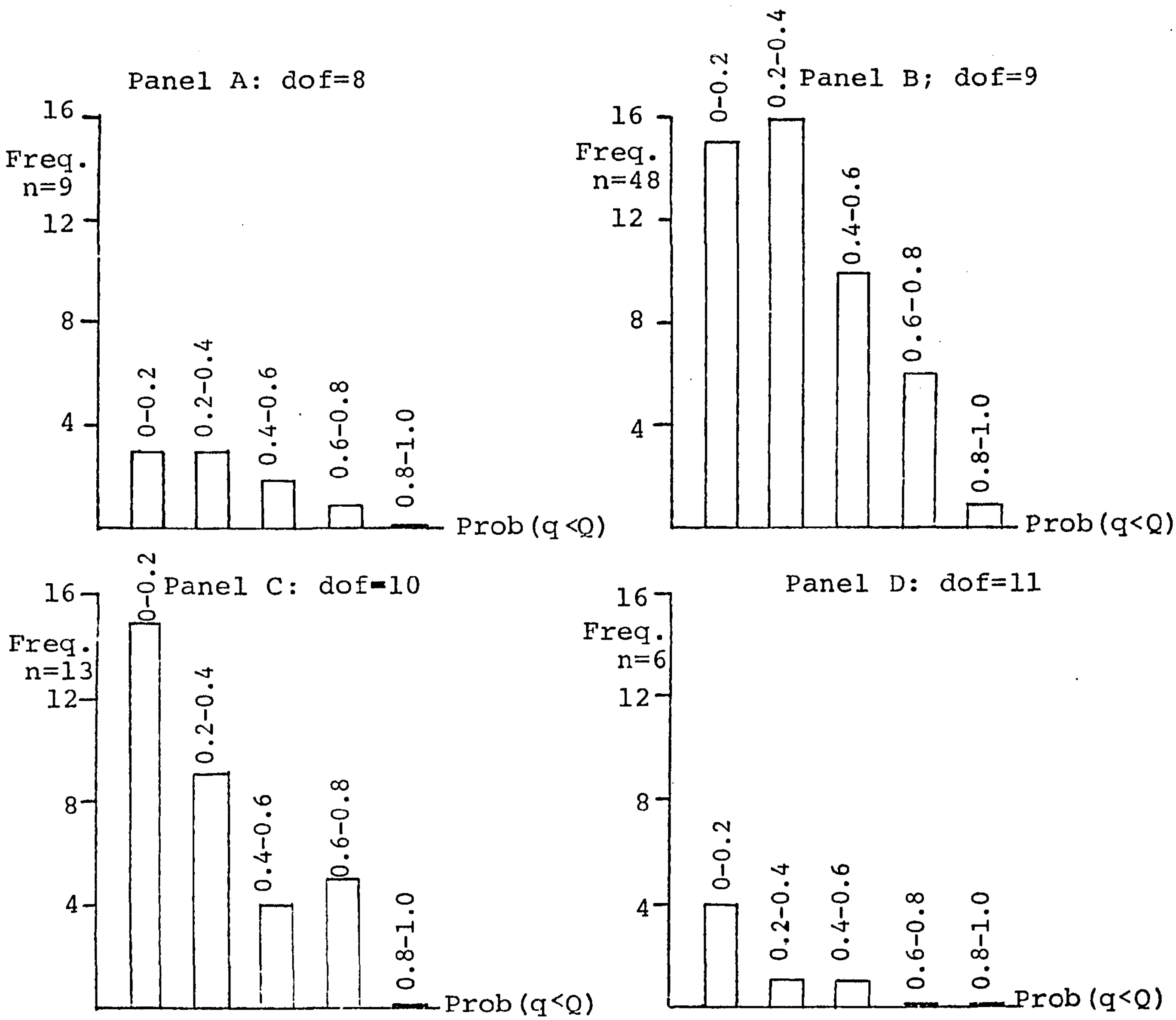

Chart 4-2. Frequency Histograms of χ^2 Probability for Portmanteau Test of Model Adequacy: Quarterly Earnings Available for Common.

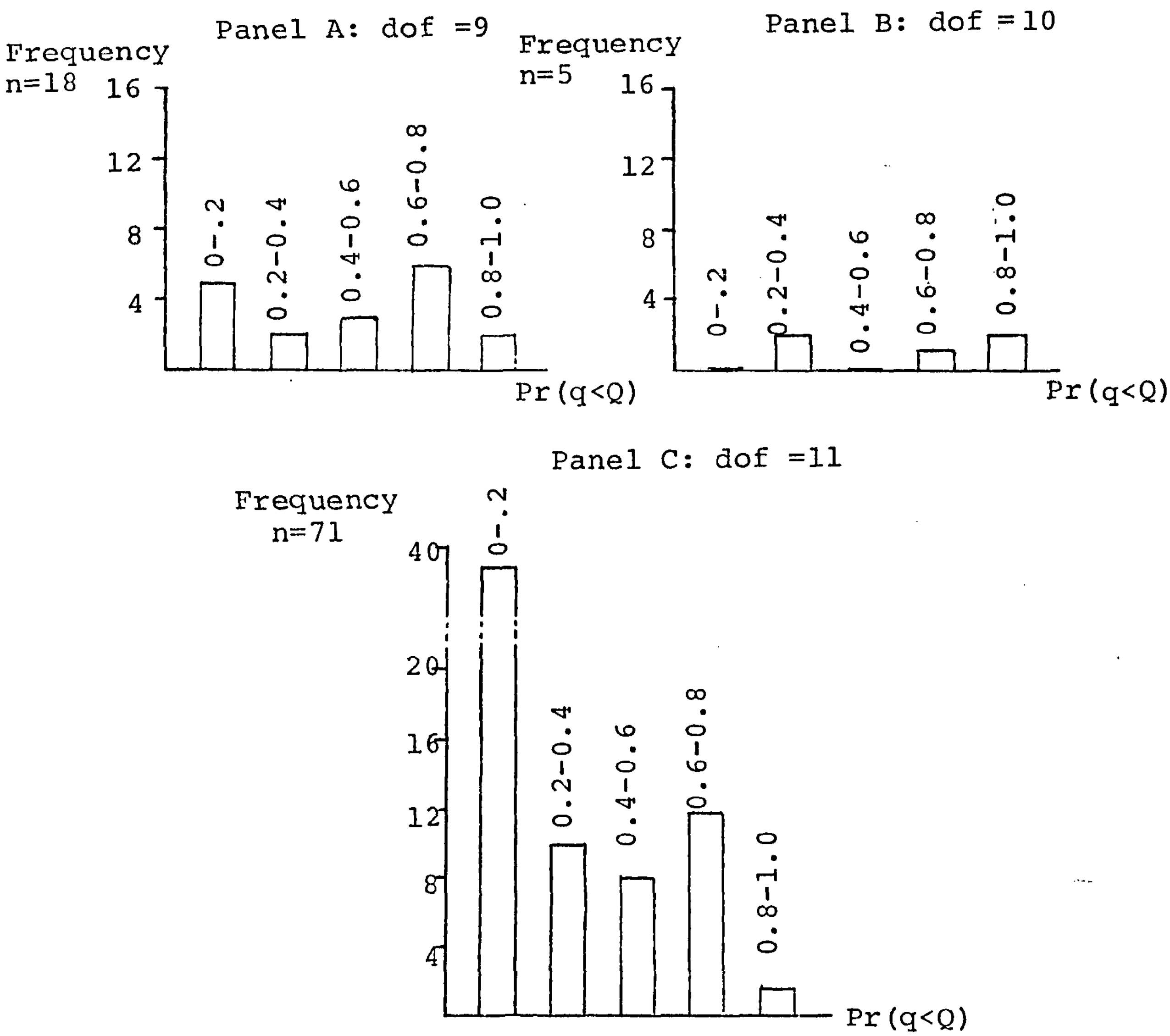

Chart 4-3. Frequency Histograms of χ^2 Probability for Portmanteau Test of Model Adequacy: Quarterly Dividends per Share.

for earnings and dividends respectively. Although each histogram in Charts 4-2 and 4-3 should conform roughly to the shape of the chi-square distribution with the appropriate number of degrees of freedom, two reasons suggest why this was not always observed: (1) The iterative model building procedure encourages lower values for Q [thus lower values of $Pr(q<Q)$] due to a tendency to consider the lower values as indicating an improved model. (2) A small number of observations for Q may be insufficient for the histogram to reflect a true chi-square distribution.

The results of the third diagnostic test are contained in Chart 4-4, Panels A and B. The ordinate indicates the frequency of the process and the abscissa indicates the probability that the standardized mean of the estimated residuals is not within sampling variation from zero. More precisely the abscissa is $Pr(s<|S|)$ where $s \sim N(0,1)$ and $|S| = |\hat{\bar{a}}|/(\sigma_{\hat{a}}/T^{1/2})$. $\hat{\bar{a}}$ is the mean of the estimated residuals and $\sigma_{\hat{a}}/T^{1/2}$ is the estimated standard error of the mean where T equals the total number of residuals. Only two processes in 188 were not acceptable at .05 significance. But the exact probabilities that the residuals of these two processes would be rejected as having mean equal to zero were .0484 and .0498 respectively. In view of the prior tests which did not reject the selected models for these processes, and noting that for a large sample, one might expect to find some perfectly adequate processes

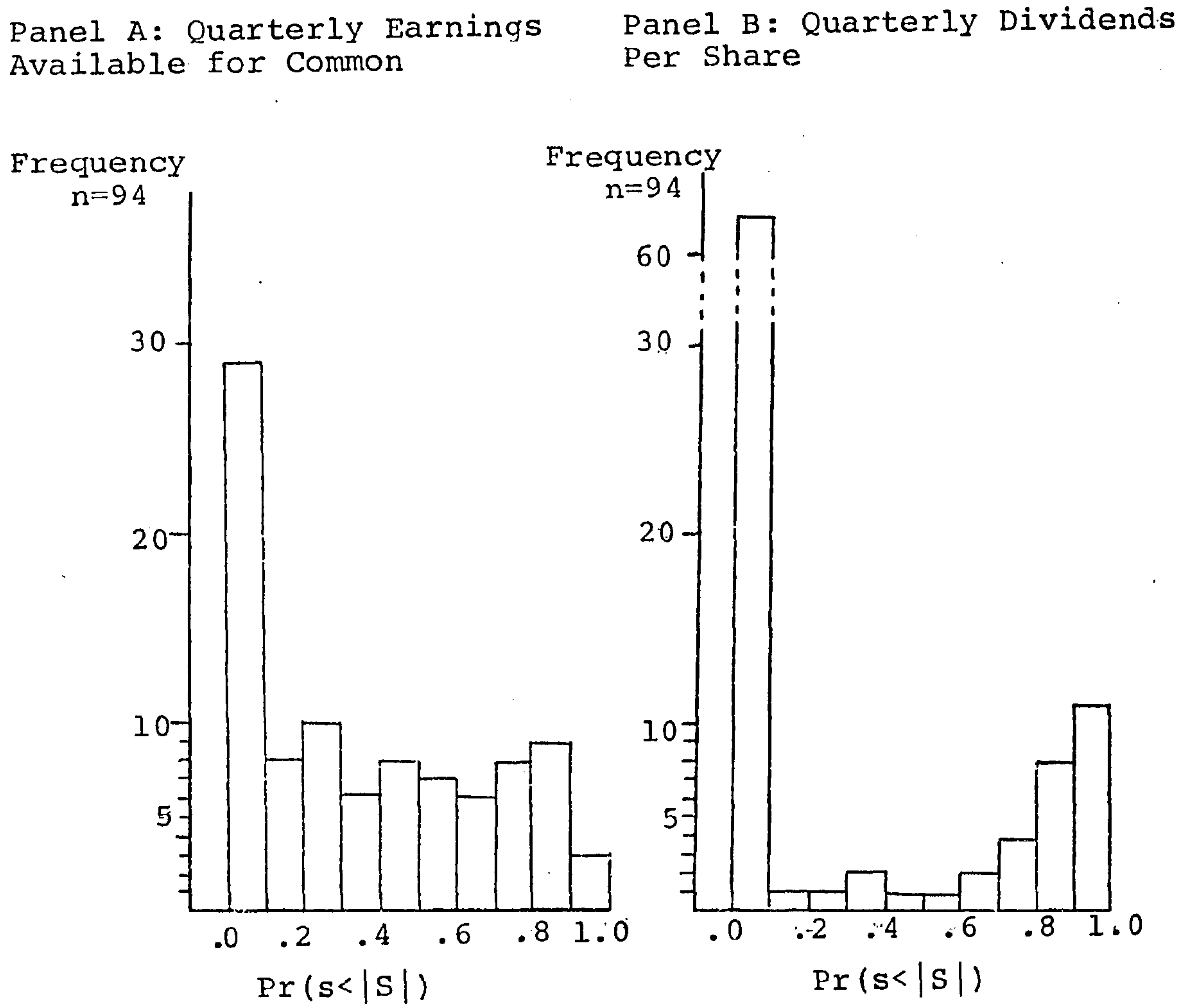

Chart 4-4. Frequency Histograms of Normal Probability that Mean of Estimated Residuals Equals Zero.

rejected on the basis of this test, the two series were regarded as adequate and no respecifications were attempted.

Finally, it is noted that although each frequency histogram should, in theory, resemble probabilities characteristic of a normal distribution, Chart 4-4 reveals a tendency towards small values of $Pr(s<|S|)$. This may be attributed to: (1) an emphasis on small values of the standardized mean resulting from the iterative model building procedure, and (2) the use of the deterministic trend parameter, θ_o.

Conclusion

Utilizing the Box and Jenkins methodology, the unexpected changes in quarterly earnings and quarterly dividends for each sample entity were determined as the estimated residual, $\hat{a}_t$, from an ARIMA time series model. Each model of the process generating quarterly earnings and quarterly dividends was tested via diagnostic checks for model inadequacy. On the basis of the tests, it appears that each model reflects both the seasonality and the nonstationarities that may be present, and hence is expected to produce estimates of the residuals that are independently and normally distributed with mean of zero and constant variance. Together with the estimated residuals from the no forecast model (generating process one), the estimated residuals from the selected ARIMA models (generating process two) are used in Chapter Five to derive estimates of risk information flowing to the capital market conveyed by published quarterly earnings and quarterly dividend announcements.

CHAPTER V

HYPOTHESIS TESTING AND EMPIRICAL RESULTS

The statistical procedures to test the hypotheses and the empirical results of these tests are presented in this chapter. In the first section the cross-sectional statistics of the sample are detailed. The second section outlines the overall results of the association between market beta and estimates of an entity's relative risk derived from published quarterly earnings and quarterly dividend announcements. A link between changes in market beta and changes in the derived estimates of risk is analyzed in the third section. The fourth section evaluates the effect of a combined signal about risk conveyed by published quarterly earnings and quarterly dividend announcements. The final section is ancilliary to the main results and provides further direct evidence to support the concept of "the information content of dividends," a hypothesis maintained throughout this research.

To reiterate, the three basic steps in the estimation procedure described in Chapter Three were as follows. First, the security return variables, R'_{jt}, and the estimates of unexpected changes in quarterly earnings and quarterly dividends, a^E_{jkt} and a^D_{jkt}, were derived. Two generating processes were used for this purpose: one was called the no forecast model, k = 1, and the other was called the ARIMA model, k = 2. The ARIMA analyses were fully reported in Chapter Four. For the cross-sectional analyses the residuals were deflated and denoted in this form as x_{jkt} and d_{jkt} for quarterly earnings and quarterly dividends respectively.

The second step comprised the determination of market beta. Estimates of market beta for individuals securities, $\hat{\beta}_j$, were derived from the market model for two subperiods. Further, by partitioning the individual security market beta in groups of five from highest to lowest, portfolio market betas were computed as an equally weighted average of each group. Market beta for subperiod one was the basis of the partitioning. The third step was to compute for each entity the non-market estimates of risk (the estimates of risk conveyed by published quarterly earnings and quarterly dividend announcements). The non-market risk estimates were derived for two subperiods, two definitions of risk, two generating processes and two kinds of information: a total of 16 estimates altogether. One definition implied a procedure analogous to the market model and consequently required the construction of an economy-wide index. These indexes were formed as equally weighted sample averages of the x_{jkt} and the d_{jkt}. The second definition computed the non-market risk quantities as the standard deviation of the x_{jkt} and the d_{jkt} for each of the two subperiods. Last, estimates of non-market risk for portfolios were derived. In short, the independent criterion of risk information reflected in security prices was market beta. The tests to be discussed in the following sections constitute contemporaneous and predictive tests of the association between market beta and the non-market estimates of risk under alternative generating processes and definitions.

Cross-Sectional Summary Statistics

Moments of Distributions

Prior to hypothesis testing, it is important to review the distributional characteristics of the empirical estimates. This serves two purposes: (1) to evaluate the specification of the estimation procedures, and (2) to choose the appropriate test statistics. Table 5-1 presents the summary statistics for market beta and eight non-market estimates of risk for subperiod one (Panel A) and subperiod two (Panel B).

Column 1. The mean of market beta, $\hat{\beta}_j$, is .8256 for subperiod one and .7405 for subperiod two. In each subperiod it is less than the market average for all NYSE entities which by definition equals one. This result confirms an expected post-selection bias due not only to the

TABLE 5-1

CROSS-SECTIONAL SUMMARY STATISTICS FOR
MARKET BETA, QUARTERLY EARNINGS AND QUARTERLY DIVIDEND RISK ESTIMATES

	Mean	Standard Deviation	Skewness	Kurtosis	Median	Lowest	Highest
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: Subperiod One							
1. Market Beta, $\hat{\beta}_j$	.8256	.3474	-.2738	2.5350	.8545	-.2213	2.1102
2. Quarterly Earnings							
Definition One, $\hat{\omega}^E_{jk}$							
No Forecast Model	.8870	1.3472	3.4265	18.7726	.7011	-1.6171	9.5673
ARIMA Model	.8209	1.2327	2.9723	13.6019	.5456	-1.2058	8.2982
Definition Two, $\hat{\sigma}_{jk}(E)$							
No Forecast Model	.1505	.1877	2.3320	6.7628	.0641	0.0001	1.0965
ARIMA Model	.0236	.0469	6.6746	51.1366	.0130	0.0001	.4160
3. Quarterly Dividends							
Definition One, $\hat{\omega}^D_{jk}$							
No Forecast Model	.9772	2.5449	3.3643	13.3594	.0728	-2.0363	15.7060
ARIMA Model	1.1136	4.5613	6.8027	51.0505	.1555	-1.5203	39.0910
Definition Two, $\hat{\sigma}_{jk}(D)$							
No Forecast Model	.0085	.0052	2.2176	7.9627	.0073	.0023	.0365
ARIMA Model	.0070	.0043	2.7228	12.6253	.0060	.0015	.0330

TABLE 5-1 (contd.)

	Mean (1)	Standard Deviation (2)	Skewness (3)	Kurtosis (4)	Median (5)	Lowest (6)	Highest (7)
Panel B: Subperiod Two							
4. Market Beta, $\hat{\beta}_j$	.7405	.3132	-.2307	.6873	.7479	-.0941	1.5189
5. Quarterly Earnings							
Definition One, $\hat{\omega}^E_{jk}$							
No forecast Model	.9042	.9969	.6571	3.6447	.8183	-2.4648	4.9926
ARIMA Model	.9536	1.0284	.7951	1.1747	.7573	-1.8242	4.4155
Definition Two, $\hat{\sigma}_{jk}(e)$							
No Forecast Model	.1590	.5593	8.9252	81.0920	.0554	0.0001	5.4047
ARIMA Model	.0238	.0282	3.1406	14.5259	.0142	0.0001	1.9990
6. Quarterly Dividends							
Definition One, $\hat{\omega}^D_{jk}$							
No Forecast Model	.8497	2.9928	.5471	10.5172	.1115	-14.1110	13.1180
ARIMA Model	1.0465	2.1883	3.0106	9.7939	.3023	-1.1179	12.1480
Definition Two $\hat{\sigma}_{jk}(D)$							
No forecast Model	.0102	.0058	1.3595	2.0760	.0090	.0012	.0311
ARIMA Model	.0063	.0040	1.9171	6.6110	.0055	.0008	.0270

large and successful firm orientation of the firms selected from the NYSE population, but also to the sample inclusion criteria. Criterion one, for example, required that cash dividends must have been positive and non-zero for each entity for the full study period 1958-1971.

The means for the quarterly earnings risk estimates, $\hat{\omega}^E_{jk}$, are the range [.8209, .9563] and those for the quarterly dividend risk estimates, $\hat{\omega}^D_{jk}$, are in the range [.8497, 1.1136]. Both results are an artifact however, since by construction of the indexes, which are based only on sample data, the means should equal one. For the mean values of the non-market estimates, $\hat{\sigma}_{jk}(E)$ and $\hat{\sigma}_{jk}(D)$, there are no prior values to act as a standard of comparison. But, between the no forecast and the ARIMA model estimates, it is evident that the range in mean values for ARIMA estimates, [.0063, .0238], is smaller than the range in mean values for the no forecast estimates, [.0085, .1590]. This result is consistent with the objectives of the ARIMA model, since it implies that, on average, the ARIMA model effectively reduces the variability of the unexpected changes in either quarterly earnings or quarterly dividends. Part of this reduction is due to the elimination of seasonal effects.

Column 2. In contrast to the standard deviation for $\hat{\beta}_j$, the standard deviations for $\hat{\omega}^E_{jk}$ and $\hat{\omega}^D_{jk}$ are higher. One reason for this may be that the $\hat{\beta}_j$ estimates are more efficient since they use monthly rather than quarterly observations. There is also a potentially greater impact of measurement error in estimating ω^E_{jk} and ω^D_{jk} because of the possible misspecification of the economy-wide indexes, x_{mkt} and d_{mkt}. Note that the larger standard deviations for $\hat{\omega}^D_{jk}$ of range [2.1883, 4.5613], compared to the standard deviations for $\hat{\omega}^E_{jk}$ of range [.9969, 1.3472], may reflect that measurement error is a more pressing problem for $\hat{\omega}^D_{jk}$ than for $\hat{\omega}^E_{jk}$.

Columns 3 and 5. The market betas are skewed slightly to the left and hence reflect median values that are slightly higher than the mean. On the other hand, all nonmarket risk estimates are skewed to the right. However right skewness is expected for the $\hat{\sigma}_{jk}(E)$ and $\hat{\sigma}_{jk}(D)$, since the standard deviation is unbounded from above and has a lower bound of zero. The median values for $\hat{\omega}^D_{jk}$ are lower relative to those for $\hat{\omega}^E_{jk}$, suggesting that asymmetry is more pronounced in the case of the quarterly dividend risk estimates, $\hat{\omega}^D_{jk}$.

Columns 4, 6, and 7. From column 4 (kurtosis) it appears that all cross-sectional distributions of the nonmarket risk estimates are leptokurtic in comparison to a normal distribution with kurtosis equal to zero. Several other observations may be made. First, the $\hat{\omega}^D_{jk}$ have wider range than the $\hat{\omega}^E_{jk}$. Second, with one exception, the range of the ARIMA estimates is less than that for estimates derived via the no forecast model. Of further interest is that the range of $\hat{\beta}_j$ is less than that for all $\hat{\omega}^E_{jk}$ and $\hat{\omega}^D_{jk}$. The findings of Beaver, Kettler and Scholes, Gonedes, and Beaver and Manegold[1] are consistent with this last result. It may be presumed attributable to either decreased estimation efficiency or increased measurement error associated with the non-market estimates of risk. As previously mentioned, Column 2 (standard deviation) exhibits similar characteristics.

In brief, the results of Table 5-1 conform generally with prior knowledge and expectations. Although a post-selection bias toward low relative risk entities may be implied by the results, no serious misspecification of the market model is apparent. To ascertain whether autoregression in the market model residuals may have induced a specification bias, a generalized least squares (GLS) estimation procedure was applied to the security return data in addition to the ordinary least squares (OLS) market model. The GLS procedure represented the market model residuals as a first order autoregressive process of the form

$$e_{jt} = \delta_j e_{j,t-1} + \xi_{jt} \text{ for } t = 1, 56 \text{ and } j = 1, 94 \qquad (5.1)$$

where ξ_{jt} is distributed independently with mean zero and constant variance. Figure 5-1, Panel A and Panel B, plot

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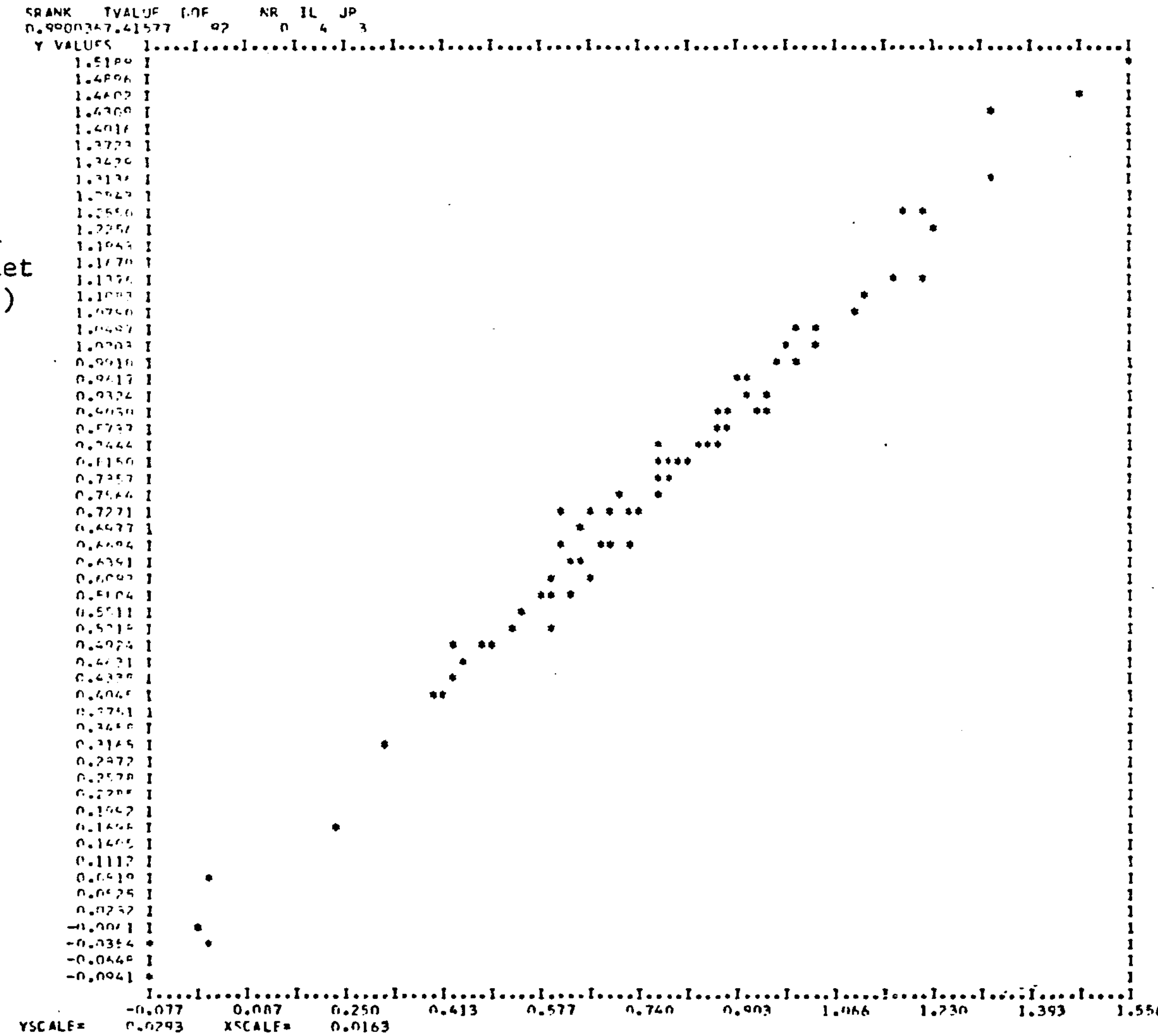
[1]Beaver, Kettler and Scholes, *op. cit.*; Gonedes, *op. cit.*; and Beaver and Manegold, *op. cit.*

Panel A

Subperiod Two: Market Beta (OLS)

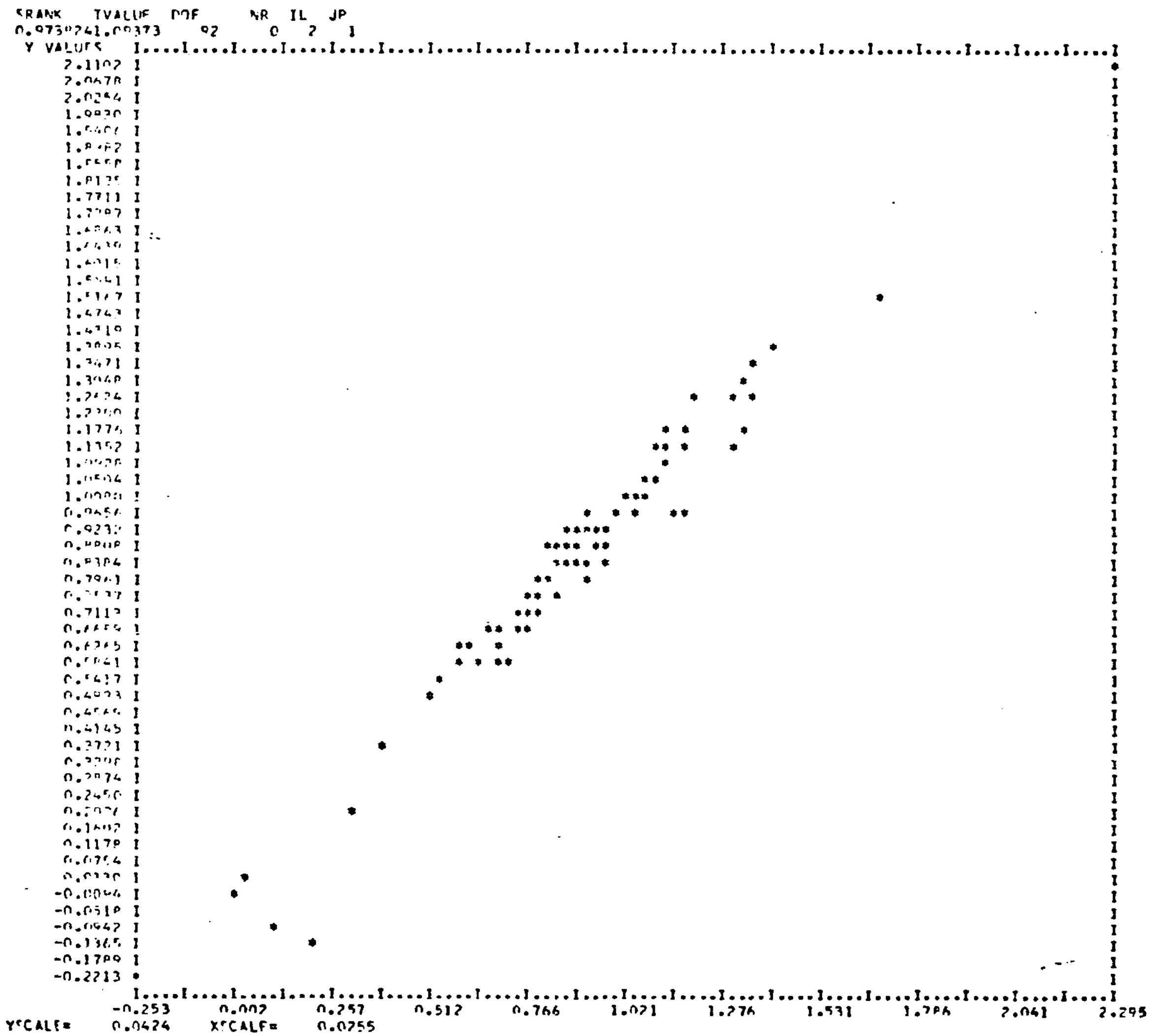


Subperiod Two: Market Beta (GLS)

Figure 5-1. Plots of Market Beta (OLS) Versus Market Beta (GLS).

Panel B

Subperiod One; Market Beta (OLS)



Subperiod One: Market Beta (GLS)

Figure 5-1 (Continued)

market beta estimated via the market model based on OLS procedures against market beta estimated via the above GLS representation, for subperiod two and subperiod one respectively. The indicated Spearman rank correlation coefficients for the plots suggest that the time dependency in the residuals e_{jt} is trivial. A similar technique is proposed by Pettit and Westerfield[2] to investigate the effects of cross-sectional dependency in the market model residuals.

With one exception, the non-market risk distributions also appear satisfactory. It is apparent that the distribution for the $\hat{\omega}^{D}_{jk}$ estimates may be unduly confounded by measurement error sufficient to obscure its potential association with market beta. This point is elaborated in the second section of this chapter. Finally, the expected reduction in the variability of unexpected changes derived from the ARIMA model, relative to the no forecast model, is apparent.

Normality of the Distributions

Although the preceding discussion concerns distributional aspects of the risk estimates, the specific question of whether these estimates are normally distributed was not asked. This question is important since it answer influences

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[2]R. Richardson Pettit and Randolph Westerfield, "Using the Capital Asset Pricing Model and the Market Model to Predict Security Returns," Journal of Financial and Quantitative Analysis (September, 1974), p. 590.

the selection and efficiency of the hypothesis test statistics. Beaver and Manegold[3] found that in most cases their "accounting beta" estimates were well approximated by an assumption of normality. A graphical cumulative periodogram technique was used. The technique employed in this study, to confirm whether the assumption of normality is appropriate, was the Kolmogorov-Smirnov one sample test. The test statistic is of the form

$$J = \sqrt{n} \max_{-\infty < z < \infty} |F'(z) - F(z)|$$

where F'(z) is a normal cumulative frequency distribution function with sample mean as specified in Table 5-1 (column 1) and sample standard deviation as specified in Table 5-1 (column 2). F(z) is the observed cumulative frequency distribution.[4] Under the null hypothesis that each risk variable is distributed normally, the critical value for J, for $n = 94$ and $\alpha = .05$, is 1.36. The Kolomogorov-Smirnov statistic, J, and its approximate probability (the approximate probability of rejecting z as a normal and being incorrect) are displayed in Table 5-2. Although the null cannot be rejected for market beta in either of the subperiods, it is rejected for 13 out of the 16 non-market risk estimates. Hence, normality may not be safely assumed

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[3]Beaver and Manegold, op. cit., p. 31.

[4]Sidney Siegel, Nonparametric Statistics (New York: McGraw-Hill, 1956), p. 48.

TABLE 5-2

SUMMARY OF KOLMOGOROV-SMIRNOV ONE SAMPLE TEST FOR NORMALITY OF MARKET BETA, QUARTERLY EARNINGS AND QUARTERLY DIVIDEND RISK ESTIMATES

	Subperiod One		Subperiod Two	
	Kolmogorov Statistic[a] (1)	Approximate Probability[b] (2)	Kolmogorov Statistic[a] (3)	Approximate Probability[b] (4)
1. Market Beta: $\hat{\beta}_j$	1.1560	.1381	.6305	.8215
2. Quarterly Earnings:				
Definition One, $\hat{\omega}^E_{jk}$				
No forecast	1.5897	.0128	1.3470	.0531
ARIMA	1.9032	.0014	1.0765	.1968
Definition Two, $\hat{\sigma}_{jk}(E)$				
No forecast	2.2492	.0	3.7628	.0
ARIMA	2.9807	.0	2.3527	.0
3. Quarterly Dividends:				
Definition One, $\hat{\omega}^D_{jk}$				
No forecast	2.9656	.0	2.8800	.0
ARIMA	3.5299	.0	2.7656	.0
Definition Two, $\hat{\sigma}_{jk}(D)$				
No forecast	1.5966	.0122	1.3391	.0554
ARIMA	1.4883	.0238	1.5172	.0200

[a]Kolmogorov Statistic = $\sqrt{94}\max|F'(z) - F(z)|$ where F'(z) is normally distributed c.d.f. with μ = sample mean and σ = sample standard deviation, and F(z) is the empirical c.d.f.

[b]Implies that one can reject that the set z is from normal distribution (significant at $\alpha = .05$ level) with approximate probability of being incorrect.

to characterize the data. The product moment correlation coefficient, the significance test of which requires normality, and the Hotelling test for the equality of two dependent degrees of correlation were thus rejected. Instead, nonparametric statistics, the significance tests of which did not require assumptions of normality, were used in all subsequent analyses.

Stability of Risk Estimates between Subperiods

For the purpose of estimation, market beta was assumed to be constant within each subperiod. But between each subperiod no prior assumption was required, despite some evidence that market beta behaves as an autoregressive process with long run mean equal to one.[5] Table 5-3 shows the Spearman rank correlation coefficients (and, for completeness, the product moment correlation coefficients) between subperiod one estimates and subperiod two estimates. The Spearman rank correlation coefficients may be interpreted as indicators of the relative degree of the stability of the estimates over the study period, 1958-1971.

Column 1 of Table 5-3 indicates that the stability of market beta (the correlation is equal to .4373) and the stability of the non-market risk estimates (the correlations are in the range [.2898, .6106]) do not differ appreciably. This empirical finding has a corollary which concerns the extent to which the instability in non-market risk estimates may be able to explain the instability of market beta. The third section of this chapter further examines this corollary.

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[5]Bogue, op. cit., p. 164.

TABLE 5-3

CROSS-SECTIONAL CORRELATIONS BETWEEN RISK ESTIMATES FOR SUBPERIOD ONE AND RISK ESTIMATES FOR SUBPERIOD TWO

	Single Securities		Portfolio (five securities)	
	Spearman Rank Correlation (1)	Product Moment Correlation (2)	Spearman Rank Correlation (3)	Product Moment Correlation (4)
1. Market Beta, $\hat{\beta}_j$	.4373	.5222	.5842	.7614
2. Quarterly Earnings				
Definition One, $\hat{\omega}^E_{jk}$				
No forecast	.5353	.3664	.5421	.4308
ARIMA	.2965	.3260	.2070	.3246
Definition Two, $\hat{\sigma}_{jk}(E)$				
No forecast	.4461	.2739	.7070	.2472
ARIMA	.5301	.7007	.0606	.8645
3. Quarterly Dividends				
Definition One, $\hat{\omega}^D_{jk}$				
No forecast	.3418	.7104	.7965	.7152
ARIMA	.2898	.5617	-.1158	.6707
Definition Two, $\hat{\sigma}_{jk}(D)$				
No forecast	.5722	.6326	.5211	.6168
ARIMA	.6106	.5720	.6754	.5969

One expected benefit of the portfolio groupings should be an increase in the between subperiod correlations, since with the proper selection of the partitioning instrument, the within portfolio variance is minimized relative to the between portfolio variance. However this is supported only in five out of nine correlations shown in Column 3 of Table 5-3. Contrary to expectations there is a drop in the correlations for the risk estimates, $\hat{\sigma}_{j2}(E)$ and $\hat{\omega}_{j2}^{D}$. Recall that the chosen partitioning instrument (market beta for subperiod one) should possess two properties. It should be correlated with an entity's relative risk yet also be independent of the measurement error in the estimated risk magnitudes. Otherwise the individual measurement error within the portfolios cannot be diversified. By implication therefore, it appears that the partitioning instrument inadequately reflects these properties for the non-market risk estimates, $\hat{\sigma}_{j2}(E)$ and $\hat{\omega}_{j2}^{D}$. The choice of a partitioning instrument which is sensitive to error not only in market beta, but also in all the non-market risk estimates would appear to be a topic for further study. In fact, Beaver and Manegold[6] indicate that an investigation is being planned especially for this purpose.

Correlation between Market Beta and Risk Estimates Derived from Published Quarterly Earnings and Quarterly Dividend Announcements

The first set of hypotheses of this study contended that an entity's relative risk and the information about risk which is conveyed by published quarterly earnings and quarterly dividend announcements were positively correlated [H.1(a) and H.1(b)]. To test this set of hypotheses, Spearman rank correlation coefficients between market beta and the non-market risk estimates were derived. The significance

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[6]Beaver and Manegold, op. cit., p. 45.

of the correlation coefficients was based on an approximation of a normal distribution with mean r_s and standard deviation $1/\sqrt{(n-2)/(1-r_s^2)}$, where r_s is the Spearman rank correlation coefficient, and n = 94 for individual securities and n = 19 for portfolios.

Table 5-4 presents the Spearman rank correlation coefficients between market beta and all non-market risk estimates. Product moment correlation coefficients are also given for completeness. Columns 1-4 and 5-8 report the contemporaneous correlation for subperiod one and subperiod two respectively. Columns 9-12 report the predictive (non-contemporaneous) correlations between the non-market risk estimates for subperiod one and the market beta for subperiod two.

First, consider the correlations in Columns 1 and 5 of Panel A. All individual correlations between market beta and quarterly earnings risk estimates are significant at $\alpha<.05$ for definition one. The equivalent portfolio correlations are higher and, in general, are also significant at $\alpha<.05$. In contrast, for definition two, only one out of four individual security correlations is significant.

Second, the contemporaneous correlations between market beta and quarterly dividend risk estimates are indicated in Columns 1 and 5 of Panel B. All individual correlations and three out of the four portfolio correlations are significant at $\alpha<.05$ for definition two. As expected the

TABLE 5-4

CROSS-SECTIONAL CORRELATIONS BETWEEN MARKET BETA, QUARTERLY EARNINGS RISK ESTIMATES AND QUARTERLY DIVIDEND RISK ESTIMATES

	Subperiod One Contemporaneous Correlation				Subperiod Two Contemporaneous Correlation				Subperiod One Risk Estimates vs. Subperiod Two Market Predictive Correlation			
	Single Securities		Portfolio (5 Securities)		Single Securities		Portfolio (5 Securities)		Single Securities		Portfolio (5 Securities)	
	S.R.[a] (1)	P.M.[b] (2)	S.R. (3)	P.M. (4)	S.R. (5)	P.M. (6)	S.R. (7)	P.M. (8)	S.R. (9)	P.M. (10)	S.R. (11)	P.M. (12)
Panel A: Market beta vs. Quarterly Earnings Risk Estimates												
Definition One, $\hat{\omega}^E_{jk}$												
No forecast	.2224*	.1284	.3000	.2778	.4433**	.2568	.4719*	.2775	.1659	.1051	.2000	.1991
ARIMA	.2330*	.1630	.5404**	.5220	.3252**	.2379	.4561*	.3191	.1384	.1103	.4386*	.4038
Definition Two, $\hat{\sigma}_{jk}(E)$												
No forecast	.1343	.0337	.2754	.0302	.1164	-.0217	.0930	.1805	-.1353	-.1866	.0053	-.2178
ARIMA	.1993*	.1311	.7214**	.2120	.0973	.0692	.3316	.1628	-.0864	-.0976	.3633	.0933

TABLE 5-4 (Contd.)

	Subperiod One Contemporaneous Correlation				Subperiod Two Contemporaneous Correlation				Subperiod One Risk Estimates vs. Subperiod Two Market Predictive Correlation			
	Single Securities		Portfolio (5 Securities)		Single Securities		Portfolio (5 Securities)		Single Securities		Portfolio (5 Securities)	
	S.R.[a] (1)	P.M.[b] (2)	S.R. (3)	P.M. (4)	S.R. (5)	P.M. (6)	S.R. (7)	P.M. (8)	S.R. (9)	P.M. (10)	S.R. (11)	P.M. (12)
Panel B: Market beta vs. Quarterly Dividend Risk Estimates												
Definition One, ω^D_{jk}												
No forecast	.0809	.0151	.1684	-.0277	-.0645	-.0589	-.1596	-.2230	.0608	-.1866	-.0018	-.2656
ARIMA	.1729*	.1225	.5702**	.2044	.1523	.0839	.2351	.1084	.1155	-.0663	.4526*	.1061
Definition Two, $\hat{\sigma}_{jk}(D)$												
No forecast	.2739**	.1256	.3842	.3155	.4148**	.2913	.6211**	.4624	.2182*	.1467	.3579	.3755
ARIMA	.3400**	.2152	.5754**	.4455	.4167**	.3136	.6509**	.5403	.2968**	.2527	.5175*	.4511

*Significant $\alpha < .05$.

**Significant $\alpha < .01$.

[a] Spearman Rank correlation coefficient.

[b] Product moment correlation coefficient.

portfolio correlations are higher than those for the individual securities.

Third, a comparison between the ARIMA correlations and the no forecast correlations reveals that 13 out of a total of 16 (columns 1, 3, 5, 7) are higher for the ARIMA category. Further, in 6 out of the 13 above, the ARIMA correlations are significant at $\alpha<.05$ whereas the no forecast correlations are not. In no case is this trend reversed.

To summarize thus far, the evidence suggests that if ω_{jk}^{E} is an appropriate definition for risk information conveyed by published quarterly earnings, then hypothesis H.1(a) can be rejected. There is, however, little to support that this definition applied to the quarterly dividend announcements in the form ω_{jk}^{D} is appropriate. Instead, definition two, $\sigma_{jk}(D)$, appears to be the appropriate specification. Thus for definition two, $\sigma_{jk}(D)$, hypothesis H.1(b) can be rejected. Measurement error in $\hat{\omega}_{jk}^{D}$, most likely induced by the low variability of d_{jkt} and d_{mkt} (defined in Chapter Three) and by a misspecification of the economy-wide index, would seem to account for the insignificant correlations between market beta and estimates of risk defined as ω_{jk}^{D}. This was observed also in an earlier table (Table 5-1) which reported higher measures of variability for $\hat{\omega}_{jk}^{D}$ (columns, 2, 6 and 7, Table 5-1) compared to $\hat{\omega}_{jk}^{E}$. Moreover, an implicit assumption of the dividend risk definition, ω_{jk}^{D}, that unexpected dividend changes are a function of an economy-wide index may require reexamination in addition to the errors-in-variables problem. Alternative specifications of the economy-wide factors (and possibly industry factors) common to unexpected dividend changes may be needed to fully investigate this area.

A corroboration of the appropriateness of the ω_{jk}^{D} and the $\sigma_{jk}(D)$ definitions is reflected in Lev and Kunitzky.[7] Somewhat consistent with the results reported above, they found that, for annual dividend per share changes, smoothing measures in a form similar to the $\sigma_{jk}(D)$ definition were significantly reflected in market-determined risk estimates. But in a form similar to the ω_{jk}^{D} definition, the smoothing measures were essentially uncorrelated with market beta.

Table 5-4 also details the correlations between market beta for subperiod two and the non-market risk estimates for subperiod one (columns 9-12). Interpreting the non-contemporaneous measures of correlation as simple indicators of predictive ability, it is evident that the non-market risk measures are no better than the subperiod one market beta as predictors of subperiod two market beta. The correlation between the market betas is .4373 (Table 5-3) whereas the correlations between quarterly earnings risk

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[7]Lev and Kunitzky, op. cit., p. 267.

estimates from subperiod one and market beta for subperiod two are in the range [-.1353, .1659]. Equivalently, the correlations for the dividend risk estimates are in the range [.0608, .2968]. But note that the only significant correlations for individual securities are between market beta and the dividends risk estimates, $\hat{\sigma}_{jk}(D)$. One explanation of this significance may pertain to the difference in time orientation between unexpected changes in quarterly earnings and unexpected changes in quarterly dividends which is implied by the "information content of dividends" hypothesis.

If management use dividend changes as a way of conveying information about an entity's permanent earnings, then such changes may reflect their prospective expectations about the entity's future performance. On the other hand, if published quarterly earnings changes are viewed by market participants either to contain excessive noise or to be retrospective in nature (that is relating to past performance), then their ability to predict future period market beta should be lower, relative to dividend changes. They are poorer predictors of future entity performance as perceived by the capital market. Some additional evidence of this relationship is presented in the final section of this chapter.

Overall, the predictive correlations for non-market risk estimates are lower than that for market beta. But apart from the comment of the preceding paragraph, this was not altogether unexpected. Due to: (1) the maintained efficiency of the capital market, (2) the observed similarity in the stability of market beta and the non-market risk estimates, and (3) the significant contemporaneous correlations between non-market risk estimates and market beta, there is little empirical evidence to support the proposition that naive extrapolation of historical non-market risk estimates can outperform an extrapolation of market beta as an assessment of a future period market beta. Instrumental variables, however, that combine market and/or non-market information have been shown by Beaver, Kettler and Scholes, and Rosenberg and McKibben[8] to provide better estimators of future market beta. The instrumental variables technique was not incorporated into this study, since apart from the difficulty of selecting the instruments, it tends to obscure the original impact of the estimates as predictors by the removal of error.

To supplement the correlation analysis of Table 5-4, the contemporaneous association between market beta and non-market estimates of risk was examined via a dichotomous

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[8]Beaver, Kettler and Scholes, op. cit.; Barr Rosenberg and Walt McKibben, "The Prediction of Systematic and Specific Risk in Common Stocks," Journal of Financial and Quantitative Analysis (March, 1973), pp. 317-333.

classification test. The test reflects a simple investment strategy in that it examines the ability of the non-market estimates to distinguish two states of a security's market beta. Market beta is dichotimized as "high" or "low." "High" beta and "low" beta information may be all that some investors require if the objective of their strategy is to switch from "high" to "low" risk securities and vice-versa depending on the expected direction of the market as a whole. A natural benchmark for the market beta dichotomy is the NYSE average, that is market beta equals one. But since from Table 5-1 the sample under study has lower than average market beta, the chosen benchmark was the median for each subperiod. The test statistic is a χ^2 value with one degree of freedom under the null hypothesis that market beta and non-market estimates of risk are independent. Each non-market risk estimate was compared to market beta in a two by two contingency table of the form

	Market beta below median (1)	Market beta above median (2)
(1) Non-market risk below median	(11)	(12)
(2) Non-market risk above median	(21)	(22)

Under independence the frequencies in cells (11), (12), (21) and (22) should be equal whereas under the alternative hypothesis the frequencies in cells (11) and (22) should dominate. The results reported in Table 5.5, confirm the results of the previous table (Table 5.4). Columns 1

TABLE 5-5

DICHOTOMOUS CLASSIFICATION TEST OF CONTEMPORANEOUS ASSOCIATION: χ^2 VALUES WITH ONE DEGREE OF FREEDOM

	Subperiod One		Subperiod two	
	Individual Securities (1)	Portfolio (5 securities) (2)	Individual Securities (3)	Portfolio (5 securities) (4)
Panel A: Market beta vs. Quarterly Earnings Risk Estimates				
Definition One, $\hat{\omega}^E_{jk}$				
No forecast	6.1277*	.0475	10.8936**	1.2954
ARIMA	4.2553*	1.2954	8.3404**	1.2954
Definition Two, $\hat{\sigma}_{jk}(E)$				
No forecast	2.0861	.0475	2.7234	.4932
ARIMA	4.2553*	8.8719**	.6809	.0475
Panel B: Market beta vs. Quarterly Dividends Risk Estimates				
Definition One, $\hat{\omega}^D_{jk}$				
No forecast	0.0	1.2954	0.0	.0475
ARIMA	.1702	1.2954	2.7234	.0475
Definition Two, $\hat{\sigma}_{jk}(D)$				
No forecast	5.1513*	.0475	4.2553*	4.2369*
ARIMA	4.2553*	1.2954	7.1947**	4.2369*

*Significant $\alpha < .05$.

**Significant $\alpha < .01$.

and 3 of Table 5-5 clearly reveal that the non-market risk estimates, $\hat{\omega}^E_{jk}$ and $\hat{\sigma}_{jk}(D)$, are able to significantly differentiate between high and low beta securities. Thus for quarterly earnings risk estimates defined as ω^E_{jk}, and for quarterly dividends risk estimates defined as $\sigma_{jk}(D)$, the rejection of hypotheses H.1(a) and H.1(b) is supported.

The second question raised at the outset of this research concerns the possibility of a differential capital market response to the risk information conveyed by published quarterly earnings and quarterly dividend announcements. The main propositions in support of this contention related to differences in: (1) the criteria for measurement of earnings and dividends, (2) the mode of transmission of the information, and (3) the time orientation of the information. Consequently, a test of the second hypothesis was to assess whether the correlations between market beta and the quarterly earnings risk estimates and the correlations between market beta and the quarterly dividend risk estimates were significantly different. Due to the non-normality of the distributions, a nonparametric statistic based on the Kendall sample rank correlation coefficient was chosen.[9] The Kendall statistic (which is an estimate of the Kendall correlation coefficient tau) may be used to test the independence of the two variables, $\hat{\beta}_j$ and $\hat{\zeta}_{jk}$, where

$$\hat{\zeta}_{jk} = [\hat{\omega}^{E}_{jk} - \hat{\omega}^{D}_{jk}] \text{ for risk definition one, or}$$

$$= [\hat{\sigma}_{jk}(E) - \hat{\sigma}_{jk}(D)] \text{ for risk definition two.}$$

For tau>0, quarterly earnings risk estimates are more highly correlated with market beta; for tau = 0, quarterly earnings and quarterly dividend risk estimates are equally correlated

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[9]This test was suggested by Douglas A. Wolfe, co-author of Myles Hollander and Douglas A. Wolfe, Nonparametric Statistical Methods (New York: John Wiley and Sons, 1973).

with market beta; and for tau<0, quarterly dividend risk estimates are more highly correlated with market beta. The Kendall test statistic is approximately normally distributed with mean equal to zero and standard deviation equal to $[n(n-1)(2n+5)/18]^{1/2}$ where n = 94 for individual securities.[10]

Table 5-6 details the Kendall rank correlation coefficients for each subperiod, each definition and each generating process. Of the 16 tests made, only two indicated significance. Hence, there appears to be no consistent evidence to suppose that hypothesis H.(2) can be rejected. Stated alternatively, the risk information conveyed by quarterly earnings and the risk information conveyed by quarterly dividends do not appear to differ in their association with market beta.

Correlation between Changes in Market Beta and Changes in Non-Market Risk Estimates

The third hypothesis considers the degree of association between changes in market beta and changes in estimates of risk derived from published quarterly earnings and quarterly dividend announcements. To test this hypothesis the algebraic change in all risk estimates over the two subperiods was determined and estimates of the Spearman rank correlations between the changes in market beta and the

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[10]Hollander and Wolfe, op. cit., p. 186.

TABLE 5-6

TEST FOR EQUALITY OF DEPENDENT SPEARMAN RANK CORRELATIONS

	Subperiod One Kendall Rank Correlation[a]		Subperiod Two Kendall Rank Correlation[a]	
	Single Securities	Portfolio (5 securities)	Single Securities	Portfolio (5 securities)
Definition One, ω_{jk}				
No forecast:				
$corr(\hat{\beta}_j, \hat{\omega}^E_{j1}) =$				
$corr(\hat{\beta}_j, \hat{\omega}^D_{j1})$	.0496	-.0877	.1911**	.2632
ARIMA:				
$corr(\hat{\beta}_j, \hat{\omega}^E_{j2}) =$				
$corr(\hat{\beta}_j, \hat{\omega}^D_{j2})$	-.0062	-.2749	.1009	.0058
Definition Two, $_{jk}$				
No forecast:				
$corr(\hat{\beta}_j, \hat{\sigma}_{j1}(E)) =$				
$corr(\hat{\beta}_j, \hat{\sigma}_{j1}(D))$	.0661	.1930	.0465	.0409
ARIMA:				
$corr(\hat{\beta}_j, \hat{\sigma}_{j2}(E)) =$				
$corr(\hat{\beta}_j, \hat{\sigma}_{j2}(D))$	.0767	.4386**	.0080	.1345

**Significant $\alpha < .01$.

[a]If $\tau > 0 \rightarrow$ Quarterly earnings risk information is more highly correlated with market beta.
If $\tau < 0 \rightarrow$ Quarterly dividend risk information is more highly correlated with market beta.
If $\tau = 0 \rightarrow$ Quarterly earnings risk information and quarterly dividend risk information are equally correlated with market beta.

changes in non-market risk estimates were derived. As such, the correlations measure the degree to which rankings of the magnitude and direction of differences in market beta are similar to those of the magnitude and direction of changes in the non-market risk estimates. The results are tabulated in Table 5-7. Column 1 reveals that for individual securities, all correlations are significant at $\alpha < .05$ for the ARIMA generating process. The correlations are of approximately the same degree for the quarterly earnings versus the quarterly dividends comparison, and are generally larger for portfolios. The evidence therefore suggests that hypothesis H.3 can be rejected.

The cross-sectional distributions of the risk changes were reasonably symmetric, although the mean change in some cases was slightly above zero (for example, change in market beta). This is evident in Figure 5-2 (Panel A and Panel B) which provides representative plots of the relationship between the change in market beta and the change in two non-market risk estimates, $\hat{\omega}^{E}_{jk}$ and $\hat{\sigma}_{jk}(D)$ for the ARIMA application.

To summarize, the results appear to support two related propositions. First, as new risk information is conveyed to market participants, it is impounded into their expectations about relative risk (as estimated by market beta). By implication, this may mean that the same set of economic events that cause expectations about relative risk

TABLE 5-7
CROSS-SECTIONAL CORRELATIONS BETWEEN CHANGE IN MARKET BETA AND CHANGE IN QUARTERLY EARNINGS AND QUARTERLY DIVIDEND RISK ESTIMATES

	Single Securities Spearman Rank Correlation Coefficient (1)	Portfolio (5 securities) Spearman Rank Correlation Coefficient (2)
Panel A: Change in Market Beta vs Change in Quarterly Earnings Risk Estimate		
Definition One: $\hat{\omega}^{E}_{jk}$		
No forecast	.2190*	.1123
ARIMA	.2067*	.2754
Definition Two: $\hat{\sigma}_{jk}(E)$		
No forecast	.3207**	.2982
ARIMA	.4247**	.7088**
Panel B: Change in Market Beta vs. Change in Quarterly Dividend Risk Estimate		
Definition One: $\hat{\omega}^{D}_{jk}$		
No forecast	.0154	.1667
ARIMA	.2402**	.6526**
Definition Two: $\hat{\sigma}_{jk}(D)$		
No forecast	.3379**	.5263*
ARIMA	.3126**	.6070**

*Significant $\alpha < .05$.

**Significant $\alpha < .01$.

Panel A

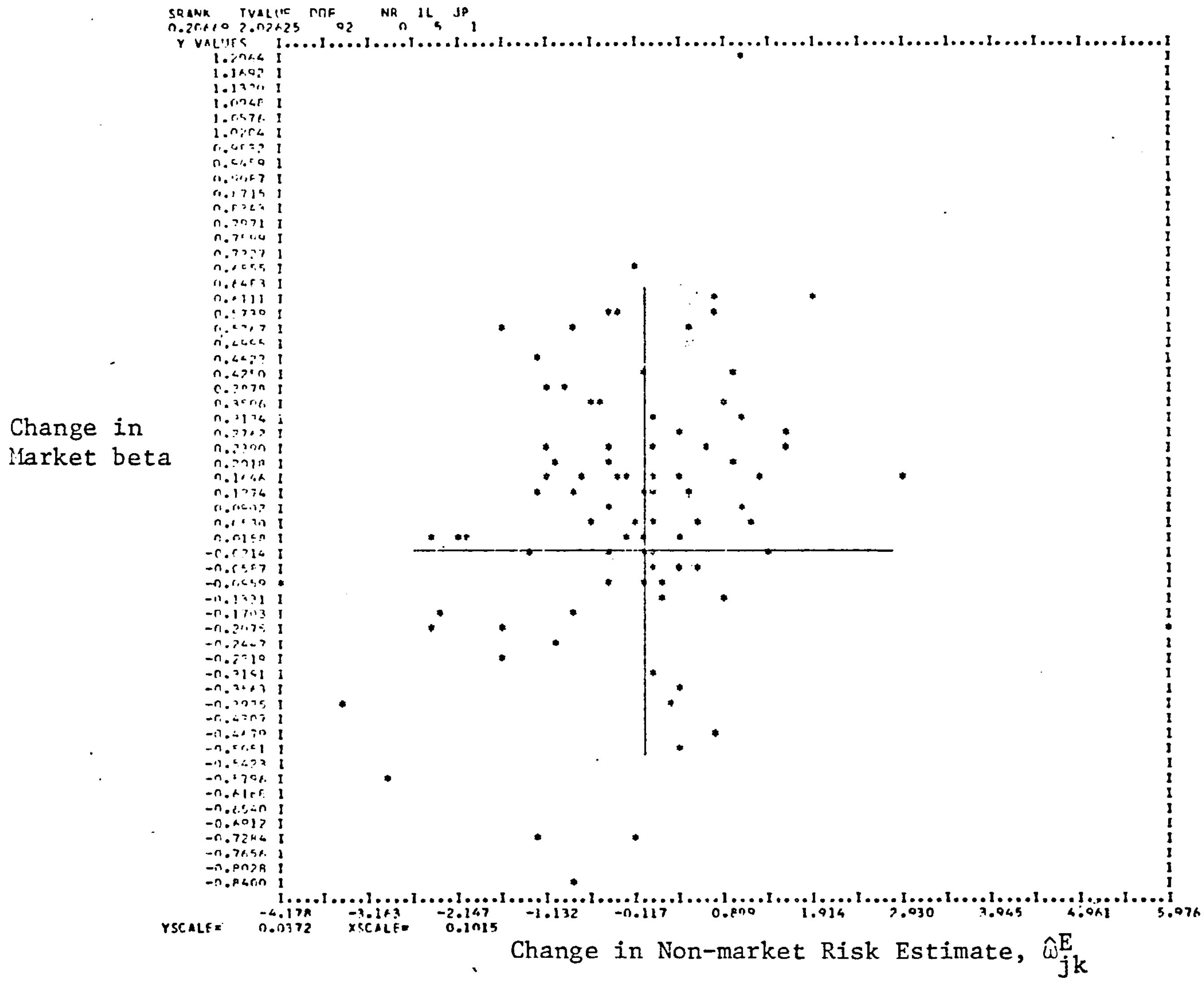

Figure 5-2. Plots of Change in Market Beta Versus Change in Non-market Risk Estimates, $\hat{\omega}^E_{jk}$ and $\hat{\sigma}_{jk}(D)$.

Panel B

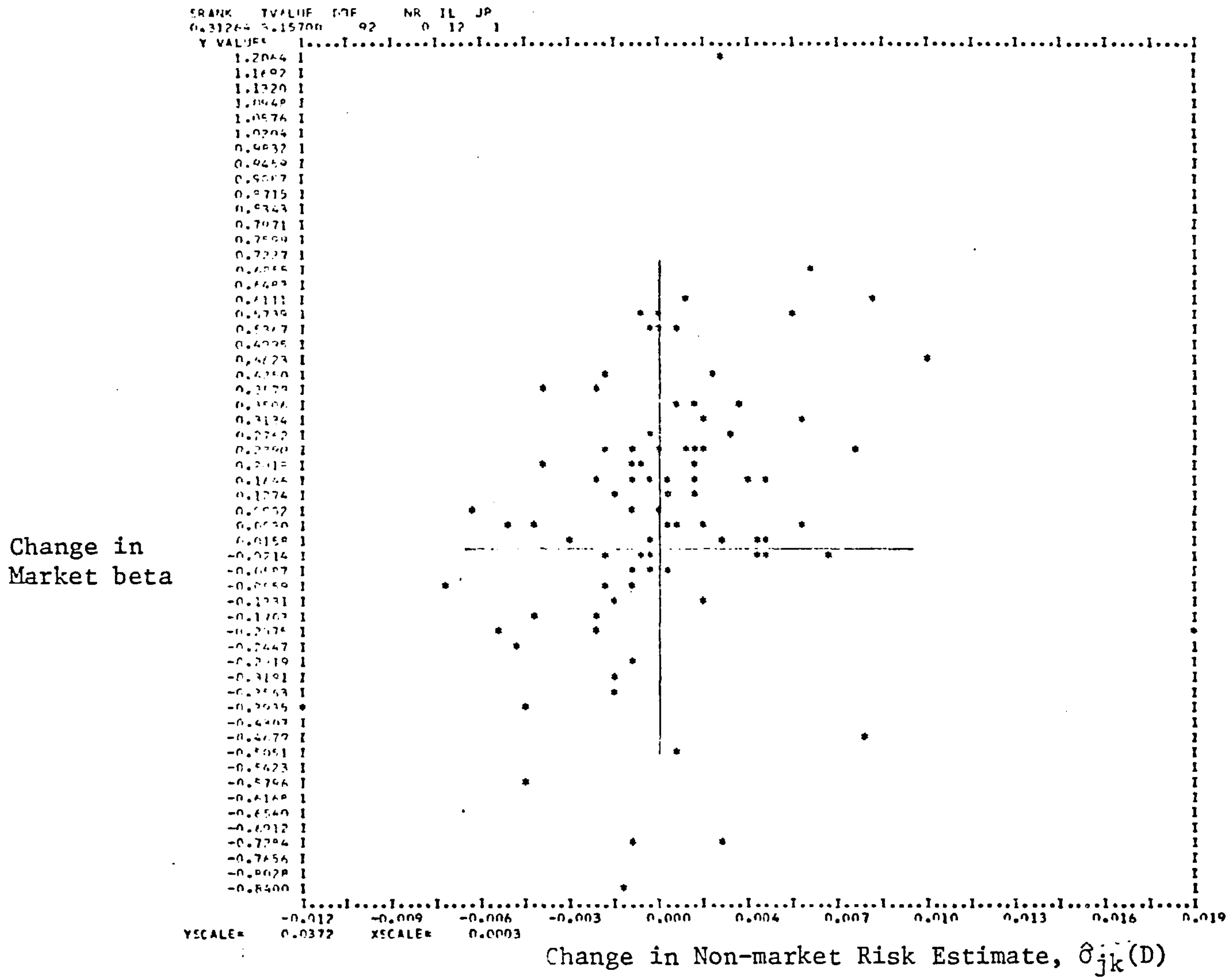

Figure 5-2 (Continued)

to vary, are also reflected by the variation in quarterly earnings and the quarterly dividend risk information. Second, at least part of the instability in market beta would appear to be explained by the information about risk that is reflected in quarterly earnings and quarterly dividends.

Test of Combined Effect of Risk Estimates

Risk information conveyed by published quarterly earnings and quarterly dividend announcements is released to the market on or about the same point in time. Hence, an interaction effect is likely to exist in the security price response to quarterly earnings and quarterly dividends. This research does not attempt to isolate this effect in the design of the empirical tests. Instead it focuses on the impact of each kind of information in the presence of the other. In this regard, the test of hypothesis H.2 provided no support for the existence of a differential capital market response. The hypothesis to be tested in this section, H.4, approaches the issue from the viewpoint of the combined impact of quarterly earnings and dividend risk information.

The empirical test was constructed in the following manner. First, each estimate of risk was cross-sectionally ranked according to magnitude from lowest to highest, and then partitioned into one of two groups. The benchmark for the partition was the median of the cross-sectional distribution. Second, two contingency tables were constructed. Contingency table one isolated non-market risk estimates, the combined message of which was unambiguous (an unambiguous message was operationally defined to be one where both quarterly earnings and quarterly dividend risk estimates were above or below their respective median values). Contingency table two isolated those messages operationally defined to be ambiguous (the quarterly earnings risk estimate was above (below) its median and the quarterly dividend risk estimate was below (above) its median.

The tables were of the following form:

1. Contingency Table One--Unambiguous Message.

	Market beta below median (1)	Market beta above median (2)
(1) Both non-market risk estimates below median	(11)	(12)
(2) Both non-market risk estimates above median	(21)	(22)

2. Contingency Table Two--Ambiguous Message.

	Market beta below median (1)	Market beta above median (2)
(1) Earnings estimate below, and Dividend estimate above median	(11)	(12)
(2) Earnings estimate above, and Dividend estimate below median	(21)	(22)

To reject hypothesis H.4, (and accept the alternative that only unambiguous risk messages are positively correlated with market beta) the χ^2 statistic for contingency table one should be significant with frequencies dominating cells (11) and (22). In addition, the χ^2 statistic for contingency table two should be insignificant and therefore indicate that ambiguous messages are independent of the dichotomy in market beta.

The χ^2 statistics are reported in Table 5-8 for three comparisons of the non-market risk estimates: (1) $\hat{\omega}_{jk}^{E}$ and $\hat{\omega}_{jk}^{D}$, (2) $\hat{\sigma}_{jk}(E)$ and $\hat{\sigma}_{jk}(D)$, and (3) $\hat{\omega}_{jk}^{E}$ and $\hat{\omega}_{jk}(D)$. Although from the first comparison (row 1), it is evident that the results are inconclusive, one should recall that, in part, the $\hat{\omega}_{jk}^{D}$ risk estimates may be seriously affected by measurement error. This error may have a downward biasing effect on the χ^2 values. Accordingly, the second (row 2) and third (row 3) comparisons are likely to constitute more reliable tests of hypothesis H.4. As shown in Rows 2 and 3, the χ^2 values are significant for the unambiguous messages and are insignificant for the ambiguous messages. Since the unambiguous messages are able to differentiate the market beta dichotomy and the ambiguous messages are not, hypothesis H.4 can be rejected.

To the extent that this operational and _a priori_ notion of ambiguity may be more generally associated with the degree of confidence that market participants have in the distributions of security returns, it appears that it may be a significant _intervening_ variable in the relationship

TABLE 5-8

DICHOTOMOUS CLASSIFICATION TEST FOR COMBINED EFFECTS OF EARNINGS AND DIVIDEND RISK ESTIMATES: χ^2 VALUES WITH ONE DEGREE OF FREEDOM (single securities only)

	Subperiod One		Subperiod Two	
	Unambiguous (1)	Ambiguous (2)	Unambiguous (3)	Ambiguous (4)
1. Definition One: $\hat{\omega}^E_{jk}$, $\hat{\omega}^D_{jk}$				
No forecast	2.3504	2.9557	5.4180*	4.3346*
ARIMA	3.0560	.8839	8.4351**	.4571
2. Definition Two: $\hat{\sigma}_{jk}(E)$, $\hat{\sigma}_{jk}(D)$				
No forecast	5.3720*	.1181	6.0082*	0.0
ARIMA	6.4516*	0.0	5.4688*	1.1882
3. Definition One: $\hat{\omega}^E_{jk}$ and Definition Two: $\hat{\sigma}_{jk}(D)$				
No forecast	8.5106**	0.0233	10.3278**	0.5989
ARIMA	6.8966**	0.1111	11.2085**	0.0281

*Significant at $\alpha <$ .05.

**Significant at $\alpha <$ .01.

between security prices and competing sources of information. Another potentially interesting implication of these results pertains to an assumption on which the test was based. The assumption stated that each source of information was judged by market participants as equally reliable (refer to Chapter Two). Since the ambiguous messages are generally independent of the market beta dichotomy (11 out of 12 cases), the results do not appear to contradict the proposition that risk information conveyed by quarterly earnings and quarterly dividends are not significantly different (hypothesis H.2).

Correlation Test of the Information Content of Dividends

The information content of dividends hypothesis was stated at the outset of this study. It refers to a proposition that dividend changes convey information to market participants about management's expectations of permanent earnings. If this information is not already available via other sources such as published earnings, it should enable market participants to more accurately predict an entity's future performance. The empirical test applied was similar to one outlined by Watts.[11] Essentially, the procedure was to evaluate the ability of the standard deviation of the unexpected quarterly dividend change for subperiod one to predict the standard deviation of the unexpected quarterly earnings change for subperiod two. The results of this test are contained in row 3 of Table 5-9. The Spearman rank correlations indicate that the proposition is supported for both the no forecast and the ARIMA derived estimates of unexpected changes. In addition, the reverse correlations (subperiod one unexpected earnings and subperiod two unexpected dividends), as

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[11] Watts, op. cit., p. 202.

TABLE 5-9

CROSS-SECTIONAL CORRELATIONS BETWEEN RISK ESTIMATES DERIVED FROM QUARTERLY EARNINGS AND QUARTERLY DIVIDENDS (DEFINITION TWO ONLY)

	Single Securities		Portfolio (Five securities)	
	Spearman Rank Correlation (1)	Product Moment Correlation (2)	Spearman Rank Correlation (3)	Product Moment Correlation (4)
Panel A: Contemporaneous				
1. Subperiod One				
No forecast	.2959**	.3153	.2035	.2139
ARIMA	.3227**	.1279	.6573**	.1700
2. Subperiod Two				
No forecast	.2328*	.1222	.1614	.5653
ARIMA	.2619**	.2112	.3667	.1214
Panel B: Non Contemporaneous				
3. Subperiod Two Earnings and Subperiod One Dividends				
No forecast	.2473**	.1603	.4123*	.5968
ARIMA	.2485**	.2668	.3158	.2138
4. Subperiod One Earnings and Subperiod Two Dividends				
No forecast	.1092	.2200	.0596	-.0112
ARIMA	.0937	.0599	.1580	-.0304

*Significant at $\alpha < .05$.

**Significant at $\alpha < .01$.

indicated in row 4, are insignificant. That is, the standard deviation of the unexpected changes in earnings does not appear to predict the standard deviation of future unexpected changes in quarterly dividends. In short, both results appear to strengthen the descriptive validity of the information content of dividends hypothesis.

Finally, rows 1 and 2 of Table 5-9 disclose that the contemporaneous correlation between the quarterly earnings and quarterly dividend risk estimates (Definition Two only) are significant at $\alpha < .05$. This result was anticipated since the correlations merely reflect that the same information about unexpected permanent earnings is reflected in both types of estimates. Recall that the permanent earnings concept was the basis for the model of capital asset risk outlined in Chapter Two.

CHAPTER VI

SUMMARY AND CONCLUSIONS

The intent of this final chapter is to evaluate the research findings of the dissertation in terms of the relationship between security prices and risk information. It will be recalled that the primary objective was to answer two empirical research questions. The first sought to determine the extent to which published quarterly earnings and quarterly dividend announcements convey risk information pertinent to the "value" of an entity as reflected in security prices. The second endeavored to ascertain whether significant differences exist between the ability of published quarterly earnings and quarterly dividend announcements to convey risk information pertinent to the "value" of an entity.

Initially, the major propositions inherent in this study are briefly reviewed, and the principal substantive and methodological findings are summarized. Second, the potential limitations of the research design and the estimation procedures are indicated. Third, the conclusions and their implications for related studies are presented.

Finally, several research possibilities that constitute logical extensions of this research are described.

Summary

Theoretical Propositions

To evaluate the risk information content of quarterly earnings and quarterly dividends, a conceptual structure linking security prices and risk to each source of information was presented in earlier chapters. The theoretical propositions inherent in this structure are briefly reviewed to reintroduce the reader to the overall framework of this study.

The impact of each kind of information on capital market behavior was assessed from the viewpoint of the relative risk associated with an entity's securities. Relative risk was defined as *ex ante* market systematic risk in terms of the two parameter capital asset pricing model. Since within the model an assumption of efficient markets was maintained, all available risk information was regarded as being impounded in this variable. Further, it was argued that new information would induce a revision of expectations which in turn would cause a change in the capital market equilibrium price. The difference between an actual price change and the expected price change, given available information, was viewed as the effect of new information.

The effect of new information, in addition to inducing change in equilibrium prices, was also assumed to have an impact on an entity's risk characteristics. Accordingly, the effect of new risk information could be assessed by the change that it induced in relative risk. Two propositions implied by the preceding arguments (detailed in Chapter Two) were the basis for the risk criterion: (1) Since the level of an entity's relative risk may be expected to reflect all available risk information, and since relative risk may be expected to differ between entities, a positive correlation between such information and relative risk should exist. (2) If, <u>for estimation purposes</u>, relative risk is assumed to be stable for short periods of time, then the risk information flowing to the capital market in a future period may be expected to induce change in the estimated value of relative risk. Hence a positive association between the change in the risk information for each period and the change in relative risk should also exist. The change occurs as a result of the new risk information which is quickly and unbiasedly impounded in security prices.

To specify the relationship between entity valuation, published quarterly earnings and quarterly dividend announcements, a standard valuation model was presented. Under simplifying assumptions, entity market value was defined to be equal to permanent earnings (<u>ex ante</u> earnings generated in perpetuity by assets currently held) times a capitalization factor (the reciprocal of the rate at which earnings are discounted). Within a capital market setting, if (1) market value changes are reflected via changes in the value of an entity's securities, and (2) two sources of information about change in permanent earnings are quarterly earnings and quarterly dividends, then those numbers may be expected to convey information about changes in the "value" of an entity's securities.

As sources of information about change in permanent earnings, they differed in their orientation. While in both cases it was presumed that the capital market response was a function of the magnitude and direction of unexpected change, a number of factors (e.g., measurement criteria) gave rise to the possibility of a differential response. Unexpected changes in quarterly earnings were viewed as relatively direct signals of change in permanent earnings. On the other hand, unexpected changes in quarterly dividends were regarded as indirect signals dependent on the notion of the information content of dividends. In fact, it was argued that if management perceive that participants are unable to distinguish change in published earnings which is due to random variation from that which is due to change in permanent earnings, then they may use dividend payout as a device for disseminating their expectations about change in permanent earnings.

Finally a model of capital asset risk was stated to relate the propositions concerning relative risk and risk information derived from quarterly earnings and quarterly dividends. In brief the model implied that an empirical analog of an entity's relative risk (market beta) is a function of two factors: (1) the covariability of an unexpected change in permanent earnings for an entity with an unexpected change in the permanent earnings for a market portfolio, and (2) the covariability of an unexpected change in an entity's capitalization rate with an unexpected change in the capitalization rate for a market portfolio. Since two sources of information about change in permanent earnings were posited to be published quarterly earnings and quarterly dividend announcements, a logical relationship between an entity's relative risk and each kind of information was thus established.

The remainder of this section is taken up with a restatement of the hypotheses and a summary of the empirical results of the tests of such hypotheses.

Hypotheses and Empirical Results

1. Four hypotheses were derived from the above theoretical propositions. The first hypothesis was tested on the basis of correlation and dichotomous classification.

> H.1(a)--Risk information as reflected in security prices (relative risk) is uncorrelated with risk information conveyed to market participants via published quarterly earnings.

H.1(b)--Risk information as reflected in security prices (relative risk) is uncorrelated with risk information conveyed to market participants via quarterly dividend announcements.

The results of Table 5-4 (p. 146) indicates that if ω^E_{jk} is an appropriate definition for quarterly earnings risk information, and if $\sigma_{jk}(D)$ is an appropriate definition for quarterly dividends risk information, then the above hypotheses H.1(a) and H.1(b) can be rejected. In each case there was a statistically significant similarity in the ranking of market beta (empirical estimate of relative risk) and the non-market estimates of risk. This held for both the no forecast and the ARIMA specification of the process generating unexpected changes.

The dichotomous classification test (refer Table 5-5, p. 153) also supported the rejection of H.1(a) and H.1(b) for the risk definitions ω^E_{jk} and $\sigma_{jk}(D)$. Each non-market risk estimate was able to significantly differentiate high risk and low risk securities. However, it was evident from the non-contemporaneous correlations detailed in Table 5-4 that non-market risk estimates were no better predictors of a future period market beta than was market beta of a prior period. The prediction model was interpreted as a direct extrapolation of the prior period estimate, without adjustment.

2. Although published quarterly earnings and quarterly dividend announcements were expected to convey risk information pertinent to the "value" of an entity, their

criteria for measurement and mode of transmission to the capital market were dissimilar. A second hypothesis was directed toward the potential differential capital market response.

> H.2--Risk information conveyed by published quarterly earnings and quarterly dividend announcements are not significantly different in their correlation with risk information as reflected in security prices (relative risk).

As shown in Table 5-6 (p. 156) their seems to be no significant difference in: (1) the correlation between market beta and quarterly earnings risk estimates, and (2) the correlation between market beta and quarterly dividend risk estimates. The risk information content of each kind of signal does not appear to be substantially different. Note that this result pertains to the differential impact of each kind of information in the presence of the other. The test on which it is based did not endeavor to isolate or control for the effects of the information common to both.

3. The emphasis of the third hypothesis was on the change in relative risk induced by the new information flowing to the capital market.

> H.3--The change in relative risk as indicated by published quarterly earnings and/or quarterly dividend announcements is uncorrelated with the change in relative risk as reflected in security prices.

The rank correlations presented in Table 5-7 (p. 158) are generally significant for all comparisons applicable to single securities. Consequently, the results support the rejection of hypothesis H.3 and tend to strengthen two related propositions. The first concerns the existence of a positive association between variation in relative risk as reflected in security prices and variation as revealed by the information. The second proposition refers to the stability characteristics of market beta which in part appear to be explained by the information in quarterly earnings and quarterly dividends.

4. Inherent in the fourth hypothesis is an *a priori* notion of ambiguity. This was imposed on the research design as an intervening variable in order to distinguish two classes of capital market response. The first was the response to the earnings and dividend information the implications of which were similar for the assessment of an entity's relative risk (unambiguous implications). The second was the response to earnings and dividend information the implications of which were dissimilar for the assessment of relative risk (ambiguous implications).

> H.4--Risk information convened by published quarterly earnings and quarterly dividend announcements, the combined signal of which is *unambiguous*, and risk information conveyed by the above two sources, the combined signal of which is *ambiguous*, do not differ in their correlation with risk information as reflected in security prices (relative risk).

As evidence by the χ^2 analyses presented in Table 5-8 (p. 164), hypothesis H.4 can be rejected for all stated definitions of non-market risk except ω^{D}_{jk}. The unambiguous risk information significantly explains the dichotomy between high and low beta securities, while the ambiguous information is essentially independent of the high-low dichotomy in market beta. Hence the rejection of H.4 confirms the potential importance of ambiguity as a significant intervening variable. The rejection of H.4 may also be consistent with the non-rejection of H.2. This is because one assumption of the test of H.4 was that the reliability of each source of risk information be judged by market participants as approximately equivalent.

5. The last substantive result provided additional insight into the information content of dividends hypothesis. In spite of the overall inability of the non-market risk estimates to predict market beta of a future period, it is of importance to note that the only significant non-contemporaneous correlation reported in Table 5-4 was between the subperiod one dividend risk estimate $\hat{\partial}_{jk}(D)$ and the subperiod two market beta. Since this result may have directly reflected management's expectations conveyed via dividend changes, a more direct test was applied. Table 5-9 (p. 166) indicates that a significant association exists between the variability of subperiod one quarterly dividend changes and the variability of subperiod two quarterly earnings changes. Further, it also indicates that the reverse association is non-existent. Consequently,

one testable implication of the information content of dividends hypothesis is confirmed.

Methodological Results

Thus far in summarizing the results, no mention has been made of the sensitivity of the results to alternative specifications and estimation procedures.

1. No Forecast versus ARIMA Generating Process. In order to identify the seasonality and the non-stationarity that may bias the variability of unexpected changes, the ARIMA model building procedure was applied. Notwithstanding substantial testing to ensure that the ARIMA models were internally consistent, the overall benefits were only marginally apparent. It was expected that if the ARIMA model was a more descriptive representation of the expectations behavior of the capital market vis-à-vis information, then this should be evident in higher correlations between market and non-market estimates of risk relative to the correlations associated with the no forecast model. Table 5-4 indicates that 13 out of 16 contemporaneous correlations are higher for the ARIMA procedure; Table 5-5 indicates that the χ^2 values for the ARIMA procedure are equal to or higher than the no forecast values in 11 out of 16 cases; and Table 5-7 indicates that the correlations are higher for the ARIMA procedure in 6 out of 8 cases. The magnitude of the differences is, however, generally small

and thus it seems unlikely that a test of equality of dependent degrees of correlation, if applied, would indicate that such differences could not have been the result of sampling variation.

While some may argue that the marginal, but insignificant, increase in the correlations under the ARIMA procedure is evidence that large amounts of historical data may not be used by market participants, a more direct interpretation may be that the complex ARIMA model provided too good a fit for each earnings and dividend process and hence understated the significance of the unexpected changes. The ARIMA procedure was such that model parameters were developed using the full set of observations. Thus the unexpected change estimates at a given point in table benefited to some degree from observations forward of that point. A third interpretation is that the seasonality and non-stationarity inherent in the observations may not constitute as serious a problem for risk estimation as originally thought.

2. Measurement Error. Error in the determination of market beta and the non-market risk estimates may have arisen from at least two sources: (1) misspecification of the unexpected changes in quarterly earnings and quarterly dividends, and (2) omitted variables in the risk estimation procedures. It is evident from inspection of Tables 5-1 (p. 132) and 5-2 (p. 141) that market beta was less affected

by measurement error than were the non-market risk estimates. In addition the results of Tables 5-4 (p. 146), 5-5 (p. 153), 5-7 (p. 158), and 5-8 (p. 164) would seem to imply that the dividend risk estimate, $\hat{\omega}_{jk}^{D}$, was biased by error more so than the others. The source of this apparently excessive error is most likely attributed to the lack of variability in d_{jkt} and d_{mkt} (used to estimate ω_{jk}^{D}) and to misspecification of the economy-wide index, d_{mkt}.

Since measurement error in market beta and the non-market risk estimates introduces a downward bias into the estimated correlations between such variables, a portfolio grouping technique was used. The evidence suggests that although the portfolio correlations were generally higher than those for single securities (as expected), the loss of information that occurred due to aggregation more than counteracted the benefits of the grouping procedure as a technique to diversity error at the individual security level. Moreover, the partitioning instrument appeared to be insufficiently sensitive to error in quarterly earnings and quarterly dividend risk estimates. It appears that substantial effort will be required in future investigations to derive a partitioning instrument which is sensitive to error in variables other than market beta.

Limitations

The results of the preceding section are of course conditional on the research design and the empirical procedures used to implement the design. Some qualifications of these results are noted below. First, the approach addresses the evaluation of information from the viewpoint of an entity's relative risk. Other benefits of information (e.g., private trading gains achieved through foreknowledge) and other users of information (persons not engaged in capital market transactions) are not the concern of this approach. Second, the design does not attempt to isolate the specific effects of either kind of information on capital market behavior. The emphasis is on the effects of each kind in the presence of the other. Third, underlying the design are *ex ante* relationships about market efficiency, asset pricing and the derivation of capital asset risk. Although available empirical evidence supports the descriptive validity of the relationships in this study, one cannot deny that the same evidence may also be consistent with the implications of other conceptual relationships.

Another limitation of the design may be its reliance on the statistical techniques applied. The techniques not only required transformation of the original variables that may have had unknown consequences, but also required certain "niceties" that may not have been meticulously adhered to in each and every estimation procedure. The instability of market beta, the insensitivity of the portfolio aggregation procedure and the effects of measurement error particularly in the construction of the market or economy-wide indexes, may have constituted serious infringements of the assumptions of the estimation procedures.

Conclusions and Implications

In view of the above results the following tentative conclusions appear to be justified.

1. The risk information contained in published quarterly earnings and quarterly dividend announcements is consistent to a significant degree with underlying information about relative risk that is reflected in security prices.

2. Although the information from either source reflects only part of the risk characteristics that market participants may consider pertinent to the "value" of an entity, there is no significant difference in the risk information content from either source.

3. Further, when the risk information from each source is treated as a combined signal that has unambiguous implications for the assessment of relative risk, it is significantly different to that of a combined signal that has ambiguous implications. The degree of ambiguity inherent in competing sources of risk information appears to be a significant intervening variable.

4. Both the direction and the magnitude of changes in relative risk are significantly related to the changes in risk reflected via published quarterly earnings and quarterly dividend announcements. Accordingly, at least part of the same set of risk-related events that cause instability in an entity's relative risk are indicated by quarterly earnings and dividend risk information.

Implications

The above conclusions have implications for past studies and future research in the relationship between security prices and the nature of information impounded therein. First, it is worthwhile to contrast the findings to the "related studies" mentioned in earlier chapters. May[1] found that, although statistically insignificant, the relative price change response to quarterly earnings was less than the response to annual earnings. Using the annual earnings risk estimates (accounting beta) reported in studies of Beaver, Kettler and Scholes, Gonedes, and Beaver and Manegold[2] as benchmarks, May's finding would

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[1]May, op. cit.

[2]Beaver, Kettler and Scholes, op. cit., Gonedes, op. cit., and Beaver and Manegold, op. cit.; for instance, Beaver and Manegold, Ibid., p. 44, report that their initial efforts to compute "accounting betas," from quarterly earnings "have been unable to produce an accounting beta . . . that has a higher association with the market beta than the annual accounting betas do."

appear to be supported on the basis of the relative risk criterion. Moreover, the present study tends to confirm the significance of an interaction effect between quarterly dividends and quarterly earnings suggested also by May, among others. Not only is there little difference in the risk information content from either source, but also when one signal implies a message about risk in conflict with the other, the combined information content of this "ambiguous" message is minimal.

Pettit's[3] conclusions that the quarterly dividend announcement may convey significantly more information than is inherent in a quarterly earnings announcement, and his suggestion that there is virtually no market response to quarterly earnings, are unsupported on the basis of the risk criterion. The conclusions of this research reinforce the belief that Pettit's findings are more likely the result of model misspecification than anything else.

The conclusion by Watts,[4] that the information contained in dividends over and above earnings is trivial is partly confirmed by the findings of this study. To the extent that the risk information content of published quarterly earnings and that of quarterly dividend announcements are not substantially different, there would appear

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[3]Pettit, op. cit.

[4]Watts, op. cit.

to be little risk information reflected in dividend changes that is not also reflected in earnings changes. Accordingly, there is partial agreement with Watts on this point. But it was noted earlier that between two non-overlapping intervals the variability of dividends in the earlier period was significantly related to the variability of earnings in the later period. The reverse relationship (as expected) was not substantiated. This result together with those for the study as a whole seem to imply more than trivial support (as concluded by Watts) for the information content of dividends hypothesis. As such the results of this present study imply conclusions that are contrary to those of Black and Scholes.[5]

Future Research

Apart from the basic need to expand the population and broaden the time basis in a replication of this study, several extensions and new avenues for research are noted below. First, since an entity's relative risk is a market criterion that may be useful to differentiate the information content of alternative information systems, it is worthwhile to thoroughly examine its implications as an evaluative procedure comparatively against other evaluative procedures. For example, one question that should be asked is: Under what conditions does the relative risk criterion

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[5]Black and Scholes, op. cit.

establish the same ranking for two or more alternative information systems as that established by the use of the abnormal performance index (API) criterion?

Second, there is an obvious need to examine the sensitivity of the risk criterion to methodological alternatives. Some alternatives that may be considered are alternative risk estimation procedures, alternative data bases (quarterly versus annual data), alternative specifications of the processes that generate unexpected changes, and alternative bases for the construction of economy-wide indexes for earnings and dividends. Moreover, substantial work needs to be done on the portfolio grouping technique if it is to be successfully utilized in situations that require the comparison of market and non-market information.

Third, the study raises a more general question: To what extent does the time series behavior of an entity's security returns or relative risk reflect the processes that generate risk information? Although some time series work has been done in this area, the time series behavior of accounting (more generally non-market) risk variables and the similarity of such behavior to the time series behavior of relative risk remains largely unresearched.

Fourth, it would seem fruitful to fully explore the effects of ambiguity for capital market behavior. Some questions that may be asked are as follows: What is the relationship (if any) between the formation of expectations in the capital market and the degree of ambiguity that may be present when alternative sources of information are being studied? Does ambiguity increase the diffuseness of market participants' assessed distributions of returns? Does ambiguity provide some insight into the extent to which market participants hold heterogeneous expectations? The concept of ambiguity, as it applies to investment decision-making, would seem to require theoretical definition and systematic integration into a general framework for assessing the effects of information on capital market behavior.

APPENDIX A

LIST OF COMPANIES AND INDUSTRIAL GROUPINGS

Industry Code	Company Code	Company Name	Industry Name
1000	27465	American Metal Climax Inc.	Metals-Misc.
1000	29663	American Smelt & Refining	
1000	460056	Intl. Nickel Co. of Canada	
2000	209219	Consolidated Foods Corp.	Food-Packaged
2000	369856	General Foods Corp.	
2020	99599	Borden Inc.	Food-Dairy Products
2042	751277	Ralston Purina Co.	Food-Prep Feeds for Animals
2085	254723	Distillers Corp-Seagrams Ltd.	Beverages-Distillers
2111	532202	Ligget & Myers Inc.	Tobacco-Cigarette Mfg
2111	718167	Philip Morris Inc.	
2111	761753	Reynolds (R J) Inds.	
2200	121691	Burlington Inds. Inc.	Textile Products
2200	860163	Stevens (J P) & Co., Inc.	
2600	494368	Kimberly-Clark Corp.	Paper
2600	793453	St Regis Paper Co.	
2600	809877	Scott Paper Co.	
2801	19087	Allied Chemical Corp.	Chemicals-Major
2801	25321	American Cyanamid Co.	
2801	150843	Celanese Corp.	
2801	260543	Dow Chemical	
2801	263534	Dupont (E I) De Nemours	
2801	611662	Monsanto Co.	
2801	680665	Olin Corp.	
2801	905581	Union Carbide Corp.	
2802	775371	Rohm & Haas Co.	Chemicals-Intermediate
2835	2824	Abbott Laboratories	Drugs-Ethical
2835	589331	Merck & Co.	
2835	717081	Pfizer Inc.	
2835	832135	Smith Kline & French Lab	
2836	859264	Sterling Drug Inc.	Drugs-Proprietary
2837	478160	Johnson & Johnson	Drugs-Medical & Hospital
2841	194162	Colgate-Palmolive Co.	Soap
2844	375766	Gillette Co.	Cosmetics
2912	492386	Kerr-McGee Corp.	Oil-Integrated Domestic
2912	565845	Marathon Oil Co.	
2912	718507	Phillips Petroleum Co.	
2912	822635	Shell Oil Co.	
2912	830575	Skelly Oil Co.	
2912	853700	Standard Oil Co. (Indiana)	

Industry Code	Company Code	Company Name	Industry Name
2913	302290	Exxon Corp.	Oil-Integrated Intl.
2913	607080	Mobil Oil Corp.	
2913	853683	Standard Oil Co. of Calif.	
2913	881694	Texaco Inc.	
2950	478124	Johns-Manville Corp.	Bldmaterial-Roof & Wallboard
3000	318315	Firestone Tire & Robber Co.	Tire & Rubber Goods
3000	382388	Goodrich (B F) Co.	
3000	382550	Goodyear Tire & Ruber Co.	
3310	42195	ARMCO Steel Corp.	Steel-Major
3310	87509	Bethlehem Steel Corp.	
3310	457470	Inland Steel Co.	
3310	637844	National Steel Corp.	
3310	760779	Republic Steel Corp.	
3310	912656	U S Steel Corp.	
3331	489314	Kennecott Copper Corp	Primary Smelting & Refining
3331	717265	Phelps Dodge Corp.	
3511	56147	Babcock & Wilcox Co.	Machy.-Steam Generating
3511	200273	Combustion Engineering Inc.	
3522	244199	Deere & Co.	Machy.-Agricultural
3531	149123	Caterpillar Tractor Co.	Machy.-Construction & Mat.
3531	181396	Clark Equipment Co.	
3533	261597	Dresser Inds. Inc.	Machy.-Oil Well
3533	406216	Halliburton Co.	
3570	6716	Addressograph-Multigraph	Office & Business Equip.
3570	122781	Burroughs Corp.	
3570	459200	Intl Business Machines Corp.	
3570	635230	National Cash Register Co.	
3600	369604	General Electric Co.	Elec.& Elec.Leaders
3610	580628	McGraw-Edison Co.	Elec. Equipment
3630	829302	Singer Co.	Elec.Household Appliance
3630	963320	Whirlpool Corp.	
3651	620076	Motorola, Inc.	Radio-TV Manfacturers
3651	989399	Zenith Radio Corp.	
3711	171196	Chrysler Corp.	Motor Vehicles
3711	345370	Ford Motor Co.	
3713	459578	Intl. Harvester Co.	Auto Trucks
3714	81689	Bendix Corp.	Auto Prts & Accessories
3714	488188	Kelsey Hayes Co.	
3721	97023	Boeing Co.	Aerospace
3721	666807	Northrop Corp.	
3721	909296	United Aircraft Corp.	
3740	800	A C F Inds Inc.	Railroad Equipment
3740	368838	General American Trans Corp.	
3740	745791	Pullman Inc.	
3861	277461	Eastman Kodak Co.	Photographic
3861	604059	Minnesota Mining & Mfg. Co.	

Industry Code	Company Code	Company Name	Industry Name
4811	30177	American Tele & Telegraph	Telephone Companies
4811	371028	General Telephone & Electronics	
5311	45573	Assd. Dry Goods Corp.	Retail-Dept. Stores
5311	314099	Federated Dept. Stores, Inc.	
5311	556139	Macy (R H) & Co. Inc.	
5411	4716	Acme Markets Inc.	Retail-Food Chains
5411	501044	Kroger Co.	
5411	786514	Safeway Stores Inc.	
5411	974280	Winn-Dixie Stores Inc.	

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