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CHAPTER I

INTRODUCTION AND PREVIOUS RESEARCH

Introduction

The usefulness of financial reports has been the subject of several studies in recent years. Two factors contributed to the increased interest in this area: The development of the "capital asset pricing" theory and the growing recognition by the accounting profession that "usefulness" is an important criterion for evaluating financial reports and accounting procedures.

On the one hand, the development of capital asset pricing theory (Sharpe (1969), Cootner (1967), Fama (1965), Lintner (1965), King (1966) and Cohen and Pogue (1967)) has provided new criteria by which usefulness can be assessed. On the other hand, the recognition of "usefulness" as an important test of the financial reporting system is explicit in Statement No. 4 of the APB: "Accounting is a service activity. Its function is to provide information .... intended to be useful in making economic decisions" (AICPA (1970), ch. 3 §78); or in particular, "to provide financial information that assists in estimating the earnings potential of the enterprise" (ibid., §79).

Dealing with the issue of usefulness, a number of studies have first sought to evaluate the informational (i.e., predictive) content of annual reports and specifically that of annual earnings. Among the major contributions are those of Beaver (1968) and of Ball and Brown (1968). More recently, however, attention has focused on the informational content of quarterly reports. Several theoretical considerations provide a strong presumption that in their present form quarterly reports cannot be a useful tool in the hands of investors:

First, the quarterly reports are "inaccurate" in the sense that they deal arbitrarily with major measurement problems. Besides the familiar difficulties which must exist in reports covering a period shorter than the life of the enterprise, there are problems of measuring income for a period as short as a quarter. For reporting purposes the fiscal quarter may be conceived in two different ways. One, as a discrete accounting period the income of which is to be determined, insofar as possible, independently of the income of other discrete accounting periods; and second, as a preliminary and partial approximation of the income attributable to the current year. Adoption of each of these points of view leads to different measurement principles with regard to revenue determination and inter-period cost-allocation (for a review of these problems see for example Blough (1953), Shillinglaw (1961) and Taylor (1965)). Although some guidelines have been recently provided by the AICPA (APB 28, 1973), the theoretical issue and some of its practical aspects remain unresolved.

Second, unlike the annual reports, the quarterly reports are unaudited. As a result they are more likely to be subjected to income manipulations by management.

Third, the seasonality factor requires a great deal of sophistication in the analysis and interpretation of the quarterly reports of firms which experience seasonal fluctuations. Supposedly, many investors lack this sophistication and might thus misinterpret quarterly results.

Literature Survey

Assessing the effect of the information contained in the quarterly reports on investment decisions and comparing the informational content of these reports with the content conveyed by the annual reports, have been the subject of several studies.

Two different empirical approaches have been used in these studies. The first approach attempts to assess the usefulness of quarterly reports by determining whether they improve earnings forecasts. The idea behind this approach is that expected earnings are a dominant factor in the determination of stock prices and that better earnings forecasts result in more effective decisions. This approach was adopted by Green and Segall (1967), Brown and Niederhoffer (1968) Coates (1971) and Barnea et al. (1972A). Green and Segall studied the improvement contributed by the first quarterly report in forecasting annual EPS. In order to assess this contribution, annual EPS forecasts were made based on two data series: Past annual EPS and past quarterly EPS. Two groups of prediction models, each consisting of three models, were specified: One group was applied to annual data and one to quarterly data. The prediction models were basically naive in the sense that the forecasts produced by them were simple extrapolations of past observations. A random sample of forty-seven companies was drawn from the N.Y.S.E. listing. The above prediction models to forecast 1964's EPS, based on the data for the period 1959-1963. Thus, six forecasts were made for each company: three based on quarterly data and quarterly prediction models and three based on annual data and annual prediction models. Two forecast error measurements were used to evaluate the forecasts' performance: The difference between actual and forecasted EPS and the relative error (the above difference, in absolute terms, divided by the actual EPS). The forecast errors of each model and of each group of models were summarized over a cross-section of the companies. Comparisons between the performance of the two groups were made in order to evaluate the contribution of quarterly information to the improvement of annual EPS forecasts. Using the same approach, Brown and Niederhoffer (1967) conducted a more comprehensive study: The contribution of each of the first three quarters to the annual forecast was investigated; 519 companies drawn from the Standard and Poor's Compustat tapes were included; annual data for the years 1947-1965 and quarterly data for the years 1962-1965 were retrieved. Eight quarterly and four annual prediction models were used to predict the EPS for the years 1963, 1964 and 1965. The contribution of each of the first three quarters to the accuracy of the annual forecast was measured and analyzed.

Coates (1972) used a times-series analysis in which a prediction model was assigned to each firm, based on its unique earnings generating process. This model was then applied to past data of the firm to produce annual EPS forecasts. Three sets of models were employed. One set corresponds to a true random walk (with or without drift) in earnings. Another set of models was also derived by assuming that the earnings of any quarter are best described by a random walk but that such earnings are uncorrelated with the earnings in the other three quarters. The third set of models was based upon the assumption that the earnings in any quarter are the best estimate of the earnings in the other three quarters provided that adjustments are made for the different level of earnings in each quarter. The last two sets were applicable, obviously, only to quarterly data. The data was derived from the reports of twenty-seven firms listed in the N.Y.S.E. for the period 1945-1966. The contribution of each quarter to the accuracy of the annual EPS forecast was assessed for each firm separately, using two error measurements -- the means absolute error and the root mean squared error. Barnea et al. (1972A) too conducted a time series rather than a cross-section analysis. Forecasts based on several naive models were made and analyzed for twenty-five firms for the years 1967, 1968, 1969 and 1970. Unlike Coates' study, an attempt was made here to aggregate the results over a cross-section of the firms. In addition, Barnea et al. introduced, for the first time, the notion of the marginal predictive content of interim reports by comparing forecasts made on the basis of quarterly reports to forecasts made on the basis of past annual reports and other publicly available information, namely macro-economic data.

The second approach evaluates the usefulness of quarterly reports by determining their effect on investment decisions as reflected in stock price changes. Here, the information revealed by a quarterly report is defined as "useful" if it causes investors to revise their earnings expectations, namely it is associated closely with a significant price-change. In other words, according to the second approach, a timely and significant stock price movement in the "right" direction, is necessary and sufficient evidence of "usefulness".

Based on this approach two testing methodologies have been developed. According to the first methodology which was used by Brown and Kennelly (1972) (who adopted it from Ball and Brown (1968), an earnings expectation model was constructed on the basis of which "unexpected" changes in earnings were defined. Two classes of earnings expectation models were used: One class consists of a regression of the type:

$$\Delta I_{jt} = \hat{a}_{1j} + \hat{a}_{2j} I_t^M + \hat{u}_{jt}$$

where I_{jt} is the EPS (or net income) of the firm j for period t and I^M is the average EPS (or net income) of all firms (other than firm j) in the market. This model makes use of the fact that historically earnings of firms have tended to move together (for empirical evidence see for example Brown and Ball (1968)). Accordingly, the expected income change for time j in period t, given the market average, is

$$E\{\Delta I_{jt}\} = a_{1j} + a_{2j}\Delta I_j^M$$

and the unexpected income change (or the forecast error) is u_{jt}. The other class of forecasts consists of two naive models: Under one model, this period's EPS will be the same as last period's. Under the other naive model this period's EPS will be equal to last period's, plus the average change over the available history of the data. These two classes of models (regression and naive) were applied to annual data to produce annual earnings forecasts and to quarterly data to produce quarterly forecasts.[1] Unexpected changes in income were measured. A financial report was said to contain "good news" if actual reported earnings exceeded expectations (the forecast) or "bad news" if actual reported earnings fell short of those expected. Assuming the validity of the "market model" (Sharpe (1967)) "unexplained" changes in price were calculated. The relationship between the rate of return on the individual stock j, R_j, and the market rate of return, R^M, was given as

$$R_{jm} = \hat{b}_{1j} + \hat{b}_{2j}R_m^M + \varepsilon_{jm}$$

where m denotes the month and ε_{jm} measures the extent to which the realized return differs from the expected return conditional upon the estimated regression parameters (b_{1j}, b_{2j}) and the market rate of return, R_m^M. Thus, it was argued that since the market had been found to adjust quickly and efficiently to new information, the residual must represent the impact of new information unique to the firm, on the return from holding its stock. Useful information is contained in the financial reports if, when actual income differs from expected income, the market reacts in the same direction. In other words, a positive correlation between "unexplained" changes in the rate of return and "unexpected" changes in earnings would provide evidence that investors do revise their earnings expectations. To further test the usefulness of quarterly reports, Brown

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[1] The time-series of quarterly data used by Brown and Kennelly in forecasting the earnings of the nth quarter (n= 1,2,3,4) of Year T, consisted of the nth quarters of years T-1, T-2, ..., 1.

and Kennelly measured the gain to the investor (in terms of return in excess of the market's) from a foreknowledge of the sign of the difference between forecast and actual earnings twelve months in advance of the announcement date. This gain was compared to the potential gain from a foreknowledge of the signs of forecast errors for the three quarterly earnings numbers. Such foreknowledge permits a switching of positions ("buy", "hold", etc.) in each stock, at the beginning of each quarter. Brown and Kennelly's hypothesis was essentially that if the quarterly numbers have information content, then strategies exploiting foreknowledge of that content would do better than strategies exploiting foreknowledge of the content of the annual numbers only.

A second methodology involves an investigation of stock price (volume) behavior around the announcement date and the testing of the hypothesis that price (volume) fluctations of the individual individual stock on the announcement data -- adjusted for fluctuations of the market -- does not differ significantly from its price (volume) fluctuations on the preceding and following trading days. Under the assumptions of efficient capital markets, rejection of such a hypothesis would mean that reports do have an informational content which behooves investors to revise their expectations. Such testing procedures were employed by May (1971), Barnea et al. (1972B) and by Kiger (1972). May addressed himself to two empirical questions: 1. Do quarterly earnings announcements have a significant effect on investor decisions as reflected in market price changes? And 2. Do investors' response to quarterly and annual announcements reflect perception of the lesser quality of measurement widely attributed to quarterly reports? The period selected by him extended from July 1964 through June 1968. A sample of 105 firms was selected from the A.S.E. listing. The standard comparison used in the study to gauge the significance of response to quarterly earnings (and to answer the first research question was the average price response for all weeks of the year excluding weeks of earnings announcements. The price response in each case was defined as the residual response net estimated effects of market-wide influences. Both parametric (the t test) and non-parametric tests were employed to answer the above mentioned questions.

Barnea <u>et al</u> (1972B) used a similar methodology to assess the effect of quarterly reports announcements on the investors' reaction. The period covered in that study was January 1, 1968 to September 30, 1969. Stocks were selected at random from those listed on the N.Y.S.E. This data yielded 286 observations the first quarter's reports, 264 observations on the second quarter's reports and 161 observations on the third quarter's. Daily rather than weekly data were used. A comparison was made of a stock's residual price change adjusted for market effects on the day of the quarterly announcement to its residual price change for each trading day in the six weeks before and the six weeks after the announcement date. For each stock the days were ranked by the absolute value of the residual price change and the announcement date was tested for significance using a nonparametric test on the distribution of ranks.

A slightly different approach was developed by Kiger (1972) who investigated the market reaction to the issuance of published interim statements in terms of both price and volume. The market response to the release of the quarterly reports in the years 1968 and 1969 was observed and analyzed.

The results of the above studies support, in general, the hypothesis that quarterly financial reports do have information content which is useful to investors. The only exceptions were Green and Segall's studies (1967, 1966) which failed to find a significant improvement in annual earnings forecasts based on first quarter reports. Green and Segall admitted,nevertheless, that their findings were inconclusive.[2]

Within the framework of the same approach (asessing the improvement in forecasts accuracy) Brown and Niederhoffer (1968) conclude that "the interim predicators as a group generally were superior to the annuals as a group." Another conclusion is that interim predictors tend to improve their performance relatively to annual predictors as the end of the financial year approaches. The greatest improvement in the forecast of annual EPS is contributed by the last quarter. This finding is consistent with the observation that most of the unusual accounting adjustments are made in the final quarter, when the annual reports are being prepared. Coates (1972) and Barnea _et al_. (1972B), using time series analysis arrived, essentially, at similar conclusions. Coates concludes that successive quarterly reports make it possible to forecast with increasing accuracy the forthcoming annual report. Even the first quarter's

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[2]See the concluding paragraph to their 1966 paper.

reports are decidedly useful in predicting the annual report. Other important results of Coates' study are the unequivocal demonstration of the existence among firms of different earning generating functions (in the study seven different models were used to describe the earnings pattern of twenty-seven companies in the sample) and the fact that fifteen out of the twenty-seven companies had seasonal earnings. Barnea et al. find that the results concerning the increase in predictive ability due to the first announcements are mixed. The results for the second and third quarters, however, show a more substantial error reduction due to the quarterly announcement.

Taking the alternative approach (observing market reactions to announcements), May (1971), Barnea et al. (1972A) Kiger (1972) and Brown and Kennelly (1972) received results which generally concur with the above conclusions.

With the exception of a particular quarter's announcements of each of two subgroups of firms, May's findings are that "the magnitude of price-change response in the weeks of announcements was signficicantly greater than the average for other weeks." This is true for all three quarters. Moreover, the relative price-change response to quarterly announcements is not significantly weaker than its response to annual announcements.

The results of Barnea et al. show that there is a significant announcement effect on the market prices for the second and third quarter reports. No such strong effect is detected for the first quarter.

Kiger produces evidence indicating that, in general, the average (adjusted for market fluctuations) of both the trading volume and the price change was greater during the period in which the quarterly announcement of earnings was made than during a control period (in which no new information about the company was introduced in the market). Brown and Kennelly conclude that the information contained in quarterly reports is useful in that if actual income differs from expected income, the market typically has reacted in the same direction. Another major conclusion is that disaggregation of annual EPS into its quarterly components improves the informational value of the EPS series by at least 30 to 40 percent by enabling the investor to take advantage of abnormal returns by adopting alternate investment strategies through the year. This result suggests that currently prepared reports are useful independent of any annual prediction difficulty.

Each of the two approaches described above has its own theoretical weaknesses. Generally speaking, the weaknesses stem from the restrictive nature of the assumptions underlying these approaches.

The first approach tries to measure the improvement in forecast of annual earnings by using information obtained from quarterly figures. The informational content of the report is limited to one, although imporant, aspect -- predictive ability with respect to annual earnings. Other possible uses of the reports, such as the evaluation of risk or the estimation of the firm's earnings co-variability with earnings of other firms, are ignored.

Another limitation of the first approach is inherent in the need to specify a market expectation model. The studies conducted so far have employed semi-naive expectation models which might understate the market's ability to forecast, thus introducing an unknown upward bias in the estimated contribution of quarterly reports.

Finally, a serious problem might be associated with the common use of a quadratic loss function. Notwithstanding an important theoretical advantage (investors are assumed to be risk averse) the function arbitrarily assumes indifference of investors to the sign of the error and is also sensitive to the magnitude of the variable measured.

The second approach reads market reactions to the financial reports. According to one methodology, the message delivered by a financial report can be considered as either "good news" or "bad news", depending upon the relation between expected and actual earnings. Here again, the need to specify an earnings expectation model and a loss function is clearly a drawback. Furthermore, it seems that the results obtained using this methodology would be highly sensitive to the forecast model and loss function chosen, since the critical classification of financial information into "good news" and "bad news" depend directly on the specific earnings forecast model employed. Finally, it should be noted that the weight of any results produced by this approach depends on the validity of the market efficiency assumption.

Under the alternative methodology (of the second approach) price changes are observed and ranked on and shortly after the announcement date. The results are then subjected, in most cases, to non-parametric rank tests. A serious theoretical drawback of this procedure is that it involves "averaging" of the ranks received by each trading day over a number of announcements, and over a cross-section of companies. This treatment tends to subdue any significant results that might emerge in individual announcements, as long as they have no significant bearing on the average. Another potential pitfall in the statistical tests is in the occasional use of a variance which is based on theoretical distribution rather than on the sample distribution.

Finally, a general comment on the second approach is in order. According to this approach, any announcement which is not associated with price revisions has no informational content which is relevant to the decision maker. The definition of "relevance," however, should be of an a priori nature: an information is relevant as long as it may affect decisions (for a further discussion see Feltham (1968)). The last reservations have more to do with the test design than with the validity of the conclusions, since in most of the tests conducted on the basis of this approach, the hypothesis that the announcement has no effect on price behavior was rejected anyway.

Purpose of the Research

The prime objective of the research is to measure and analyze the instrumental contribution made by each of the quarterly reports to the accuracy of annual earnings forecasts. The study employs the series approach (used also by Coates) under which the prediction models, rather than being applied indiscriminately to all firms are selected individually for each firm on the basis of its observed earnings generating function. Adoption of the time-series approach avoids the implicit averaging process which tends to subdue the superior performance potentially inherent in quarterly prediction models. The present study seeks to improve upon the methodology and design of Coates' study and to some extent upon that of Barnea *et al.* (1972B) on four counts:

First, the study adds a measure of the marginal information content of quarterly accounting numbers, i.e., the improvement that can be attributed exclusively to such numbers. This point needs perhaps an explanation.

At the time immediately preceeding the quarterly announcement, various sources of information are available to investors besides the past annual reports. Investors are provided with information about such macroeconomic variables as the GNP, total corporate earnings, total sales by industry, etc., as well as about individual firms (e.g., through annual forecasts prepared by financial analysts). Part of this information is normally incorporated into the market forecasts of annual earnings.

In order to measure the marginal information content of quarterly reports, the forecast made on the basis of quarterly data should be compared to the best alternative, i.e. to the forecast which integrates all other sources of information -- past annual reports, macroeconomic data, industry trends, etc. Comparison with forecasts made on the basis of past annual reports alone would tend to overstate the contribution of quarterly announcements to the prediction of annual earnings.

The studies which tried to infer from measured price (or rate of return) changes attributed to quarterly reports on the information content of such reports (referred to earlier as the "second approach"), were consistent with the notion of marginal information content. Based on their assumptions (in particular the assumption of market efficiency), changes in the price of an individual stock (corrected for market effects), can be attributed to new bits of information unique to the individual firm, plus random factors. Isolating a certain bit of information makes it possible to measure its effects on price changes and hence its marginal information content.

The findings of studies which used the above approach are not comparable with the results of Green and Segall (1967, 1966), Brown and Niederhoffer (1968) and others who employed the alternative approach (referred to earlier as the "first approach"). Those studies measured the improvement of earnings forecasts introduced by quarterly reports, by comparing them to forecasts based merely on past annual reports. As explained above, this comparison constitutes an inappropriate measurement of the marginal contribution of quarterly reports to the forecast of annual earnings. In this respect, the results of this study should serve as a link between the results

Derived under the two approaches. Investigation of the "marginal" contribution of quarterly reports, in the above sense, was conducted only by Barnea et al. (1972A) and on a limited scale (four years, twenty four companies and one type of adjustment to macro-economic data).

Second, several methodological limitations present in other studies are explicitly dealt with and partially removed. For example, the study allows for instability in the earnings generating function; it selects the models and estimates their parameters independently of the predicted period; it assigns different weights to past observations - depending on their proximity to current predictions; and it determines the best quarterly models independently of the best annual models.

Third, based on the time-series study a cross section analysis of the results is added and their statistical significance is tested. Further analysis is conducted on a portfolio or market index representing a weighted average of the entire sample. These and other methodological characteristics of the model-building phase are discussed in detail in Chapter II.

Finally, compared with previous works, the present study is more general and comprehensive in its basic features: The sample size, the length of period studied, the number of models examined and the variety of tests applied.

An ancillary objective of the research is to explore some of the time-series properties of quarterly numbers. Investigating statistical properties such as seasonality in sales and earnings and the co-movement over time of different quarterly variables might be valuable for the selection of predictors and for the building of effective predictor models. The statistical investigation extends also to other areas, not directly related to the model-testing of the research namely the interdependence between results of different quarters and the commonality in the quarterly numbers of a firm, its industry and the market. Given the scope of the study the investigation into these areas is of a preliminary nature and could serve as a guideline for further research.

The experimental design of the prediction model tests is outlined in the next chapter. The sample and the data are described in Chapter III. Chapter III presents tests and results of the time-series properties of quarterly numbers. Chapter IV describes and analyzes the findings concerning the predictive ability of quarterly accounting numbers. Finally summary of the results is presented and suggestions for further research are made in Chapter VI.

CHAPTER II

EXPERIMENTAL DESIGN

Methodology - General

The main purpose of the study is to assess the information content of quarterly reports where the information content is defined as the contribution of the quarterly reports to the prediction of annual earnings. As noted before, although workable, this definition is restrictive; the information content measured according to this definition is at best a lower limit to the true informational value of quarterly reports. The contribution is measured as the incremental improvement in annual earnings forecasts achieved by adding quarterly reports to other publicly available information used for these forecasts. Such information would come from past annual reports and various macro-economic data. The tests designed to determine the improvement in earnings forecast involve first a time series analysis conducted separately for each company in the sample; the results are then used as an input in cross-sectional analyses that led to conclusions about the entire sample, about certain industries and about other "homogeneous" groups of companies.

The initial steps in the research design can be formulated in the following way:

Let X_{jk} be the vector of the values of predictor j for firm k, observed over time. The predictor, which is a variable or a combination of several variables, is supposed to have a predictive power with regard to A_K , the annual earnings (or earnings per share)[1] of firm K. A prediction model PM_i transforms X_{jk} into a vector of annual earnings forecasts, A_{ijk} for the corresponding period.

$$PM_i \{X_{jk}\} = \hat{A}_{ijk}$$

A loss function, L, is specified so that

$$Loss = L(\hat{A}_{i,j,k}, A_k) = L[PM_i \{X_{jk}\}, A_k].$$

The optimal prediction model, PM* , for a given predictor $j = j_o$ for a given firm $k = k_o$, is the one which minimizes L

$$\text{Min Loss} = L[PM^* \{X_{jo,ko}\}, A_{K_o}].$$

It follows that before any experiment can be conducted X_j , PM_i and L have to be defined and chosen. The discussion below touches upon considerations that should guide such a choice. It is followed by a description of the choice made here.

<u>Accounting Variables</u>

The quarterly accounting numbers, whose forecasting power is being explored, constitute the first set of predictors. The

[1]Unless specified otherwise, earnings and earnings-per-share will be used interchangably.

second set of predictors is the annual accounting data which appear to be a natural predictor of future annual earnings and are presumably incorporated by the market in its earnings forecasts.

The subject of the various prediction models is the primary annual earnings per share (adjusted for stock splits and dividends) before extra-ordinary items. This is considered the single most important accounting measure used by investors to assess the profitability of a company. It was the predictability of this variable that was used in recent studies as a measure for the information content of quarterly reports (e.g. Brown and Kennelly (1972), Green and Seagall (1967), Brown and Niederhoffer (1968)). Such commonly used measures as the fully diluted EPS and the EPS after extra-ordinary items, were avoided for the following reasons: (a) they seem to be of secondary importance; (b) they introduce elements which are difficult, if not impossible, to predict (the dilution effect and the extra-ordinary items); and (c) their quarterly counterparts -- their most natural predictors -- are not available for many companies and periods.

The following "accounting" variables are selected as predictors (their full definitions appear in Appendix A).

1. Primary EPS before extra-ordinary items, adjusted for stock splits and stock dividends, (EPSAD). In some instances, especially in the earlier periods, the extra-ordinary items were not presented separately. Efforts were made in each case to separate the effect of those items by using information provided by the notes to the financial statements. These effects were not always fruitful,

however. This was particularly true for the quarterly earnings series. Some companies for which the effect of the extraordinary items was considered material yet not separable, were dropped from the sample.

EPS as a time-series is probably more meaningful if it is adjusted for stock splits and stock dividends. It should be noted, however, that adjusted EPS is still affected by changes in the capital structure and by increases in capitalization. Mergers and new issues could therefore result in a shift in the earnings trend of the original company. This effect would tend to obscure time-series patterns, and possibly the commonality in earnings of individual companies (see Brown and Ball (1967), pp. 58-61. thus impairing the performance of any naive prediction model. A preliminary investigation (see Chapter III) shows, however, that the correlation coefficient between EPSAD and Net Income is very high, so that the effect of the above distortion should be small. In order to minimize the "noise" produced by changes in capital composition and size, the following deflated form is also used.

2. Net Income to Total Assets. The major weakness of this measure is that assets - its denominator - are recorded at their historical cost; this would produce a distorted measure of size, especially in periods of a significant change in total assets. One point of strength of the measure relative to the EPS is its insensitivity to mergers involving changes in leverage.

3. Sales. Sales are sometimes considered to be more responsive to "real" economic factors, less dependent on accounting procedures and subjected less to management manipulations (especially in quarterly reports) than earnings. Because of these properties the measure is commonly viewed as a reliable "barometer" of business conditions, as well as a good predictor of future results of the firm's operations. Indeed, the predictive power of sales was suggested by Reilly et al. (1972) and tested by Barnea et al. (1972A), who found it to be at par with the predictive power of quarterly earnings figure.

Two other promising predictors - Net Income before tax and Income from Operations- are not used becaus their data are missing in many cases. However, the desired property of the latter- the relative freedom of accounting adjustments and manipulations is shared by Sales.

Macro Economic Variables

There is substantial evidence that earnings of the individual company are correlated with those of its industry as well as with the aggregate economic activity (see for example Brown and Ball (1967), and Gonedes (1972)). The following seasonally adjusted macro-economic variables are used as predictors: (1) GNP in constant dollars (base = 1958); (2) Corporate Profits after tax ; (3) Industrial Production and (4) Manufacturing Sales. These series are available for the entire survey period.

Micro Economic Variables

Micro-economic data other than those obtainable from the financial statements are transmitted to investors through different channels and in many forms: management forecasts, expansion programs, production plans, labor-management events, personnel changes, etc. If this information is available to the market independently of the financial reports, it is probably used by investors in their forecasts. The present study, however does not consider the possible effects of the micro economic data on the performance of annual earnings forecasts for the following reasons:

First, non-accounting micro-economic information on a firm is available, by definition, mainly to its "insiders" while the purpose of this study is to find the informational content of quarterly reports to "regular" investors - the firm's "outsiders".

Second, unlike the accounting data, micro-economic information on the firm is sporadic, non-systematic and quite often unquantifiable; therefore, even if such information were publicly available it would be difficult to meaningfully incorporate it into forecasting models.

Third, some of the macro-information cannot be directly associated with future earnings. There is no established theory to straightforwardly relate data on R & D expenditures, new designs in production or price changes to future earnings.

Finally, from a methodological viewpoint, the direction of the effect of omitting micro-economic variables from the analysis is known: it might caus an upward bias in the estimated informational content of quarterly reports. Consequently, the exclusion of these variables from the predictors' list would affect the conclusions of this study only if quarterly reports are found to have a positive marginal information content. It should be noted, however, that in any event, the above bias is not expected to be large. Previous research (Elton and Gruber (1972)) shows that financial analysts forecasts, presumably containing micro-economic information, are not superior to naive forecasts.

Experimental Design

The prediction models fall into four groups, depending on the input used. Four alternative input sets are employed (the time reference relates to the data of forecast):

A: Past annual accounting data

MA: Past annual accounting data plus recent macro-economic data

MQ: Past quarterly accounting data plus recent quarterly macro-economic data

Q: All available quarterly accounting data

The following comparisons are of special interest:

Comparison	Marginal Information
Q - A	All information in quarterly reports
Q - MA	All information in quarterly reports not captured by macro news
Q - MQ	All information in most recent quarterly reports, not captured by macro news or by past quarterly reports.

The comparison Q - A yields the gross improvement in forecasts accuracy, resulting from the use of quarterly in addition to annual accounting data. The comparison Q - MA measures the improvement in forecast accuracy, if any, attributed to the existence of quarterly accounting data.

The comparison Q - MQ when made for each quarter yields the marginal improvement attributable to the accounting information of the last quarter.

Each of the above sets produces a new prediction of annual earnings every time new information becomes available. This means that the first set, A, produces one prediction a year while sets MA, MQ and Q produce three predictions a year, one after each of the first three quarters.

It should be noted that the quarterly macrœconomic data are published a few weeks or even few months after the quarterly reports become available to the public. Listed below are the release dates of the four macro-economic variables selected for the study:

The Variable	Frequency	Time lag of publication
GNP	Quarterly	one month
Corporate Profits after Tax	Quarterly	three months
Industrial Production	Monthly	one month
Manufacturing Sales	Monthly	one month

An examination of the above time-lags shows that time-wise macro-economic data are not substitutable for accounting reports. In other words, the most recent quarterly macro data available at the time of the quarterly accounting announcement (about two weeks after the end of the quarter) refer to the period ending a month (or three months) earlier. Nonetheless, sets MA and MQ employ, in each case, the values of the macrovariables for the most recent quarter , not yet available to the general public. The reason is that the information content of macroeconomic data is defined on the basis of its inherent predictive power independently of its timely availability. This is also the reason why the revised (hence the "true") macro-economic series are employed despite the fact that revisions are made long after investors use the information for their forecasts. As a matter of fact, the above discussion is of greater theoretical than practical value since, except for corporate profits the publication of the macro data is fairly close to the quarterly announcements. Furthermore, as mentioned earlier, the revisions in the macro series are minor and do not introduce an apparent systematic change in the pattern of the series over time.

The Prediction Models

The prediction models incorporate the above predictors into forecasting rules. In proposing such rules or models one should bear in mind that the purpose of their construction is to stimulate the generation of forecasts by the market. In particular the "best" model for a given predictor in a given firm is assumed to approximate fairly (especially in terms of performance) an investor forecasting model based on this predictor.

Previous studies have produced evidence that changes in earnings can, in general, best be approximated by a random walk or by a random walk with some trend. (See for example Brealey (1967) and Ball and Watts (1972)). Although the above evidence refers to the behavior of changes in annual earnings, the results can be applied under some assumptions to quarterly earnings. This approach was taken by Coates (1972) who used the models of earnings-generating processes as prediction models. His approach with some modifications, will be adopted here.

Coats presented three sets of models, each employing three alternative assumptions. The first assumption was that earnings are identically distributed over the four quarters. The three corresponding models are:

(1) $E\{Q_t\} = Q_{t-1}$ (random walk)

(2) $E\{Q_t\} = Q_{t-1} + C$ (random walk with an additive trend)

(3) $E\{Q_t\} = Q_{t-1}(1+P)$ (random walk with a multiplicative trend)

where Q_t is the firm's quarterly earnings in period t, (t = 1,2,3, ...). The respective annual forecasts can be readily derived.

The second assumption is that earnings of adjacent quarters are uncorrelated, whereas earnings of the same quarter in subsequent years are. Under this assumption, Model (1), for example, becomes $E\{Q_t\} = Q_{t-4}$. The third assumption is that earnings of any quarter are correlated with earnings of its adjacent quarters and the same quarter last year. The resulting forecasts would then be $E\{Q_t\} = Q_{t-4} \cdot (Q_{t-1}/Q_{t-5})$.

Using past annual earnings and employing Model (3) under the second assumption would yield the forecast:

$$\hat{A}_m = \hat{A}_{m-1}\ (1+P) \qquad \text{for each firm,}$$

where A_{m-1} is the annual earnings in m-1 and P is the annual rate of growth. The respective naive forecast based on quarterly data would be

$$\hat{A}_{m,1} = Q_{m-1} + (Q_{m-1,2} + Q_{m-1,3} + Q_{m-1,4})(1+P)$$

after the first quarter, and

$$\hat{A}_{m,2} = Q_{m,1} + Q_{m,2} + (Q_{m-1,3} + Q_{m-1,4})(1+P)$$

after the second quarter, and so forth. The second index refer to n, the quarter, (n = 1,2,3,4).

There is a total of seven quarterly models used by Coates and tested here (Set Q above).

$$Q_t = Q_{t-1} + \mu t$$

$$Q_t = Q_{t-1} + C + \mu t$$

$$Q_t = Q_{t-1}(1+P) + \mu t$$

$$Q_{m,n} = Q_{m-1,n} + \mu_{m,n}$$

$$Q_{m,n} = Q_{m-1,n} + C + \mu_{m,n}$$

$$Q_{m,n} = Q_{m-1,n} \cdot (1+P) + \mu_{m,n}$$

$$Q_t = Q_{t-4} \cdot (Q_{t-1}/Q_{t-5}) + \mu_t$$

Their annual counterparts (models based on past annual results - Set A above) correspond to the three assumptions on the time series behavior of earnings, namely,

$$A_t = A_{t-1} + \epsilon t$$

$$A_t = A_{t-1} + C + \epsilon t$$

$$A_t = A_{t-1} \cdot (1+P) + \epsilon_t$$

The prediction model based on past annual accounting data is augmented by introducing macro-economic information (set MA above):

$$\hat{A}_{m,n} = A_{m-1} \frac{M_{m,n}}{M_{m-1,n}} \text{, for each firm}$$

where $M_{m,n}$ represents the seasonally adjusted value of the cumulative macro-variable for the end of the n-th quarter of year m. The respective forecast based on past quarterly accounting data (set MQ above) would be after the first quarter

$$\hat{A}_{m,1} = A_{m-1} \cdot \frac{M_{m,1}}{M_{m-1,1}}$$

and after the second quarter

$$\hat{A}_{m,2} = Q_{m,1} + (Q_{m-1,2} + Q_{m-1,3} + Q_{m-1,4}) \cdot \frac{M_{m,2}}{M_{m-1,2}}$$

The above models that were used by either Coates or Barnea et al. (1972A) are the only ones to be employed in the initial model evaluation (for a detailed description of the models see Appendix O). The results produced are to some extent a replication of those studies on a wider scale both in terms of the period surveyed and the sample size.[2] Clearly the use of the same models results in a high degree of comparability with the above studies and in particular with this of Barnea et al. which used macro-economic data as an input for the prediction models.

In an extension of the study a larger set of models is evaluated. By and large the prediction models added at that point are either a variation of models used in the first part or models employed by other studies on the predictive power of quarterly reports. The added models although still 'naive' in their

[2]The comparison is imperfect due to differences in the methodology and in particular in the model selection and evaluation procedures. (These procedures are outlined in the following sections).

reliance on past accounting or macro-economic series are generally more sophisticated in the measurement of these past patterns. Aside from the advantage of making analyses and drawing conclusions based on a large number of models, the extension enables one to assess the effect of the comprehensiveness of the group of models on the results.

The annual models (set A) are supplemented by (among others) the model $\hat{A}_m = f(m) = \beta_o + \beta_1\sqrt{m} + \beta_2 m + \beta_3 m^2$ where the β_i are determined by past annual data. The rationale behind the use of this function is the excellent fit it provided the actual time-series of earnings (This is one of the results reported in Chapter III). The regression model could be considered an extension of the simpler model $\hat{A}_m = A_{m-1} + C$. Similarly the quarterly set (Q) is augmented by the prediction model $\hat{Q}_{m,n} = \gamma_{on} + \gamma_{1m}\sqrt{m} + \gamma_{1m}\, m + \gamma_{3n}\, m^2$ where the γ_i are determined by past quarterly data over the most recent years. Model-set MA is also expanded by additional models.

Appendix O lists the models included in the initial set and the extension and details the forecasts made under each model after the first, second and third quarter. Appendix P compares the set of models in the two parts with those used in several other studies.

The Loss Functions

The performance of a forecast can be evaluated through the use of different measures of error, each implying a different loss function of the forecast user. No single error measure (or loss function) is impeccable and it is therefore desirable to outline the advantage and limitations inherent in each.

The error measure which comes first to mind is the mean error-the difference Forecast minus Actual. There are serious drawbacks associated with this measure. Inaccuracies in the forecasts are not reflected in the error measure as long as they are offsetting. This implies that the loss function of the use is insensitive to the size of the errors provided they cancel each other. What it does measure, however, is the size of the uncancelled error - i.e., the systematic bias. Since such a bias would be adjusted to by a rational investor, the error measure appears to be irrelevant.

An error measure free of the above limitations is the absolute error - Forecast minus Actual. The measure assumes that over-estimation and under-estimation of the same magnitude result in the same loss. It could be argued, of course, that an over-estimation of EPS is associated with a bigger potential loss to investors than an under-estimation: an underestimation may bring the investor to overlook one of the stock under consideration while an over-estimation may cause him to wrongly abandon numerous investment opportunities. This argument is nullified when the error measure is employed to select forecast models for <u>all</u> stocks. Ordinarily, therefore, the assumption of indifference to the sign of the erroris most reasonable. Another assumption implied by the absolute error is that the loss to the forecast user is proportional to the size of the absolute error. The validity of this assumption is questionable but hard to determine. A clear disadvantage of the measure is that it ignores the relationship between the error and the predicted value. This can be corrected by using the absolute relative error which is defined as: (Forecast minus Actual)/ Actual. Unfortunately, the relative error is misleading in its own right since it heavily penalizes small absolute errors when the predicted values (in this study EPSAD) are close to zero.

A widely used error measure is the mean or the root mean squared error. This measure implies too that the user is indifferent to the sign of the error. The loss from a forecast error is assumed to be <u>more</u> than proportional to the error size. This implies a particularly appealing loss function, one which is consistent with the notion of risk-aversion.

The study employs four alternative error measures (loss functions) to evaluate the performance of models and predictors. The measures are :

(1) The Squared Error: $(P-A)^2$; P = predicted value and A = actual value.

(2) The Absolute Error : $|P-A|$

(3) The Squared Relative Error: $(\frac{P-A}{A})^2$

(4) The Absolute Relative Error: $\frac{P-A}{A}$

As pointed out earlier, the relative error might be very large when the predicted value is close to zero. These extreme values distort the comparison between prediction models and between predictors. To circumvent the problem, the value of error measures 3 and 4 is automatically set to 1.0 (100% relative error) when such extreme error occurs.

The above error measures do not take into consideration the time span between the forecast and the actual occurence. When performance of quarterly prediction models is compared to that of annual prediction models, allowance should be made for the length of the predicted period. Although all models seek to predict the same actual value, namely, next year EPS, it is obvious that the annual forecasts produce prediction of an outcome completely in the future while the quarterly models predict an outcome partially determined in the past (the earnings of past quarters in the forecast year). To put the performance of predictions made for different lengths of time on a comparable basis, the following error measures are added:

(5) The Squared Time-Relative Error: $\frac{(P-A)^2}{\text{A-Accumulated Actual at prediction time}}$

(6) The Absolute Time-Relative Error: $\left|\frac{P-A}{\text{A-Accumulated Actual at Prediction Time}}\right|$

In terms of the relative performance of different annual models, measures (5) and (6) produce the same results as (3) and (4) respectively; in terms of the relative performance of quarterly models, one would expect the relative error measure to produce similar (but not necessarily identical) results to those of their time-relative counterparts. Analogous to the case of the relative error measures, extreme values of the time-relative error are eliminated by arbitrarily setting a "ceiling" of 4.0 to error measure (5) and of 2.0 to error measure (6).

Forecasting and Estimating Procedure

The estimation procedure of the model parameter and the selection of the "best" models are devised so as to simulate the behavior of investors and the information available to them at the time of the forecast. As a result, both the estimation and the model selection are based on events prior to (and therefore independent of) the period predicted. Furthermore, consistent with the idea that more recent information is more relevant to future expectations, different weight are assigned to past observations, dependent upon their closeness to the forecast time. The twenty-six year period is divided into two: an initial base period of fourteen years - 1947 to 1960, and a test period of twelve years - 1961 to 1972. This base period is used to produce first estimates for the parameters of the forecast models. A loss function is selected (one of the six outlined in the preceding section) and the prediction models are applied to produce forecasts for the years in the base period; their performance is measured and a best model is selected for each of the model sets A, MA, MQ and Q (for their description see page 25). The best model of any given set is the one which minimizes a weighted average of the loss function values over the base period. The weights are an exponential function of the time distance to the end of the base period, with the base 0.8 (the weights of periods -1, -2, -3 for instance are 0.8, $(0.8)^2$ and $(0.8)^3$ respectively, where a period is defined here as a sequence of four consecutive years - i.e., twelve predictions).

The selected model in each set represents its group in the following years (1961 to 1964). A new fourteen year base period- 1951 to 1964 - is defined and the same estimation and selecting procedure is repeated. The new selected models are applied to forecasting the four-year period 1965 to 1968. Finally, years 1955 to 1968 serve as the base period from which models are selected to predict years 1969 to 1972. For the flow chart of the computational procedure and a sample output see Appendix Q.

The analysis of the results is conducted for individual companies and for cross-sections of all or some sub-sets of the sample companies. The cross-sectional analysis takes two forms:

(1) presentation and analysis of summary results (frequency, averages, etc) for the sample.

(2) presentation and analysis of prediction of a portfolio EPSAD, where the portfolio is composed of all the sample companies. For any given company the best model of each set is used to predict its EPSAD; the predicted portfolio EPSAD produced by any given set is the weighted average of the individual companies predictions made by the set (the weight of each company is the adjusted number of shares). The performance of each set of models is evaluated by comparing the actual portfolio-EPSAD with the prediction made by that set. For a flow-chart of the computational procedure used in the "portfolio" cross-sectional analysis see Appendix Q.

The exam nation of the relative performance of different sets of models in predicting a portfolio EPSAD is of particular importance for two reasons: First, investors concern in earnings forecast for a portfolio of companies is not less and perhaps stronger than their interest in earnings forecasts for individual companies.

Second, the cross-sectional method adopted here according to which the predicted portfolio EPSAD is a weighted average of the predicted individual EPSAD, singles out the bias in the prediction models.[3] The performance of any given set of

[3]In the framework of naive forecast models investors could possibly use two alternative inputs to predict a portfolio EPSAD: Past aggregate data and past data on individual companies. Past aggregate data can be extrapolated to predict results for the portfolio and past individual data can be used in predicting individual company results. Under the latter method, predictions of portfolio results are derived from the individual predictions. The selection of forecasting method depends on the variance of the aggregate estimate relative to the variance of the sum of its components; nonetheless, it is safe to say that in general a prediction method that makes use of the distinct behavior over time of earnings of different companies is likely to outperform forecasts using aggregate data only.

models would reflect, among other things, the extent to which the predictions produced are systematically biased or alternatively offset each others errors over a cross-section of the sample. To clarify this point let A_{jt} be the annual EPSAD of company j in period t, and A_{jst}, its best forecast using set of models s. Let L_{jst} be the corresponding value of the loss function, where

$$L_{jst} = f(|A_{jst} - A_{jt}|)$$

The measure $\sum_t L_{jst}$ is a function of the variability of the predictions around the actual values but not directly of the bias of s. The average value of the function over the sample over time $\sum_j \sum_t a_{jt} L_{jst}$ ($_{jt}$ is the weight of company j in period t) is alsoinsensitive to the bias of s.[4] It is traditionally assumed that bias is detectable and can therefore be corrected by investors; as a result it is not a major consideration in evaluating performance of forecasting models.[5] This assessment is true only when the bias is substantial and persistent. If it is a temporary nature it becomes impossible for investors to adjust their forecasts accordingly. This is the case, for example, when a certain set of models during a relatively short period of two or three years produces predictions

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[4]The loss functions used in the study are symetric i.e., the loss is an increasing function of the absolute error. A loss function of the type L=f(A-A), however, would reflect the bias and an unbiased estimator would minimize its value.

[5]See, for example, Coates (1973).

which for most companies systematically overstate or understate the respective actual values. This temporary bias (caused by interdependencies between contemporeneous predictions made for different companies, in the sample) is not conveyed by summary measures such as $\sum_t L_{jst}$ or $\sum_j \sum_s \alpha_{jt} L_{jst}$. This bias, however, is reflected in the portfolio cross-sectional error measure. Under the portfolio cross-sectional approach $A^P_{st} = \sum_{j \epsilon p} \alpha_{jt} \hat{A}_{jst}$ where P is the portfolio. The cross sectional error measure for period t is:

$$L^P_{st} = f(|A^P_t - \hat{A}^P_{st}|) = f(|A^P_{st} - \sum_{j \epsilon p} \alpha_{jt} \hat{A}_{jst}|)$$

which can be re-written as

$$L^P_{st} = f(|\sum_{j \epsilon p} \alpha_{jt} (A_{jst} - A_{jst})|) \quad .$$

This measure clearly reflects non-offsetting errors (cross-sectional bias).

Performance Measures and Tests

Three statistics are selected to measure and compare the performance of the prediction models over time and over a cross-section of companies: (1) value of the loss function, (2) rank, based on the value of the loss function, (3) the number of times that a model ranked highest (number of times best). Each of these statistics conveys a slightly different information about the performance of the prediction model. None of these measures is perfect - each has its own advantages and deficiencies, rather, they complement each other and the employment of all three enables a comprehensive and meaningful analysis of the results.

Value of loss function

The value of the loss function (or the error) is the most straightforward measure of performance. The performance over time of any set of models for a given company is determined by $\sum_t L_{st}$ and for a cross-section of companies by either $\sum_j \alpha_{jt} L_{jst}$ (for a given period, t) or by $\sum_j \sum_t \alpha_{jt} L_{jst}$ (over time). On the individual company level this average is sensitive to extreme values and the use of it implies that investors are indifferent to the distribution of the errors over time as long as their average is the same. On the cross-sectional basis, the average of some loss functions is sensitive also to the magnitude of the predicted values. This is a clear disadvantage of the use of those loss functions for cross-sectional analysis. Neither average reflects the superiority of any given set of models

. An important advantage of the use of loss values is that the results can be stated in quantitative terms(like percentage of improvement); also, the loss values lend themselves to statistical tests. Pitman test for comparison of two related variances is used to examine the relative performand of different sets of models under gradratic loss functions.[6] Another test which is applied only to the cross-sectional results is the one based on the dominance table devised by Elton and Gruber (1972)[7]. .

Rank

The ranks assigned to the sets of models are based in each case on the corresponding values of the loss function. For both analyses - within company and cross-sectional comparisons are made between the ranks of various models in a given period and between average rank of the models over all the periods. Unlike the loss value, the rank is insensitive to the size of the errors by different models but to their relative magnitude. As a result, it is devoid of any distortions caused by extreme values. No conclusion can be made, however, on the extent of the differences in performance between models.

Two non-parametric tests are used to determine the significance of the difference between the average rank of different sets of models; the Sign test to compare paired sets

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[6]The test was first devised by Pitman (1955) and described in detail by Snedecor and Cochran (1967) pp. 196-197. It replaced the traditional F test in these situations where the variables, the variances of which are being investigated, are correlated. In addition to the means and variances the test also requires the data on the correlation coefficients between the paired observations. For this purpose the correlations between the predictions under study are compared. Pitman test was also employed by Barnea et al (1972).

[7]their test used the central limit theorem and employes the "t" or the "Z" statistics.

of prediction models and Friedman ranks test to simultaneously examine the difference between all sets of prediction models.[8]

Number of times best

This statistic, a derivation from the ranking of the model sets reflect only one measure - the dominance of one set of models over the others. The aggregation of this measure over periods and over a cross section of companies produces less ambiguous results than those produced by aggregation of ranks. Like the rank it is unaffected by extreme values of the loss function. Summary results of this statistic can be used to compute the probability that a particular set of models will outperform all other sets in a given period.

[8]The Sign test and Friedman test are discussed in Conover (1971) pp. 121-126 and pp. 265-274 respectively.

CHAPTER III

DATA AND SAMPLE

Company Data: Quarterly

The incompleteness and lack of standardization in quarterly reporting by corporations constitute a major problem in any attempt to collect quarterly financial data. The fact that such data is often non-existent, sporadic or incomplete, could be attributed, in part, to the belief of investors and corporate executives, that quarterly reports are inherently unreliable and thus of limited value. This belief is shared by many accountants who reject the idea of quarterly audit, (See Chapter 1, p. 1-2). The institutional attitude toward quarterly reports was no different for a long time; e.g., it was not before 1910 that the NYSE required such reporting on a selective basis, and not before 1946 that the SEC made it mandatory for companies under its jurisdiction; similar reporting became mandatory for companies listed in the American Stock Exchange as late as 1962.

Whenever provided, the reports had no standard format and no uniformity in detail, or in their application of accounting principles. As to the format, some companies included while others excluded excise-tax whenever applicable; furthermore, it was often unclear how income tax expense was figured. As to the accounting concepts applied, it appears that there was no uniform method for allocating cost and revenue among quarters (for a description of the alternative concepts see Shillinglaw [1962]).

The presence of all of these problems required a meticulous study of the time-series of quarterly reports of each company considered.

The most comprehensive source of quarterly reports accessible is the quarterly file of the COMPUSTAT. Comparability is reasonably assured for quarterly reports of any given company. The COMPUSTAT file contains such reports for the last ten years (forty quarters). The file currently in use covers the period April 1964 - March 1973. Data for the first two years is missing for many companies.

Data for earlier periods had to be collected manually from Standard and Poor's Corporation Records. To assure that the two bodies of data were comparable, certain adjustments of the original time-series were occasionally called for. Both bodies of data could be checked when necessary against the figures reported in Moody's industrial Manual and for some companies against the data used in Coates study [1972].[1]

Company Data: Annual

Annual data for the twenty yeats 1953-1972 were retrieved from the annual file of the Compustat. Data for earlier periods were obtained from standard and Poor's Corporation Records. As with the quarterly data, comparability between different periods was assured and when necessary the data were adjusted to meet this objective. Furthermore, it was ascertained that for each year, the annual figures and their corresponding quarterly figures were consistent.

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[1]This was the only study which used original reports.

Macro-Economic Data

The source for the macro-economic data was the survey of Current Business (Department of Commerce).

In using economic aggregates there was some degree of ambiguity as to the relevant figures. There are two time-series: of the original and of the rised figures. Since the particular macro-economic variables selected serve only as proxies for the general economic condition, there is no reason to quote government's errors in measuring the correct magnitudes.[2] It should be noted that the choice of using the revised series was simplified by the commonly negligible differences between the two series.

The Sample

The selection of the study period and the sample size were largely determined by balancing the need to keep the requirements of data collection and processing within manageable limits against the need to insure that there be a reasonably representative sample for both purposes -- time series study and to some extent cross-section analysis. Given the scope of the study there was also a trade-off between the length of the period and the number of companies studied.

A number of important considerations entered the decision regarding these two parameters, but no tested way of optimizing their joint satisfaction. The main considerations were:

1. That the time period is long enough to enable the detection of time-series properties and hence the building and testing of meaningful forecasting models, yet short enough to assure stability

[2]This argument will be pursued further in Chapter IV.

of those patterns.

2. That there are enough companies to enable some significant generalizations to the entire population and to a lesser extent to individual industries.

3. That the data is available in an accessible form.

The above criteria led to the selection of a 50 company sample and a study period which extended over the 26 years 1947-1972 (104 quarters). For comparison, Green and Segall (1967) used a sample of 50 companies and a study period of 5 years (20 quarters); Brown and Niederhoffer (1968) studied a sample of 519 companies over a period of 4 years (16 quarters); and Coates (1972) who conducted a time series analysis (rather than a cross-sectional study) based his research on a non-random sample of 27 companies and 22 years (88 quarters). An initial sample of 208 companies was drawn randomly from those listed on the New York Stock Exchange on January, 1947 (source: Bank Records and Quotations (1947)).

In order for a company to be included in the final sample the following conditions had to be satisified:

1. The company had to use the calendar year for its financial reports throughout the period January 1, 1947 to December 31, 1972.
2. The company must be on the Standard and Poor's Industrial File of the COMPUSTAT (file dated April 1973).
3. The company must have data for at least twenty years out of the twenty-six surveyed for at least one of the two vairables - Net Income and Sales.

The first requirement was established to assure consistency of the time-series data for each company and to preserve comparability across companies. This condition also facilitates the incorporation of macroeconomic data which are usually published and aggregated on a calendar year basis.

The second condition was set to avoid the unmanageable task of manual data collection for the period April 1964 - December 1972. The confinement to industrial companies (the exclusion of banks and utilities) was designed to increase the homogeneity of the sample, thus making a cross-section analysis more meaningful.

The third limitation necessitated by the fact that the estimating procedures are sensitive to both number and continuity of the observations.

The above screening process brought down th number of companies to fourty-two. To allow intra-industry cross-sectional analysis and inter-industry comparisons, a minimum number of companies, at least in several industries, was considered necessary. To achieve this aim eight companies were added to the representation of some industries. These companies were randomly sampled from their respective industries. The final sample contains fifty companies of the following industries (for a list of the companies see Appendix B):

Industry Code (First two digits) SIC	Industry	Number of Companies
10	Metals and Mining	5
20	Food	5
21	Tobacco	2
23	Textile-apparel	1
27	Publishing	1
28	Chemicals and Chemical Prod.	6
29	Oil	7
32	Containers & Bldg. Matl.	2
33	Steel copper and Aluminum	6
34	Metal fabricating	1
35	Machinery	6
36	Electrical Equipment	1
37	Automobiles, Aerospace, Aircraft	3
38	Optical & Photographic	1
45	Air Transport	2
56	Retail-Apparel Chains	1
	Total	50

Evidently, by imposing the aforementioned sample selection procedure, some non-random factors were introduced into the sample. It should be recalled that S & P file and in particular the N.Y.S.E. (from which the sample was drawn) include relatively large firms. Also, S & P file contains only firms which survived through the entire study period of twenty-six years. In addition, the sample excludes companies without early data which in many cases means young companies. As a result, the sample rather than being purely random is composed of relatively old and large survivors. The effect of this is to overestimate the upward trend in earnings and sales and to overstate the stability of earning generating functions. The significance of these biases cannot be assessed through the selected sample.

These problems are common to studies that use samples from sources such as the S & P files and the N.Y.S.E. listing. Ball and Watts (1972) encountered the same bias in their sample and investigated its effect on the estimated trend by using different samples of firms over different time periods. Their finding was that the effect was "minimal" (ibid, p. 667). Brown and Ball (1967), to cite another example, investigated the degree to which their sample was representative with respect to this study's subject (the relationship between the earnings of individual companies and industry and market indices). They found that their selection criteria still produced a representative sample (ibid, p. 57).

The requirement for a calendar fiscal year excludes from the sample many companies which are not proportionally distributed among the industries. This point is demonstrated by the following table (based on S * P Industrial File).

Industry	% of Companies[3] Using Calendar Year (in 1972)
10	85%
20	45%
23	30%
33	90%
45	85%
55	25%

Considering the above limitations of the sample, we can rely to some extent on the validity tests employed by others. Nevertheless, extreme caution should be exercised before any inference is made from the sample to the entire universe of companies or even segments of it. Strictly speaking the conclusions drawn in this research are applicable only to the set of all N.Y.S.E. companies which during the study period satisfied the above listed selection criteria.

[3]It seems that these percentages are a fair representative of the composition in the N.Y.S.E.

CHAPTER IV

THE STATISTICAL PROPERTIES OF QUARTERLY TIME-SERIES

Introduction

While the time-series behavior of annual income has generated a considerable interest and has been the subject of several studies,[1] only little attention has been spared to the statistical properties of quarterly numbers. This is, perhaps, a result of the general attitude towards quarterly reports, viewed by many as unreliable and subject to management manipulation and therefore of limited use to investors. They were conceived, at best, as a tentative observation of a more basic phenomenon - the annual earnings (for objective reasons for this attitude see pp. 1-2). Contrary to these beliefs there is considerable evidence indicating that quarterly reports are useful for predicting annual results and that, in fact, the market reacts to quarterly announcement in a way not different from its reaction to annual announcement (for a review of the evidence see Chapter I). It seems that the available evidence justifies a closer look at the statistical properties of quarterly numbers.

In the context of this study, an important objective of gaining knowledge on the time series patterns of quarterly results is to simplify the selection of prediction models by narrowing down the initial set of models to the most promising ones. Information gained about the association between different accounting variables will facilitate the selection of input variables (predictors) for those models. The measured

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[1] See for example, Brown and Ball (1967), Beaver (1970) Dopuch and Watts (1972) and Ball & Watts (1972).

association might also shed some light on the question of the desirability of alternative quarterly reporting concepts.

Another objective in studying the statistical properties of quarterly data is to gain greater insight into the dependence between results in different quarters and into the commonality in quarterly earnings of the firm, its industry and the market. The latter objective is not directly related to the model-selection phase of the research but is nevertheless of potential value for the following reasons: First, the relationship between the four quarters and in particular between the fourth quarter and the first three quarters might indicate the use of the fourth quarter as a "buffer" used by management to manipulate the annual result. Second, the degree to which market and industry effects are reflected in quarterly results might serve as a partial measure of the real economic data conveyed by quarterly reports.

With the aforementioned objectives in mind, the following statistical properties of quarterly series are analyzed:

1. Association between quarterly variables
2. Seasonality
3. Volatility of sales and earnings and its implication for quarterly reporting concepts
4. Relations between the results in different quarters and their implication for income manipulation
5. Association between quarterly results of the firm, its industry and the market.

Association Between Quarterly Variables: A Preliminary Investigation

The relationships between the following quarterly variables are explored in this section: Sales, Net Income (NI), adjusted EPS (EPSAD) and Net Income divided by Assets (NIDIV).[2] An attempt is made to relate the findings to the following a-priori assessements of the association between the variables.[3]

Sales-NI Relationship: The association between these two variables depends on several factors: (1) the level and rate of change of the fixed cost: The higher the level and the rate of change of the power , the correlation between the twc (2) the association between prices of inputs and outputs (3) the extent of accounting manipulations. It is generally presumed that sales are less susceptible to accounting manipulations or otherwise to arbitary allocations than costs. These manipulations tend to obscure the real relationship between Sales and NI.

EPSAD-NI Relationship: The size of independent movements of these two variables depends on two factors: (1) The existence and materiality of preferred dividends (See APB 15, AICPA (1969)) (2) The existence and materiality of new issues.

EPSAD-NIDIV Relationship: Both variables are deflated - the first by the number of shares issued to the public and the second by the book value of the assets. We would expect a high correlation between the two if the trend in the number of shares corresponds to the trend in the book value of assets and if preferred dividends are not material.

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[2]Quarterly values for Total Assets were unavailable; the values were extrapolated from the annual Total Assets by using a weighted average of the beginning and ending value of Assets.

$$(\text{Quarterly Assets})_{m,n} = ((4-n)\ \text{Annual Assets})_m + n(\text{Annual Assets})_{m+1})/4$$

where m = the year and n = the quarter (n=1,2,3,4).

[3]Some findings are further analyzed in the next two sections.

Results and Analysis

Tables 1 and 2 summarize the results detailed in Appendix C. The positive correlation between Sales and NI is strong with a median coefficient of .733. There is to be sure some variability between industries, with industries 28 (Chemicals, Drugs) and 35 (Machinery) having relatively high correlation coefficient and industries 10 (mines) and 33 (Steel, Copper) with relatively low coefficients. The observed difference may be in part due to the higher fraction of fixed costs in industries 30 and 33. The small number of companies in each industry (5-7) prevents us from drawing any definite conclusion. (An extension of this investigation to the entire file of the COMPUSTAT is quite straightforward). Finally, variables NI and EPSAD are, as expected, highly correlated. This reflects, in essence, the growth pattern dominating both series. For some purposes, therefore, NI and EPSAD are interchangeable. The weakest association found is between EPSAD and NIDIV; for some companies the correlation is even negative. This might reflect on a sharp increase in book value of total assets, without a corresponding increase in the number of shares.

TABLE 1

DISTRIBUTION OF THE CORRELATION COEFFICIENT BETWEEN
SALES, NI, EPSAD AND NIDIV

Variables	1st Quartile	Median	3rd Quartile
Sales-NI	.560	.733	.913
NI-EPSAD	.945	.984	.993
EPSAD-NIDIV	.239	.545	.701

TABLE 2

MEDIUM OF THE CORRELATION COEFFICIENT BETWEEN
SALES, NI, EPSAD AND NIDIVD BY INDUSTRY

	Sales-NI	NI-EPSAD	EPSAD-NIDIV
All Companies	.733	.984	.545
Industry			
10	.658	.989	.667
20	N.A.	.979	.365
28	.932	.980	.613
29	.885	.981	.100
33	.634	.990	.841
35	.922	.980	.236

Seasonality Tests and Deseasonalization of The Series

Statistical Procedures

The conventional model for analyzing time-series considers the effects of four sets of factors on the independent variable, trend, seasonality, cyclical fluctuation and residual movement. The model assumes that the effects of these factors are additive,

$$Y_t = T_t + S_t + C_t + R_t$$

and the problem is to decompose the observation Y_t into these components.

Four alternative procedures are employed here to detect and test for seasonality. The first procedure (used by the U.S. Department of Commerce and referred to hereafter as the X-11 Program) is based on a ratio-to-moving-average method. A series of iterations is used such that in each iteration moving averages of the original series are computed, the ratios to moving average are found and extreme values are scaled down by a set of weights. This is followed by a computation of initial seasonal factors which are us d to generate a seasonally adjusted series. The adjusted series is then subjected to a variable trend-cycle routine, allowing the calculation of new weights for extreme values to be used to modify the original series, etc. (For a description of these routines and the corresponding statistical tests for seasonality see Appendix D.)

The X-11 Program is employed also to deseasonalize the quarterly series for the purpose of investigating some of their statistical attributes. The use of the deseasonalized series for this purpose is limited in the sense that its properties are not characterized from a statistical point of view. In the absence of information about the sampling distribution of the estimates of the seasonal component, it is impossible to decide whether a method gives rise to systematic biases in the seasonally adjusted series or whether a given method is efficient. (see Jorgenson (1964).. The results based on the analysis of the deseasonalized series produced by X-11 should therefore be approached with care. Efforts are made in each case to base the conclusions on other supporting evidence as well as the findings from the deseasonalized data, and to rely upon the broad tenor of the results rather than on some specific tests.

Two other procedures which are used to test for seasonality (but not to deseasonalize the data) are based on a linear regression technique and involve the use of dummy variables to represent the seasons. The first regression model is of the form

$$Y = Pa + Db + e$$

where P is a set of powers of time and D is the matrix 4 m x 4 (m = number of years)[4]

$$D = \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ & \vdots & & \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

A set of powers, P, specifies the trend function. A polynomial of high enough degree can describe most trends. This increase in accuracy should be weighed against the loss in degrees of freedom. The set of powers used in this study is 1/2, 1, 2, 3; for most companies

[4]Jorgenson (1964) has argued that if the P and D matrices are properly specified then a and b will be the best linear unbiased estimates of the systematic and seasonal components since Y = Pa + Db + e is a clear example of ordinary list squares.

a higher degree polynomial did not improve the R^2 considerably.

The second regression model uses the simple four-term moving average for describing the trend. (The loss in degrees of freedom is reflected here in the loss of two observations at both ends of the time-series),

$$Y^* = Db^* + e^*$$

where Y^* is defined as the difference between the original observation and its corresponding moving average. It should be noted that the moving average is not a very flexible method for eliminating the trend as some believe. Nevertheless it is quite adequate for removing linear and quadratic trends (for a further discussion see Durbin (1963)). The existence of seasonality and its direction are examined by testing the standard hypothesis

$$Ho : b(D) = 0.$$

A word of caution concerning the trend specification is in order. Both seasonality and the residual factors are determined to some extent by the specific arithmetic process employed in deriving the trend. It is of interest, therefore, to study the effect of trend elimination by moving-averages on these components.[5]

Suppose we have a series Y_t which can be decomposed to

$$\text{(I)} \quad Y_t = T_t + S_t + R_t$$

If we determine the trend by a moving average, denoted by an operation T then clearly

$$\text{(II)} \quad \Upsilon Y_t = \Upsilon T_t + \Upsilon S_t + \Upsilon R_t$$

Let us assume that the methods of determining the trend is perfect in

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[5]The following discussion is based on M. Kendall and A. Stuart (1966), chapters 45, 46.

the sense that $\tau T_t = T_t$, then by subtracting (II) from (I) to eliminate trend we find

$$Y_t - \tau Y_t = S_t - \tau S_t + R_t - \tau R_t$$

The presence of τS_t and τR_t may distort the genuinely oscillatory. parts of the residual series and induce spurious oscillatory movements. It can be shown, however, that if the simple moving average (with equal weights) is equal in extent to the period of the seasonal component, the trend value of that component is zero, so that the (seasonal) residual is unimpaired.[6]

The effect of the simple moving average of the residual element, R_t , however, does always exist. Consecutive values of R_t are (or supposed to be) independent but consecutive values of τR_t are not; for τR_t and τR_{t+k} have 1-k values of R in common (1 is the extent of the moving average) and are correlated if $k < 1$. In general, the induced residual series would be smoother than the original series. Unfortunately every smoothing process used in eliminating the trend would result in distorting the residuals. There is no escape from this situation. It seems fair to say, nevertheless, that for a wide class of economic and social statistics such computational procedures as the one proposed above work quite well in practice.

In addition to the above procedures the existence of seasonality is also detected by computing the simple ratio of the quarterly number to its annual counterpart for each of the four quarters. Seasonality would result in a ratio systematically different from the ratio expected under no seasonality (0.250).

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[6]Ibid., p. 377.

Tests, Results and Analysis

Most of the tests for seasonality are performed on three variables - Sales, EPSAD and NIDIV. In the sample of fifty companies, there is virtually complete agreement between the results of the various procedures: Only in a few cases is a seasonal behavior found by one procedure not detected by the others. Appendix D tabulates the results of the statistical tests for seasonality based on X-II, the polynomial-trend regression and the moving-average-trend regression.

If a given series is classified as seasonal when at least two of the three tests so indicate, then out of forty-two companies for which sales are available, thirty-six show significant seasonality. For EPSAD and NIDIV the results is forty-four "seasonal" series out of forty-nine. In sum, most companies show seasonality in both quarterly sales and earnings. These results are quite impressive considering the long period upon which they are based (twenty-six years), during which varying, even offsetting, seasonal patterns could develop.

The finding explains the results reported by Coates (1973) that the seasonal prediction models performed best for fifteen out of twenty seven companies.[7] It should be noted that stable seasonality means only that variability over time of any given quarter is significantly smaller than the variability between quarters. It does not follow that the seasonality pattern is constant, nor does it imply that a clear seasonal behavior exists in <u>all</u> four quarters.

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[7]Coates seems to misinterpret his results by stating that fifteen of the twenty seven firms have seasonal earnings (see Coates (1973), p. 141). The true meaning of his examination was a test of the performance of naive seasonal models, rather than a test for seasonality in the data. His results should thus be interpreted as an indication that at least fifteen companies have seasonal earnings.

Another finding is the similarity across companies in the direction of the seasonal pattern in Sales and EPSAD (Appendix F presents the rank of each quarter-based on its seasonal factor-as produced by the X-II. Similar results were derived through regression methods). This finding is not surprising -- it could already be inferred from the strong positive correlation between Sales and NI evident in most companies (See Table 1).

The dominant seasonal pattern can be characterized by a relatively low levels of sales and income in the first quarter and their relatively high levels in the last quarter. Table 3 gives the quarter-to-year ratios of Sales and NI, by industry. In five of the six industries

TABLE 3

QUARTER-to-YEAR RATIO

	Sales				Net Income			
Quarter	1	2	3	4	1	2	3	4
All Sample	.238	.250	.250	.260	.228	.250	.246	.276
Industries								
10	.243	.249	.237	.254	.238	.246	.231	.282
20		N.A.			.238	.253	.263	.250
28	.243	.246	.254	.258	.236	.238	.254	.272
29	.232	.252	.259	.258	.217	.256	.266	.264
33	.253	.263	.235	.248	.246	.266	.210	.282
35	.230	.250	.243	.280	.222	.244	.225	.315
Other	.234	.248	.258	.260	.219	.256	.259	.258

NOTE: Periods with negative NI (quarterly or annual) were excluded from the computations.

sales of the first quarter are lower than the .250 mark while the sales of the last quarter are above this average. This phenomenon manifests itself even more strongly for Net Income. For the entire sample, the last quarter is the highest in both sales and net income. The results of the X-II and the regression tests point to a similar direction. Appendix F, for example, gives the average rank of each quarter in the sample based on the X-II results. The average rank of the first and fourth quarter respectively is 2.83 and 2.20 for Sales and 3.06 and 201 for EPSAD. These figures should be compared with the expected rank of any given quarter under conditions of no seasonality, i.e., 2.5.

The volatility of the sample results is tested next on the universe of companies in the COMPUSTAT File. A market and industry averages (for the six industries 10, 20, 28, 29, 33 and 25) are computed for the thirty-five quarters between April 1964 and December 1972 (see Appendix G for the description of the procedure used in computing the indices). The market and all six industries show significant seasonal patterns in Sales, EPSAD and Net Income. As in the case of the sample companies, the seasonal pattern of Sale is almost identical to those of EPSAD and Net Income (see Appendix H). Furthermore, for the market as well as for most industries, the last quarter offers the highest value of revenue and earnings.

The existence of seasonality in a "market" consisting of many companies and industries, and representing a variety of potentially offsetting seasonal patterns poses two questions: First, what are the underlying economic factors which bring about this seasonality; second, what are the implications of the absence of similar seasonality in stock price movement. Nonseasonal behavior of stock prices might indicate that the market is aware of seasonality in earnings, capable of estimating its effects and discounting them in the determination of market stock prices.[8]

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[8]On the other hand it could be argued that the lack of any seasonality in stock prices is inconsistent with a straightforward discounting of seasonal earnings series.

Volatility of Sales and Earnings - Implications for Quarterly Reporting Concepts

Stable seasonality and quarterly reporting concepts

The seasonality in various components of quarterly reports and its stability have important implications for the relative adequacy of alternative reporting concepts. The fiscal quarter can be viewed in two different ways. First, as a discrete accounting period whose income is to be determined insofar as possible independently of the income of other discrete accounting periods (the "independent period" concept). Second, as a preliminary approximation to the annual income; that is, net income for the quarter is estimated by matching revenue earned with expenses allocated to the quarter. The expense allocations are dependent on estimates of annual revenue and cost relationship (the "dependent period" concept). If it is assumed, as is commonly done, that one purpose of interim reports is aiding investors and others in predicting annual income, then the existence of stable seasonality would reflect on the relevance of the reports. It would also bear on the question which of the reporting concepts (i.e., dependent or independent period) results in greater informational content. When seasonality in both revenues and expenses follows clear and consistent patterns, the independent period concept can produce an interim number that facilitates prediction of annual net income. Success of the application of the dependent period concept hinges on the seasonal pattern in sales. Substantial volatility in quarterly sales would increase the difficulty of determining a quarterly income figure that is predictive of annual earnings.

The predictive ability of different segments of interim financial statements was investigated by Reilly et al (1973). They concluded that interim net sales, being devoid of the allocation and estimation problems associated with costs and earnings, are more useful in predicting annual sales than are interim earnings in predicting annual earnings. This finding is, of course, a reflection of the relative stability in the seasonality of sales. The latter point was directly examined by Kiger (1974). He found that volatility in quarterly sales was about half of the volatility present in net income and suggested that this might indicate a potential advantage of the application of the dependent period concept.

The results of the present study concur with the above findings. Although in most cases both sales and earnings show a significant stability in their seasonal behavior over time, there are still differences in its degree. The relative stability of sales and earnings is assessed below by three alternative methods.

Tests, Results and Analysis

First, following Kiger's approach, the volatility around the seasonal pattern is measured by the range (high minus low) of the ratio of the quarterly number to its corresponding annual value. The results are summarized in Table 4. For all quarters and industries the dispersion of NI around its average as measured by the range, is much larger (sometimes more than twice as much) than the dispersion of Sales. The range is fairly limited as a measure of dispersion: It depends on the number of observations, sensitive to extreme values and does not lend itself

TABLE 4

Volatility of Sales and Net Income, By Industry
(Average range of Quarter-to-year-Ratio)

	First Quarter		Second Quarter		Third Quarter		Fourth Quarter	
	Sales	NI	Sales	NI	Sales	NI	Sales	NI
All sample	.108	.218	.106	.197	.094	.191	.122	.272
Industry								
10	.162	.196	.144	.170	.109	.194	.159	.241
20	N.A.	.213	N.A.	.162	N.A.	.166	N.A.	.264
28	.080	.144	.071	.126	.053	.162	.162	.178
29	.096	.204	.064	.186	.063	.143	.099	.215
33	.166	.380	.230	.335	.177	.282	.195	.414
35	.107	.219	.077	.201	.091	.232	.114	.293
Other	.091	.198	.097	.197	.092	.180	.122	.285

readily to statistical tests. An alternative measure, the standard deviation of the ratios - is therefore used. The results are similar the standard deviation of the NI ratio is higher than the standard deviation of the Sales ratio, and almost always significantly so.

These findings do not necessarily imply a potential advantage of the dependent period concept in forecasting annual income. First, such an implication presumes a naive model of annual income forecast, of the type Annual NI = (Quarterly NI) (Seasonal Factor). This is only one possible seasonal model, and as empirical studies suggest, not necessarily the best. Consequently, the predictive ability of this model is of limited bearing on the choice of a reporting concept. Second, although the use of the independent period method is predominant among corporations, it does not follow that all the companies in the sample do in fact use it. Hence it would be illegitimate to assume that the results bear on the adequacy of this method. Moreover, even if a universal application of the independent period concept can be assumed, it would be still inappropriate judge this concept on the basis of the above results. Further elaboration on this point would require an explicit analysis of the factors affecting the volatility in sales and income.

Define

S - annual sales

X - annual expenses

$\tilde{\alpha}_n$ - percent of annual sales made in quarter n, n=1,2,3,4 (the tilde denotes a random variable)

$\tilde{\beta}_n$ - percent of annual expense actually outlayed in quarter n

$\tilde{\gamma}_n$ - percent of annual net income reported during quarter n

a_n - E($_n$)

The following assumptions are made:

(1) S and X are deterministic

(2) no income tax

(3) consecutive $\hat{\alpha}_n$, $\tilde{\beta}_n$ and $\tilde{\gamma}_n$ are independent (clearly, however, $\tilde{\alpha}_4$ depends on $\hat{\alpha}_1$, $\hat{\alpha}_2$ and $\tilde{\alpha}_3$ since $\tilde{\alpha}_4 = 1 - \tilde{\alpha} - \tilde{\alpha}_2 - \tilde{\alpha}_3$).

These assumptions simplify considerably the algebraic manipulations but do not affect the basic results.

Under the "dependent period" method costs are allocated to the quarter on the basis of its expected share in the estimated annual sales.

$$\tilde{\gamma}_n(\text{dependent}) = \frac{\tilde{\alpha}_n S - a_n X}{S-X}$$

Under the "independent period" method we have

$$\tilde{\gamma}_n(\text{independent}) = \frac{\tilde{\alpha}_i S - \tilde{\beta}_i X}{S - X}$$

If the volatility of the seasonal pattern of income is measured by the variance (or the standard deviation) of $\tilde{\gamma}_n$,

$$V\left[\tilde{\gamma}(\text{dependent})\right] = \left(\frac{S}{S-X}\right)^2 \cdot V(\tilde{\alpha}_i)$$

and

$$V\left[\tilde{\gamma}(\text{independent})\right] = \left(\frac{1}{S-X}\right) \cdot \left[S^2 V(\tilde{\alpha}_i) + X^2 V(\tilde{\beta}_i) - 2XS \cdot \text{cov}(\tilde{\alpha},\tilde{\beta})\right]$$

the following points become evident:

(1) even under the "dependent period" method the volatility in net income is smaller than the volatility in sales

(2) the volatility of net income under the "independent period" method depends on the volatility in sales, the volatility in expenses, and the co-movement of expenses and sales.

The above discussion points to the necessity of comparing the the relationship between the seasonality in expenses and sales, before any conclusion on the superiority of one reporting concept over the other is made. Strong similarity in the seasonal movement of expenses and sales would indicate that the "independent" method might do as well as, or better than the "dependent" method in predicting annual earnings. There are indications that this is the case. Despite the almost identical long-term seasonal pattern in Sales and Net Income for each of the companies in the sample, the deviations of the two from their respective long-term seasonality are not strongly correlated (see Table 5 and Appendix I).

TABLE 5

Distribution of the Correlation Coefficients Quarter-to-Year Ratios of Sales and NI

	Quartile		
Quarter	1	2	3
1	.289	.479	.703
2	.200	.341	.555
3		.434	.617
4	.200	.392	..560

This could be explained by long term changes in the production process which brought about changes in the cost structure and thus in the relative weight of fixed costs. Alternatively, the relatively weak association between these fluctuations might reflect on a strong correlation between sales and expenses which would tend to diminish the association between sales and earnings (for the statistical dependencies between the variables Sales, Expense, and Income, see Appendix J). A high correlation of sales and expenses would indicate a potential success to the "independent method" (contrary to the conclusions suggested by Kiger).

Relationships Between Quarters

An inseparable part of the investigation of quarterly time-series is the examination of the relationships between the four quarters and in particular between the last and the preceding three quarters. Unlike the first three, the last quarterlyreport does not exist in the formal sense: It is not announced usually by the companies but rather calculated as a residual. Therefore the fourth quarter would be expected to incorporate any end-of-the-year adjustments as well as accounting manipulationsof annual results. The use of the last quarter as a "cushion" designed to absorb annual adjustments and manipulations is the subject of the following discussion.

If end-of-the-year adjustments are extensive it is expected that the last quarter will show higher volatility than each of the first three quarters. The direction of these adjustments might change from year to year so that their mere existence should not create a seasonal pattern in the quarter. The effect of accounting manipulations, however, might produce a distinct seasonal behavior of the last quarter results. First, the tendency to convey "good news" in the annual report might lead to a delay of income realization to the end of the year. Such a delay would create the appearance of a strong fourth quarter. Second, the objective of income smoothing (an objective recognized by practitioners as well as by scholars - see for example Copeland (1968) Barefield and Comist (1972), and Barnea et al (1974) leads to an ex-ante dependence of quarterly results which might also be reflected in ex-post relationships.

In order to evaluate the roll of the fourth quarter as a vehicle for income smoothing the nature of such smoothing must be specified. To the extent that it is a parameter in the smoothing decision, a market expectation model should also be defined.

For the purpose of this preliminary investigation, it is presumed that management objective is to minimize the deviation of the actual results (or some function thereof) from their respective expectations. Assume specifically that the expectation model is of the form

$$E(y_t) = f(T_t)$$

where T represents the trend factor. The corresponding quarterly model is $E_Q(Y_t) = f(T_t, S_Q)$ where S is the seasonal factor. Empircally, past trend and seasonality are used to establish the parameters of the expectation model; The irregular movements around the trend-seasonality line are the subject of the smoothing efforts.

If these assumptions hold, and the fourth quarter is indeed used to smooth annual results, we would expect to find a negative correlation between the direction of the irregular movements in the first three quarters and in the last quarter.

Test, Results and Analysis

Inspection of Table 4 reveals that the average range of the quarter-to-year ratio is highest for the fourth quarter both for the total sample and for each of the six industries. It further appears that this tendency is stronger for Net Income than it is for Sales which might point to the fact that end-of-the-year adjustments, the probable cause of this volatility, are more likely to affect annual income than annual sales.

Table 6 presents the distribution of the average range of quarter-to-year ratios of Sales and Net Income. The median of the range in the last quarter is the highest.

TABLE 6

Distribution of the Range of Average Quarter-to-Year Ratio

Quartile / Quarter	Sales 1	Sales 2	Sales 3	Net Income 1	Net Income 2	Net Income 3
1	6.6	8.5	13.2	13.2	19.4	26.7
2	4.8	7.8	14.7	11.5	16.2	24.6
3	4.3	8.2	11.9	11.8	18.5	23.9
4	6.4	11.4	15.5	17.8	26.1	30.7

In addition to the range, the standard deviation of the quarter-to-year ratios is computed for each quarter. Appendix K lists the quarters with the highest and next to the highest standard deviation for the entire sample. Two tests are used to compare the variability; the Cochran test for homogeneity of variances (see Guenthe (1964), pp. 21-22) and the Pitman test for correlated variances (see Snedecor and Cochran (1962) , pp 195-198).[9] Both tests produce almost identical results. The standard deviation of the fourth quarter is in most cases, signficantly larger than the other quarters.

Perhaps, not as intuitively obvious is the result that the volatility of the first quarter (sales and earnings) is consistently the second largest (see Table 6 and Appendix K). This is a somewhat surprising finding; the first quarter does not normally contain accounting adjustments. Furthermore, it is not expected that the first quarterly report is subject to entraordinary accounting manipulations. The finding would be justified if the first quarter report were used by management to affect market expectations created in response to latest annual announcements. Such a behavior

[9] Cochran's test is applied by testing each quarter against the others. Pitman test is applied by testing a pair of quarters at a time. Note that any two quarters are dependent to some extent (the sum of the four ratios is 1.0); strictly speaking, therefore, the use of Cochran's test, which assumes independent samples, is inappropriate.

on part of management can be rationalized considering the proximity of the two announcements (in many cases they are less than two months apart) and the weight assigned by investors to quarterly reports (May 1971), for example, shows that the relative price-change response to quarterly earnings is not significantly less than the response to annual earnings). Although an appealing interpretation the volidity of this interpretation has yet to be established. For instance, this could be accomplished by comparing the characteristics of the first quarter results with preceding annual results.

Further study of Table 3 reveals that the fourth quarter is also the one with the highest income (see also Appendix F), a phenomenon which is manifested even more clearly for the universe of companies on the COMPUSTAT file (see Appendix H). It might reflect a general tendency to delay realization of income to the last quarter; alternatively, it might indicate that the end-of-the-year adjustments are not random, and that on the average they boost the reported income and to a lesser extent - reported sales. A simple and testable explanation is that there are market-wide seasonal forces (e.g., weather, holidays) which are responsible for the strength of the last quarter - October to December. It should be possible to compare between the seasonal pattern of calendar and fiscal year companies during this period. The existance of market-wide effects during these months would result in a high <u>fourth</u> quarter for a <u>calendar-year</u> companies and a high <u>third</u> quarter for <u>fiscal-year</u> companies. The association between the reporting basis (calendar or fiscal) and industry affiliation may, however, impede such a simple comparison.

In order to measure the smoothing effect of the last quarter, an expectations model in which the trend is defined by a simple 12-term moving average of the deseasonalized series is used; the irregular movement is the difference between this trend line and the deseasonalized value. The results suggest that the fourth quarter is not used to smooth the annual results, by bringing them into line with their expected value. This is indicated by the fact that in general there is no negative correlation between the irregular movement of earnings in the fourth quarter and the sum of the irregular movements in the first three quarters. Similar results are derived for the first quarter. This direction of the irregular movement in earnings is common to all the quarters of the same year. Similar findings obtained for sales further supports this conclusion.

Tables 7 and 8 show the distribution of the above correlation coefficients for the sample, (For a breakdown by companies see Appendix L). In more than 70% of the companies there is a positive (in many cases significant) correlation between the irregular movements of the quarters. The similar results for sales only reinforce the conclusion that quarterly reports and in particular last quarter reports are not employed to smooth the annual income.

TABLE 7

Percentage of companies with correlation coefficient between the irregular movement in the fourth quarter and (the sum of the irregular movements) in the first three quarters

Variable	Total	Significantly negative	negative but not significant	positive but not significant	significantly positive
EPSAD	100	2	22	35	41
Sales	100	0	9	55	36

TABLE 8

Percentage of companies with correlation coefficient between the irregular movement in the first quarter and (the sum of the irregular movements) in the second third and fourth quarters

Variable	Total	significantly negative	negative but not significant	positive but not significant	significantly position
EPSAD	100	2	8	51	39
Sales	100	2	12	41	45

The hypothesis that smoothing is achieved through the fourth quarter is tested also by the correlations between the quarter-to-year ratio for the last quarter and for each of the first three quarters. A negative correlation between the fourth and each of the first three quarters would point to the existence of such smoothing.[10] The results however, do not support that hypothesis.

Two typical sets of relationships between quarters emerge from the sample: Define A as the 4x4 correlation matrix of the type (in terms of signs of the coefficient):

[10]The correlation between the ratio for the fourth quarter and the sum of the ratios for the first three quarters would, of course, be always perfectly negative since the two correlated variables are statistically dependent (the sum of the four ratios is one).

$$A = \begin{array}{c} \\ R_1 \\ R_2 \\ R_3 \\ R_4 \end{array} \left(\begin{array}{cccc} R_1 & R_2 & R_3 & R_4 \\ \diagdown & + & - & - \\ & \diagdown & - & - \\ & & \diagdown & + \\ & & & \diagdown \end{array} \right)$$

where R_n (n=1,2,3,4) is the quarter-to-year ratio for quarter n.

and B as

$$B = \begin{array}{c} \\ R_1 \\ R_2 \\ R_3 \\ R_4 \end{array} \left(\begin{array}{cccc} R_1 & R_2 & R_3 & R_4 \\ \diagdown & & \text{any} & - \\ & \diagdown & \text{sign} & - \\ & & \diagdown & - \\ & & & \diagdown \end{array} \right)$$

Table 9 shows the frequency in the sample of the above patterns for Sales and Net Income. The dominant set of relations is the one described by matrix A under which the first half of the year is negatively correlated with the second half. This wide spread pattern might reflect on the existence of semi-annual seasonal behavior of sales and earnings, rather than on any smoothing effects. Only 25% of the companies exhibit negative association between the NI ratio of the last and each of the first three quarters.

TABLE 9

Percentage of companies with Type A and Type B Relationships

Type of Relationship	Sales	Net Income
Type A	50.0	30.6
Type B	14.3	24.5
Other types	35.7	44.9
Total	100.0	100.0

The cumulative evidence presented above does not support the hypothesis that smoothing is achieved through manipulation of the last quarter results. This conclusion does not imply of course that income smoothing is not achieved by other means. Moreover, the conclusion derived under the trend-line smoothing hypothesis should be qualified on a few grounds. First the smoothing process was defined as one under which the irregular fluctuations around the expectation (or a function of them) are minimized. Management, however, might conceive smoothing differently and thus take different actions to achieve this aim. Second, smoothing of income is only one of several possible objectives of management. In analyzing results after the fact it is different if not impossible to discern the effects of this objective from others. Third, the expectation model selected is not necessarily the true one or at least the one followed by management; mis-specification of the expectation model might lead to wrong conclusions about the existence of smoothing attempts. Finally from a methodological viewpoint, an ex-post examination of actual outcome is often a poor basis for detecting motivation and intentions.

Despite the above qualifications (which apply to most studies in the area of income smoothing), it seems that the consist nt and clear relationships detected, which also contradict some preconceived notions about the smoothing effect inherent in the last quarter, deserve a further study.

Association Between Quarterly Results of the Firm, Its Industry and the Market

The purpose of the following investigation is to determine whether there is some degree of association between the quarterly results (earning and sales) of an individual firm, the quarterly results of other firms in its industry and the quarterly results of all firms in the economy. A strong commonality has been found between the returns of the individual firm, its industry and the market (see King (1966) and Farrell (1973)). Similar associations have been established for annual earnings (see Brown and Ball (1967)).

Presumably, quarterly results of an individual firm are likely to show the same seasonal behavior as its industry. This part of the commonality between the firm and the industry is quite obvious. Our interest, however, is focused on the question whether there is a commonality in quarterly results beyond seasonal co-movement. For this purpose it is meaningless to use the original quarterly series; rather, the deseasonalized data of the individual firms as well as of the industry and the market is used. Any commonality detected between these series would represent the effect of all the non-seasonal factors.[11]

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[11] One reservation should nevertheless be made: As reported earlier (see the section "Seasonality Tests..."), there is a distinct seasonal pattern in the market index. This could be a result of the effect on the market average of a few but large industries or it could represent in part the existence of economy wide effects, which influence (to various degrees) all the firms (and industries) in the market. To the extent that the latter is the case, the elimination of seasonality from the market indices (and to a lesser degree from companies and industries) would also remove part of the market-wide factors which the study seeks to detect. Unfortunately, there is no way to diagnose the causes for the market seasonality and even if there were such a way no method exist to measure and separate the market-wide seasonal effects from the distinct seasonal patterns of individual companies.

If the quarterly numbers, after eliminating the seasonal effects, possess the same properties found in annual series, it would imply that quarterly results are affected by the same underlying economics factors which affect the annual results; that the looser accounting principles governing the preparation of the quarterly reports do not materially diminish or obscure these relationships, and hence, that quarterly results convey a substantive economic message to investors.

Tests, Results and Analysis

Three variables are examined - Sales, Net Income (NI) and adjusted EPS (EPSAD). To allow inter-industry comparisons, a group of thirty five companies belonging to only six industries is used. Each industry includes at least five companies. The industries are (2-digit SIC classification) 10,20,28,29,33 and 35 (for industry names see Chapter II). Market and industry indices are constructed from the COMPUSTAT-industrial file for the available period - March 1964 to December 1972 (for their description see Appendix F). All the series are deseasonalized by the X-II Program (see Appendix C).

The approach used to measure the commonality of quarterly results between the individual firm, its industry and the market is similar to that used by Brown and Ball (1967). Basically the method involves three sets of regression equations The regression between the industry and the market, the regression between the individual firm and the market, and the regression between the individual firm, the market and the industry effect unexplained by the market (the residual from the first regression).[12] In notation form:

[12] A strict application of the least squares model would require that the market and industry indices should in every case exclude the firm against which they are regressed. Practically, however, the nuisance effect introduced by not doing so is negligible.

$$1.\ I_t^k = \alpha + \beta M_t + \epsilon_t^k$$

$$2.\ F_{it}^k = \alpha' + \beta' M_t + \mu_{it}$$

$$3.\ F_{it}^k = \alpha'' + \beta'' M_t + \gamma_i^k + \delta_{it}$$

where F,I, and M denote the firm, the industry and the market, respectively; i is the firm index, k - the industry index, t - the time and ϵ, μ and δ disturbance terms. Ball and Brown applied this model to the earnings of 316 firms drawn from the COMPUSTAT tape for the nineteen years 1947 to 1965. Some of their major findings are reproduced in Appendix M.

Tables 10 and 11 list the main results.[13] The correlation between the industries and the market is generally strong. In particular, the sales in every industry are highly correlated with the sales of the market. The correlation is somewhat weaker for the earnings variables and in particular for two industries - 10 and 33. The same trong association between individual industries and the market has been reported by Brown and Ball. The commonality in Net Income is stronger than the commonality in EPSAD and again a similar pattern was discovered by Brown and Ball: The correlation of the industries with the market was stronger for Operating Income (which is the closest measure to Sales) than for Net Income and was still stronger for Net Income than for EPSAD.

[13] -Orchutt iterative technique (see Cochran-Orchutt (1944) is used to remove the autocorrelation which was present in most of the deseasonalized quarterly series. The results shown are after the application of this technique. The results before the elimination of the autocorrelation (shown in Appendix N) however, lead to the same conclusions.

TABLE 10

Coefficient of Simple correlati n between Industry Indices and the Market Index by Variable*

Industry	Variable		
	Sales	NI	EPSAD
10	.963	.819	.817
20	.987	.978	.966
28	.992	.981	.950
29	.994	.973	.941
33	.866	.640	.662

TABLE 11

Coefficient of Determination - Summary Results for the 35 Group of Companies by Variables and Industry*

Industry	Average ^{2} (firm,market)			Average Multiple R^2(irm, k ,. arket		
	Sales	NI	EPSAD	Sales	NI	EPSAD
10	.624	.571	.547	.687	.654	.613
20	N.A.	.574	.545	N.A.	.609	.575
28	.940	.670	.635	.941	.612	.650
29	.947	.523	.475	.955	.562	.538
33	.728	.339	.283	.669	.576	.499
35	.918	.726	.696	.918	.743	.782
All group	.782	.565	.528	.844	.629	.608

*Coefficients are after the application of Cochran-Orcutt iterative process to the regression equations.

Table 11 presents summary results of the association between the firm, its industry and the market for the group of thirty-five companies (from six industries) On the average, about 56 percent of the variability of a firm's

with the variability of the market average. Also on the average, an additional 7 percent can be associated with the industry average. Brown and Ball's results for this variable are almost identical -- 55 percent and 14 percent respectively (see Appendix M).

The different degrees of association found for Sales, Net Income and EPSAD are intuitively clear: The earnings variables are a function of both sales and expenses. While some association probably exists between the costs of the firm,its industry and the market (due, for instance, to inflation), this component of earnings is quite often unique to the firm (location, cost structure) or to its industry (capitcal intensity, concentration, regulations, etc.). Consequently earnings of individual firms are expected to be less correlated with the market than sales. The above explanation is consistent with and supported by an additional finding: While the market factor is clearly stronger in explaining sales of individual firms than in explaining their earnings, the industry factor is somewhat stronger in explaining earnings. Brown and Ball found that operating income, their closest measure to sales had the strongest market factor and at the same time, the weakest industry factor.

The lowest degree of assocation between the firm, its industry, and the market is found in EPSAD. Unlike the Net Income variable which contains a clear trend, EPSAD is a deflated variable whose deflator depends heavily on the firms decisions (issuance of new stocks). Although these decisions reflect market conditions they are not necessarily common, in terms of both timing and extent, to all firms in the market or even to all firms in the same industry.

Perhaps the most significant implication of the above results is that despite the shorter measurement period (and hence the greater effect of random disturbances), the measurement problems and the less stringent accounting standards associated with quarterly reports, they, nevertheless, appear to reflect the same economic factors found to affect the annual accounting numbers. It does not follow, however, that quarterly accounting measures of income are adequate in terms of their definitions of income; rather, these desired properties of quarterly numbers should be viewed as only necessary condition for a good measure of income.

CHAPTER V

THE PREDICTIVE ABILITY OF QUARTERLY REPORTS RESULTS AND ANALYSIS[1]

Overall Performance

Accounting-based models - annual vs. quarterly

As already explained in Chapter IV (p. 26) the comparison between the performance of quarterly and annual models gives a measure of the gross informational content of quarterly reports. The results of the present study seem to concur with those of earlier studies. On the average, the quarterly predictions (set Q) perform better than the annual predictions (Set A). Table 12 presents the results for the entire sample and for six industry groups (which include thirty-five of the fifty companies), under two loss functions - the squared error and the relative (percentage) absolute error.[2] The average relative absolute error of the annual set of models is 20.60% while the average error for the quarterly set is only 14.91%. The quarterly models outperform the annual in each of the six industries. The most inaccurate predictions are made in industry 33. The reason is probably the numerous cases in

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[1] Unless stated otherwise, the results reported in the chapter are based on the initial set of models (for their identification, see Appendix P).

[2] The results produced under the first four loss functions (see Chapter II) are very similar. Therefore only the results for the relative absolute error and (sometimes) the squared error are presented.

TABLE 12

Average Error* for Quarterly and Annual Models by Loss Function and Industry

	Squared Error (loss functional)		Relative Absolute Error (loss function 4)	
	Q	A	Q	A
All Sample	.235	.582	14.91	20.60
Industry				
10	.179	.552	13.60	23.55
20	.055	.088	10.29	11.29
28	.098	.170	7.65	10.51
24	.092	.111	8.87	12.47
33	1.075	2.996	30.02	38.93
35	.100	.277	11.52	18.87

*Simple average.

which companies in this industry reported negative quarterly and annual EPSAD[3] which caused the naive models to produce poor forecasts[4]. Consistent application of the same models in all periods, however, is essential to the methodology used. Indeed, when the computations excluded companies which experienced at one time or another negative earnings, the average relative absolute error for the sample decreased to 9.40% and 13.90% for sets Q and A respectively. The superiority of the quarterly over the annual set is universal and significant. The Pitman test applied to the average squared error (loss function 1) discloses that in thirty-nine companies the difference between the errors produced by the two sets is significant at the 99% level ; in other two companies the difference is significant at the 99% level

companies the annual set outperforms the quarterly set (for a breakdown by company see Table 32 , Appendix R). On the cross-sectional level, the quarterly predictions are more accurate than the annual predictions for every year of the twelve year period (See Appendix S).

The use of other statistics yield similar findings. Table 13 presents summary results for various rank measures.

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[3] In fact, all six companies in industry 33 experienced negative earnings at least once during the survey period. In the sample, there are fifteen companies that fall in this category.

[4] Although prediction models using ratios that became meaningless or undefined when earnings are negative are not applied to companies which reported such results, large inaccuracies could still be produced (consider for instance the effect of negative EPSAD on the performance of additive-trend models like 1, 2, 14 or 18 detailed in Appendix O.

TABLE 13

Rank Measures

Based on the Squared Error

Statistic	Set Q	Set A
Average rank of error (rank averaged over all company-periods)	2.1	2.9
Average rank of company mean error	1.4	3.3
Average number of times first (out of 36 prediction periods)	16.8	6.1

NOTE: Ranks are based on a four-way comparison of sets Q, A, MA and MQ (average rank for all sets is 2.5).

Again, like the results based on the error measure, the averages above, which are independent of the size of the difference in the errors, reflect a consistent pattern overtime and across companies with almost no exception. Application of the non-parametric sign test to the paired ranks shows that the differences are significant at the 99% level (for a breakdown by company, see Table 33, Appendix R). mentioned before, were expected and concur with previous studies. The superiority of quarterly over annual prediction models might be related to several factors. First, there could exist of course a real informational content in quarterly reports which would tend to result in accurate annual earnings. Second, being made for shorter period, the quarterly forecasts are inherently more accurate. While the annual forecast predicts a period of one year in the future, quarterly forecasts are, in fact, made for periods ranging from nine months (predictions following the first quarterly report) to three months (predictions following the third quarterly report). Although this in itself does not necessarily mean that annual forecasts are less accurate, one would expect just that if quarterly reports do not have a misleading content.[5] Finally, estimates of parameters used in prediction models are more reliable when based on more observations. Quarterly data consists of more observations than the annual data, thus making it possible to estimate the required parameters more accurately.[6] An attempt to discern the first two factors is made in this chapter.

<u>Annual accounting-based models vs. macro models</u>

It appears that for individual companies, there is on the average only a slight improvement in earnings forecasts due to the use of macro economic data (set MA). It does not follow

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[5] If the results in the four quarters, Q_1, Q_2, Q_3 and Q_4 are four <u>independent</u> random variables, then the annual result, which is their sum, has larger variance (and is therefore less predictable) than a sub-period since

$$\mathrm{Var}\left\{\sum_{i=1}^{4} \tilde{Q}_i = \sum_{i=1}^{4} \mathrm{Var}\, \tilde{Q}_i < \mathrm{Var} \sum_{i=1}^{N} \tilde{Q}_i = \sum_{i=1}^{N} \mathrm{Var}\, \tilde{Q}_i, (N\ 4).\right.$$

[6] However, because of the existence of seasonality the relevant quarterly time-series is based upon past observations of the same quarter rather than on a series containing all four quarters.

however, that this data is incapable of improving considerably earnings forecasts of some companies or of all companies in some periods. It only means that there is no noticeable difference between the average performance - over periods and companies, of the two sets. It should be noted however that while the annual set (A) comprises five alternative models the macro economic set (MA) despite using four alternative variables employs only one prediction formulation. The slight improvement attributed to macro data is thus a lower limit to their contribution.

The average relative absolute error for set MA is 19.83% compared to 20.60% for set A. This difference is insignificant and the results are even reversed under the squared error loss function. Nevertheless, in a majority of the companies (twenty-eight) the average absolute error is lower for Set A. Also, industry 29 demonstrates a clear dominance of set MA over set A (both in terms of number of companies and of average error). Furthermore, as shown in the next section, macro economic data do significantly improve forecasts made after the first quarter. For detailed results and a breakdown by company see Appendix R.

<u>Quarterly accounting based models vs. quarterly macro/accounting Models</u>

This comparison between model sets Q and MQ reflects the average incremental contribution of quarterly reports. Like the previous comparisons, the results are in the form of an average over the three quarterly predictions (predictions are made after the first, second and the third quarters.)

As reported in the preceding section, the addition of macro-economic information makes little improvement in the accuracy of earnings forecast. The comparison Q-MQ would therefore measure the gross and possibly the net contribution of quarterly accounting reports. Table 14 shows the comparative results for sets Q and MQ, under the two loss functions - the square error and the relative absolute error.

TABLE 14

Average Error* for Quarterly Accounting and Macro Models by Loss Function and Industry

	Squared Error (loss functional)		Relative Absolute Error (loss functional)	
	Q	MQ	Q	MQ
All Sample	.235	.429	14.91	17.50
Industry				
10	.179	.381	13.60	19.87
20	.055	.068	10.29	10.35
28	.098	.151	7.65	8.92
29	.092	.058	8.87	9.56
33	1.075	2.419	30.02	39.02
35	.100	.194	11.52	15.27

*Simple average

Except for industry 29, set Q performs clearly better than set MQ. Tests for individual companies show that the average squared error of set A in thirty-nine companies (the difference is significant at the 99% level for twenty-seven companies and at 95% level for another six companies). The various rank statistics presented in Table 15 point to the same conclusion.

TABLE 15

RANK MEASURES

Based on the Squared Error

Statistic	Set O	Set MQ
Average rank of error (rank averaged over all company-periods)	2.1	2.4
Average rank of company means errors	1.4	2.1
Average number of times first (out of 36 prediction periods)	16.8	6.0

Note: Ranks are based a four-way comparion of sets Q, A, MA and MQ (average rank for all sets is 2.5).

Quarter by Quarter Performance

The overall performance of the quarterly model sets is an average over the three predictions made annually after each one of the first three quarters. Such a comparison yields an almost obvious finding that quarterly models outperform annual models. However, it cannot reveal the incremental improvement due to each of the quarters nor does it show the relative efficiency of different model sets after each of the quarters. Such a knowledge however is important in evaluating the informational content of alternative inputs. Table 16 presents the average error associated with the four model sets after each of the quarterly predictions. As one would expect the quality of the

TABLE 16

Average Error*

By Loss Function, Model Set and Time of Prediction

Predictions made after the: Model Set	Squared Error (loss function 1) All Quarters	First Qtr	Second Qtr	Third Qtr	Relative Absolute Error (loss function 4) All Quarters	First Qtr	Second Qtr	Third Qtr
Q	.235	.382	.218	.103	14.91	18.79	14.97	11.00
A	.582	.582	.582	.582	20.60	20.60	20.60	20.60
MA	.591	.575	.592	.606	19.83	20.04	19.78	19.76
MQ	.429	.569	.421	.296	17.50	19.82	17.78	14.98

*Simple average

forecasts improves monotonically as the forecasting time approaches the end of the year. The annual set (A) produces one prediction at the beginning of each year and the forecast error is therefore the same throughout the year.

The continuous increase in forecasting accuracy is common to most companies and to all six industry groups. Furthermore, the phenomenon of error reduction over time exists throughout the entire predicted period of 1961 to 1972. (For detailed results of individual companies and industries see Appendices R and S).

Quarterly Accounting-based models

Table 17 describes the reduction in the forecast error over time by industry. The second quarter reduces the average relative error from 18.79% to 14.97%; the error further decreases to 11.00% following the third quarter prediction. The trend of error-reduction over time is found in all industries.

TABLE 17

Average Relative Absolute Error* of set Q at Different Times of Prediction by Industry

	Prediction made after the:			
	All Quarters	First Quarter	Second Quarter	Third Quarter
All Sample	14.91	18.79	14.97	11.00
Industry				
10	13.60	18.19	14.47	8.17
20	10.29	12.93	10.70	7.24
28	7.65	10.41	7.76	4.82
29	8.87	13.58	7.54	5.50
33	30.02	37.49	30.43	22.30
35	11.52	15.60	10.85	8.14

*Simple average.

The degree of improvement between the first and the second quarters and between the second and the third quarters is very much the same (in absolute terms) for the total sample and for individual industries. The error reduction is evident in virtually all companies. In all fifty companies (!) the error decrease from the first to the second quarter predictions) and in fifty-seven companies an additional error reduction results from the third quarter prediction. Similar results are reported by Coates (1973): In twenty-five out of twenty-seven companies sampled the average error decreased monotonically over time (Ibid., p.144) The reduction in the error for the individual company is statistically significant (Pitman test is applied to the squared errors). The reduction in error between the first and the second quarters is significant at the 95% level in thirty-seven companies (out of fifty); the reduction in error between the second and the third quarters is significant at that level for thirty-four companies (out of forty-six companies in which such reduction occurred). For breakdown by company see Tables 34 and 35 in Appendix R.

Quarterly macro-based models

In an earlier comparison between the annual accounting based models (set A) and the quarterly macro-based models (set MA), the results were inconclusive or at least pointed to the fact that on the average the quarterly macro information does not contribute significantly to the accuracy of forecast of company earnings. This is reflected also in the incremental contribution of the macro-economic data. The findings indicate that the addition of quarterly macro-data does not meaningfully improve the forecast. In some instances the contribution of the most recent quarterly information is nill. The breakdown into industries points to the same minor quarter-to-quarter improvements. Examination of the individual companies reveals that in twenty-four companies the average squared error associated with predictions produced by set MA monotonically decline over the quarters, although the error reductions are small and significant. In fifteen other companies there is no reduction or increase of accuracy over the quarters and in the remaining eleven companies the error even increases on the average. For detailed results and a breakdown by company see Table 32 in Appendix R.

Quarterly macro/accounting models

The set MQ makes use, in each quarterly prediction, of the most recent macro data and of past quarterly accounting data (excluding the most recent quarter). It follows that beside the macro-economic data the first quarterly forecast employs only annual accounting data. The second quarterly prediction uses annual accounting data plus the first quarter accounting information. The third quarter forecast uses second quarter accounting information (for a description of set MQ see Appendix O).

This means only that accuracy improvement from the first quarter to the second quarters reflects the introduction of the first quarter results and similarly improvement in accuracy between the second and third quarters forecasts reflects the addition of the second quarterly report. Although the set MQ relies on a single forecast formulation the results presented in Table 18 are generally the same as those reported for the quarterly accounting-based model. Namely, there is a distinct reduction in the forecast error from quarter to quarter, a phenomenon common to all industry groups.

TABLE 18

Average Relative Absolute Error* of Set MQ by Time of Predictions and Industry

Prediction made after the:

	All Quarters	First Quarter	Second Quarter	Third Quarter
All sample	17.50	19.82	17.78	14.98
Industry				
10	19.87	23.05	20.01	16.66
20	10.35	11.60	10.64	8.83
28	8.92	10.60	9.39	6.80
29	9.56	11.73	9.65	7.31
33	39.01	39.21	40.75	37.43
35	15.27	17.41	15.92	12.55

*Simple average

The error reduction is larger between the second and the third quarter than it is between the first two quarters. This bears on the comparative marginal contribution of the first and the second quarterly reports. It appears that the second quarter accounting information has greater impact on the forecasts accuracy than the information of the first quarters. This fact is also reflected in the number of companies for which the error reduction is significant. Only twenty-seven companies experience significant error reduction (95% level) between the first and second quarter while thirty-seven companies experience such a reduction between the second and the third quarter. Moreover, seven companies show an increase in the error between the first and second quarters. These findings are further explored in the next section.

An alternative way to present the superiority of different model sets at different points of time involves the use of an ordinal statistic - "The number of times best". Summarizing this statistic for every model set over all periods and companies (1800 observations) the probability of any model set to outperform the rest can be computed for all predictions and for predictions made after each of the quarters. Table 19 which presents these probabilities offers another dimension of the comparative errors shown in Table 16.

TABLE 19

Probability of Dominance in a Given Period by Quarters and Model Sets

		Model Set			
	Total	Q	A	MA	MQ
All predictions	1.00	.47	.17	.16	.20
Predictions made after:					
First Quarter	1.00	.41	.23	.21	.15
Second "	1.00	.48	.15	.15	.22
Third "	1.00	.52	.13	.13	.22

The quarter-to-quarter improvement in the accuracy of the quarterly set (Q) is reflected in the increase in the probability of this set to become the best as the year progresses. The annual model (A) which has a dominance probability of only .23 after the first quarter is even less likely to be best after the second and the third quarters (probabilities of .15 and 13 respectively). Although the probabilities vary somewhat over the twelve-year survey, they appear to be relatively stable. Detailed results are presented in Table 33 in Appendix R.

Measures of the Marginal Contribution of Quarterly Reports

The measure Q-A represents the total improvement in earnings forecasts made by the addition of quarterly accounting information to the annual reports. As could be expected the average error decreases significantly when models of set Q rather than of set A are employed in the forecasts (see Table 16). The incremental contribution of each of the three quarterly reports to the accuracy of the earnings forecasts is of more interest and can be assessed through the comparisons Q(1)-A, Q(1)-Q(2) and Q(2)-Q(3), respectively. Table 20 summarizes the results for one loss-function, the relative absolute error. The percentage of error reduction due to the first quarter is smaller compared to the reductions attributed to the second and the third quarters. Only in twelve companies the forecasts based on the first quarterly report are significantly more accurate than those based merely on past annual accounting data.[7]

TABLE 20

Total Reduction in the Average Error* Due to New Quarterly Accounting Information (As a percentage of the initial error)

	Comparison	Error Reduction(%)	Number of companies with error-reduction	Number of companies with significant error-reduction (95% level)
First Quarterly Report	Q(1)-A	8.8	37	12
Second Quarterly Report	Q(2)-Q(1)	20.3	50	37
Third Quarterly Report	Q(3)-Q(2)	26.5	48	34

*Simple average over the sample of the relative absolute error.

It would be instructive at this point to compare the above findings with the results reported by other studies.[8] Green and Segall (1966) base their results on the average performance of several forecast model applied to all companies in the sample. They conclude that "the first-quarter reports as presently prepared, are of little help in forecasting annual EPS" (Ibid.,p. 55). This conclusion is not supported by two other studies which use a similar approach - Brown and Niederhoffer (1968)

[7]The use of the squared error produced somewhat different percentages; nevertheless, it indicates the same relation between the incremental contributions of the three quarters.

[8]As noted already the comparison is imperfect due to differences in methodologies. For a brief discussion of the methodologies used by other studies see Chapter I. The methodology employed in this study is outlined in Chapter IV.

and Reilly et al. (1973). Brown and Niederhoffer find that "the quarterly predictions as a group generally were superior to the annuals as a group" (ibid, p. 446). Reilly et al. conclude that the first quarter EPS models performed somewhat better than annual models. A careful analysis of their results, however, show; that the first-quarter error-reduction when measured by the comparison between the best quarterly and annual models is clearly smaller than the error reductions in the second and third quarters. For example, from Table 1, 2 and 3 of Brown and Niederhoffer study it can be learned that the average relative error-reduction (based on the percentage relative error) for the period 1963 to 1965 is 13.7% in the first quarter, 20.5% in the second quarter and 33.4% in the third quarter. Similarly, Tables 1 and 2 in the work of Reilly et al. show no improvement in the EPS forecast in the first quarter of 1967 compared to 17.6% error-deduction in the second quarter. Coates (1973) findings, do not point to a significant difference between the incremental contribution of the different quarters. From Table 2 (ibid., p.144) it can be learned that the average error reduction in his sample (the error-measure selected is the mean-squared deviation) is 28.3%, 28.9% and 36.5% after the first, second and third quarter, respectively. Barnea et al (1972A), find that market reaction to first quarter announcement is weak and in fact, insignificant, while market response to the second and third quarterly reports is discernable and significant.

This study's results coupled with the aforementioned empirical evidence, point to the relative inferiority of the first quarter as a predictor of annual earnings and consequently to its mild effect on market behavior. One possible explanation for these results is the high volatility found in the accounting numbers of first quarterly reports (this finding is reported in Table 4 and in the pursuant discussion in Chapter IV). For companies with seasonal earnings (and most of them have seasonal earnings-see Appendix E) such volatility would imply potential difficulties is employing seasonal prediction models which assume stable seasonal pattern.[9]

As discussed earlier (pp. 25-27), the incremental value of quarterly reports can be evaluated only after considering the contribution of non-accounting information available at the time of the forecasts. Company-related and economy-related information are presumably used by investors in complement to accounting reports. As a result, the comparisons presented in Table 20, should be viewed only as the upper limit for the contribution of quarterly accounting reports. For reasons discussed in Chapter IV (pp. 24-5), only the effect of macro-economic variables on the forecast accuracy is being considered. Set Q uses all quarterly accounting data up to and including the most recent quarter. MQ does not make use of the most recent

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[9]A different and somewhat speculative explanation for the in significant market reaction following the first quarterly announcement (reported by Barnea et al.) is the proximity of the first-quarter report to the preceding annual announcement. Existence of transaction cost might prevent investors from frequent changes in holding; therefore, if some investors revised their expectations and portfolio following the annual announcement, they are less likely to be engaged in another major holding change two months later.

accounting quarterly information; instead it uses recent macro-economic data as the only source of information about this quarter. The "marginal" contribution of quarter n to the prediction of annual earnings can thus be evaluated through the comparison Q(n) - MQ(n). Table 21 presents a comparison of sets MQ and Q. The reduction in error represents the improvement in forecast accuracy attributed exclusively to accounting information contained in the quarterly reports. Two findings emerge from the table: (1) quarterly accounting reports do have an informational content not conveyed by contemporarous macro-economic data and (2) the "marginal" contribution of the first quarterly report to annual earnings forecast is considerably smaller than the contributions made by the second and the third quarterly reports. Examination of industry sub-groups lead to similar findings (see Table 38,

It is appropriate at this point to briefly reiterate some of the qualifications concerning the above results. The "marginal" contribution of quarterly reports, although more meaningful as a measure of informational content than their total contribution, is but an upper limit of their usefulness. Only one alternative source of information is being considered the macro-economic data. Furthermore, the set MQ which incorporates the macro variables is represented by a single model formulation, which might affect its performance relative to set Q[10]. One implication of those qualifications is that the true marginal improvement due to the first quarterly report might be smaller than the one observed,

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[10] This effect is somewhat moderated by the fact that the MQ set employes the best of four macro-economic variables; also strictly speaking, the comparison of models is not between the best model in each set but rather between models which were best in prior periods. It should be noted in addition that despite its single representative, set MQ performed better than the annual set, represented by five models after each of the three quarters.

TABLE 21

Marginal Reduction in the Average Error* Due to New Quarterly Accounting Information (As a percentage of the initial error)

	Comparison	Error reduction (%)	Number of companies with error reduction	Number of companies with significant error reduction (95% level)
First Quarterly Report	Q(1) - MQ(1)	5.2	33	14
Second Quarterly Report	Q(2) - MQ(2)	15.8	45	24
Third Quarterly Report	Q(3) - MQ(3)	26.6	43	28

*Simple average over the sample of the relative absolute error.

possibly even zero. Again, one can relate this tentative conclusion to the relatively high volatility of the first quarter which tends to impair its predictive power.

Performance Relative to The Length of the Forecast Period

The results, that forecasts of annual earnings improve as the forecast period shortens, seems natural. In particular, if the four quarterly earnings numbers are assumed to be independent variables, the variance of the annual earnings given some interim result would be smaller than its unconditional variance. Under the assumption of independence

$$V(\tilde{A}) = V(\tilde{Q}_1) + V(\tilde{Q}_2) + V(\tilde{Q}_3) + V(\tilde{Q}_4)$$

where $\tilde{A}$ and $\tilde{Q}_i$ denote the random variables of annual and quarterly earnings. The variance of the annual earnings can serve as a measure of its predictability. The larger is the variance the more difficult (and therefore less accurate) is the forecast. By the time that the results of the first quarter are reported, the forecast period becomes nine months (three quarters). The variance of the earnings in the remaining part of the year is

$$V(\tilde{A}/\tilde{Q}_1=q\ ) = V(\tilde{Q}_2) + V(\tilde{Q}_3 + V(\tilde{Q}_4) \quad V(\tilde{A}).$$

In general, if the information contained in the quarterly reports is at least not misleading, forecast accuracy is expected to increase as new quarterly information arrives. It is therefore useful to examine the performance of forecasts made after each quarter relative to the length of the corresponding forecast period or to what appears to be even more meaningful - the earnings yet to be reported. Loss functions 5 and 6 measure the squared error and the absolute error, respectively, divided by the fraction of the annual income still unearned at the time of the forecast. The sample results for loss function 6 are reported in Table 22.

TABLE 22

Average Time-Relative Absolute Error* (Loss Function 6)
For Quarterly and Annual Models, by Quarter

Model Set	Forecast Period: 4 Quarters	Last 3 Quarters	Last 2 Quarter	Last Quarter
A	20.60	-	-	-
Q(1)	-	20.17	-	-
Q(2)	-	-	21.40	-
Q(3)	-	-		24.61

*Simple average.

The relative accuracy of sets A and Q(i) are not considerably different. However, the second quarter predictions are of a lower quality and the third quarter predictions have the largest relative error. The size of the errors reported in Table 22 is a function of two elements- the predictive ability of the quarterly (or annual) numbers and the predictability of the forecast period. It is hard to separate the two factors; however, if equal predictability of different interior periods is assumed, the differences between the errors of Table 22 would reflect only on the predictive ability inherent in different sets of prediction inputs. The conclusion would then be that the first quarter better predicts the last nine months than the second quarter predicts the last six months of the year, and that, on the average, annual models outperform quarterly models. This interpretation sheds a different light on earlier findings of the study (as well as on results reported in other works) about the performance of annual vis-a-vis quarterly models. However, the underlying assumption that all quarters are equally predictable is not reasonable. As reported in Chapter III the volatility of the first and the last quarters is significantly higher than that of the second and third quarters. Since the performance of any naive prediction depends on the stability in both the input period and the forecast period, one would expect that predictions of the first and the fourth quarter as well as predictions made on the basis of the first quarter should be relatively inaccurate. In fact, the latter is exactly one of the findings reported earlier; furthermore, predictability of the first and fourth quarters can be derived from Table 22. If equal predictive ability of different input sets is assumed, the differences between the errors therein would reflect only on the predictability of different quarters. Specifically, the 24.61% error would be the measure of the predictability of the fourth quarter; the 21.40% error, the measure for the predictability of the third and fourth quarter combined, etc. The predictability of the four quarters (as measured by the error in predicting each) would therefore be 21.88, 17.71, 18.20 and 24.61, respectively.[11]

These relationships between the predictability of the four quarters match rather well the relationship between their volatility (see for example Table 4 in Chapter III). These results, to be sure, are based on the assumption that the differences in the relative errors presented in Table 22 can be attributed exclusively to differences in predictability of the forecasted quarters. Although it is impossible within the present methodological framework to quantitatively separate the effects of predictive ability from those of predictability, it is nevertheless more reasonable and more consistent with prior evidence to assume that the results furnished by Table 22 bears more on the predictability of different interim periods than on the predictive ability of different quarterly reports.

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[11] To derive these values an additional assumption - that the annual earnings are evenly distributed over the quarters - is necessary.

Performance in Predicting Portfolio Earnings

The accuracy with which different prediction models forecast earnings of individual companies is not the only or necessarily the most important test of their performance. Some models which predict well individual company earnings might perform poorly when their predictions are aggregated to produce a portfolio earnings forecast. Poor performance of a model in predicting portfolio earnings could result from a systematic bias in prediction (independent of efficiency); alternatively, it could result from positive inter-company dependence of contemporenous errors (for a discussion on the effects of a portfolio aggregation on forecast performance see Chapter II, pp. 38-40). To explore the effectiveness of different sets of models in predicting portolio earnings, a portfolio consisting of the fifty company sample is constructed. Predicted earnings of individual companies made by each of the sets are aggregated to produce the predicted earnings of the portfolio. The accuracy of the latter under alternative sets of models is compared and analyzed (for a flow-chart of the computer program see Appendix Q).

Table 23 presents the average error associated with the four sets of models after each of the quarterly predictions.

Several findings emerge from the Table. The errors in predicting portfolio earnings are much smaller than the errors in predicting earnings of individual companies. This is apparently a result of the offsetting effect on the error from aggregating predictions across companies. A striking result is the strong performance of the macro-economic models (sets MA

TABLE 23

AVERAGE ERROR* IN PREDICTING PORTFOLIO-EARNINGS BY LOSS FUNCTION MODEL SET AND TIME OF PREDICTION

Predictions made after the:	Squared Error (loss function 1)				Relative Absolute Error (loss function 4)			
Model Set	All Quarters	First Qtr.	Second Qtr	Third Qtr	All Quarters	First Qtr	Second Qtr	Third Qtr
Q	.016	.029	.014	.005	3.34	4.25	3.34	2.43
A	.031	.031	.031	.031	6.24	6.24	6.24	6.24
MA	.014	.016	.014	.012	4.06	4.41	4.07	3.71
MQ	.013	.015	.014	.008	3.92	4.34	4.23	3.19

*Over time.

and MQ). These sets are not effective in predicting earnings of individual companies: both sets hardly outperform the annual accounting set-A compare for instance the errors produced by MA and MQ (1) to those of set A in Table 16). When applied to portfolio prediction they nonetheless outperform the annual and in the first quarter also the quarterly accounting models. The difference between the average squared error (over the three quarters) of set MA and that of set A (.031 and .014 respectively) is significant at the 99% level. Moreover, the performance of the macro models in the first quarter is at par with the performance of the quarterly accounting models (or even better if judged by the squared error results). Examination of the average rank of the model sets over the thirty-six predictions yields similar results. Table 24 presents summary results for two rank measures, the average and the probability of dominance (an equivalent to the statistic "number of times best"). There is a significant difference (95% level) between the average rank of the four sets (Friedman test). The annual accounting models are inferior to macro models in each of the quarterly predictions. The quarterly accounting model do not seem to outperform the macro models in any quarter. An application of the Sign test indicates that the macro set, MA, significantly outperforms the annual set and is at par with the quarterly set (95% significance level).

The superisity of the macro models could be explained by the fact that on average, earnings of individual companies

TABLE 24

RANK MEASURES BASED ON THE SQUARED ERROR, BY QUARTERS

Statistic	All Quarters				First Quarter				Second Quarter				Third Quarter			
Based on 36 periods	Q	A	MA	MQ	Q	A	MA	MQ	Q	A	MA	MQ	Q	A	MA	MQ
Average rank	2.3	3.1	2.4	2.2	2.9	2.7	2.1	2.3	2.0	3.2	2.5	2.3	1.9	3.3	2.7	2.1
Probability of dominance	.31	.11	.25	.33	.25	.17	.33	.35	.33	.08	.25	.34	.33	.08	.17	.42

NOTE: Ranks are based on a four-way comparison of sets Q, A, MA and MQ (average rank for all sets is 2.5).

tend to move in consonance with the economy. Indeed, the application of a naive macro model might produce large errors in forecasting the income of an individual company. However, because of the co-movement of earnings of individual companies with the economy the sign of such an error is expected to be random. Therefore, when aggregated across companies, overstated forecasts would tend to offset understated forecasts so that the portfolio forecast is generally unbiased. This property of unbiasness is apparently subdued in the accounting prediction models.

The marginal contribution of quarterly accounting information to the accuracy portfolio forecasts can be assessed by the comparison Q-MQ. The pattern revealed is the same as that found for individual companies. The contribution of the first quarterly report is marginal (or non-existent if judged from the results based on the squared error) while the contribution of the second and in particular the third quarterly report is considerable.

An examination of the time-relative performance of the models discloses that, similar to the case of individual companies, there is a difference between the predictability of different periods which in terp affects the predictive ability of the three quarterly reports. The relative absolute error is predicting the portfolio - EPSAD is 6.24% for set A, 5.51% for Q(1) 5.03% for Q(2) and 8.77% for Q(3). If the difference in errors is attributed entirely to differences in the predictability of the respective forecast periods (i.e., the last three quarters for Q(1), the last two quarters for Q(2), etc.) then the difficulty in forecasting the last question would be related to the 8.77% error. Similarly, the difficulty in forecasting the third second and third quarters as derived from able 23 1.28%, 6.47% and 8.44%, respectively. These results are in line with the findings that the first and the last quarter's results are highly volatile over time and therefore difficult to predict.

An Extension: Sensitivity of the Results to the Inclusiveness of the Model Set

The presumption underlying the use of the prediction models is that they simulate to a degree, investors techniques of earnings forecast. There is a large number of naive models which can be used to extrapolate from past data. Furthermore, the exact nature of the earnings process which the models try to reflect is yet to be studied with rigor. The present study, although considering comparatively large number of models must still be confined to a limited set. Thus, a question can be raised regarding the inclusiveness of the selected set of models and especially the sensitivity of the results to the particular set selected.

In this extension an attempt is made to expand the original model selection by adding several models to some of the model sets. The accounting based models added are identified in Appendix P and detailed in Appendix O. In addition, Models 28 to 31, detailed in Appendix O, are added to the macro set, MA. Although naive in the sense that they rely solely on past data, the new models are generally more sophisticated. This is particularly true for the regression models which employ a polynominal function of time.[12] The introduction of the regression models followed them observed fit to the earnings time series of most companies (see Chapter IV). Table 25 presents the results for the sample.

TABLE 25

AVERAGE RELATIVE ABSOLUTE ERROR* BY MODEL
BY MODEL SET AND TIME OF PREDICTION
(extended set of models)

Model Set	Predictions made after All quarters	First Qtr.	Second Qtr.	Third Qtr.
Q	11.99	14.72	12.15	9.11
A	15.73	15.23	15.73	15.73
MA	19.90	19.98	19.83	20.00
MO	17.50	19.82	17.78	14.98

*Simple average.

Comparison of these findings to those presented in Table 16 indicates an increase in accuracy of forecasts produced by the accounting-based sets (Q and A) to which most of the new models were added. (For detailed results see Appendix T).

The consequential contribution of macro data in predicing annual earings of individual companies seems to disappear when the accounting-based models are selected from a wide set of models, containing some semi-naive formulations (such as regressions). Indeed, a further look at the performance of the accounting-based models reveals that in about 90% of the predictions, the representatives of sets Q and A (the models which performed

[12]Elton and Gruber (1972), too, use a time-series regression (although a simpler one) as one of the "technical" (naive) forecast models.

best in the last base period) are the regression models (models number 13 and 23 in Appendix O). It could therefore be concluded that the regression models alone outperform the naive macro-economic models. One might legitimately wonder whether the polynomial regression models whose parameters are updated every year or every quarter, are really "starting points for many investors" as Green and Segall (1967) perceived the role of naive models (ibid p.45) or rather, sophisiticated models which are beyond the reach of most investors. Whatever is the answer to this question it is clear that carefully built forecasts utilizing only past accounting data can achieve a remarkable degree of accuracy.[13]

It is interesting to note that the relative contribution of different quarters does not change as a result of the application of an extended set of models. From Table 25 it can be learned that the percentage reduction in error due to the first quarterly report is 6.4%, due to the second 17.5% and due to the third quarterly report 25.2%. Again, the first quarterly report shows the least predictive power.[14]

The extended set of models is applied to predict portfolio earnings. The results are furnished in Table 26. Notably, despite the introduction of powerful accounting-based models, the macro-based models retain their superiority over the annual

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[13]The conclusion is reached also by Elton and Gruber (1972) who compare technical predictions with financial analysts forecasts.

[14]The "marginal" contribution is equal here to the gross contribution because the macro-economic models do not make an incremental contribution.

accounting set, and in the first quarter even over the quarterly accounting set. The inevitable conclusion is that macro-economic variables although clearly inferior to accounting variables in predicting future earnings of individual companies are extremely effective when employed in forecasting portfolio earnings.

TABLE 26

AVERAGE RELATIVE ABSOLUTE ERROR* IN PREDICTING PORTFOLIO EARNINGS BY MODEL SET AND TIME OF PREDICTION
(Extended set of Models)

Model Set	Predictions made after All quarters	First Qtr.	Second Qtr.	Third Qtr.
Q	2.62	3.60	1.93	2.34
A	4.20	4.20	4.20	4.20
MA	3.46	3.34	3.33	3.70
MQ	3.81	4.32	3.93	3.70

*Simple average.

An Extension: The Sensitivity of the Results to Company Size

As indicated in Chapter II, the sample selection criteria result in a sample composed of relatively old and established companies. This is a common result in studies requiring long and continuous time-series data. Consequently, there is always a danger that the findings will be biased. Specifically, large and old companies might be more conscientious about the quality of their quarterly reporting than smaller and younger companies. Furthermore, the seasonal pattern, the stability of which is a determinant in forecast accuracy, might be still vague in younger companies. It follows that results based on such a sample might overstate the contribution of quarterly reports. The existence of that bias was examined to some extent by Brown and Niederhofer (1968, p. 495) who found that with respect to performance of naive prediction models the COMPUSTAT Companies are fair representatives of the universe of companies. In any event, it is felt that at least tentative look into the effect of company size on the results of the present study is warranted. The examination of this effect is carried out by dividing the fifty-company sample into two equal-number groups of "large" and "small" companies. The size measure chosen is the value of total assets as of December 31, 1972 (the median of which is about $500 millions). The selection of the size measure and the cut-off value is arbitary. Nevertheless, it provides a useful starting point.

The companies included in each class are distributed fairly equally among the industry groups. The results presented in Table 27 indicate that there is no difference in forecast accuracy of various models between large and small companies.

TABLE 27

AVERAGE* RELATIVE ABSOLUTE ERROR
BY MODEL SET AND

Model Set	Small Companies	Large Companies
Q	14.37	15.47
A	21.20	19.97
MA	20.12	19.52
MQ	17.75	17.24

*Simple average.

It should be emphasized that the above does not constitute a direct test of the effect of company age (independet of size) on the predictability of earnings.

CHAPTER VI

CONCLUSIONS AND SUGGESTIONS FOR FURTHER RESEARCH

Consistent with prior research, the study clearly indicates that the effect of new quarterly report is to reduce the uncertainty about the annual outcome. The finding holds for all three quarters all firms and all industry groups. Although not completely trivial, the result is quite natural considering the fact that addition of any quarterly report leaves smaller segment of the annual result unreported and therefore uncertain. A more interesting finding is that the incremental contribution of each of the first three quarterly reports to predictions of annual earnings is not equal. Specifically, it appears that the improvement in earnings forecast due to the first-quarter report is significantly smaller than that achieved by the second and third quarterly reports. This seems to be a result of the relatively high volatility found in first-quarter earnings.

Another major finding is that in the presence of accounting data, additional information about macro-economic variables is of little value in predicting individual company earnings. On average, past-quarterly accounting data are a much better predictor than macroeconomic data; quite often, even past annual accounting data is superior to more recent macro information. Nevertheless, macro-economic variables are extremely effective in forecasting portfolio-earnings. In fact, a limited number of macro-based models outperform a wider set of accounting-based annual models. This phenomenon could be explained by the strong association between the average level of business earnings and other economic-activity measures. Although not the ultimate test of their usefulness to investors (such a test would require construction and evaluation of alternative portfolios it might serve as an indication to the value of macro data for investment decisions).

The investigation into the statistical properties of quarterly time-series, which precedes the model-testing phase, yields some interesting results. Stable seasonality in sales and earnings is present in almost all the companies surveyed. Moreover, the market index for these variables shows seasonal behavior. The stability in sales is stronger than the stability in earnings, indicating a plausible advantage from the application of the "dependent" approach in quarterly reporting. As argued in the study, this advantage is not always certain to exist. Notwithstanding the general pattern of stable seasonality, some volatility exists around the long-term seasonal average. The volatility of the first and the fourth quarters is the most pronounced. A preliminary investigation fails however, to support the hypothesis that the last quarter variability is a result of income smoothing efforts by management.

A high degree of association is found between quarterly results (earnings and sales - after the removal of seasonality) of the individual firm, its industry and the market. The correlation coefficients are similar to those reported fro annual results. This indicates that despite their shorter measurement period and the less stringent accounting standard applied to their preparation, quarterly reports reflect the same economic factors found to affect the annual accounting numbers.

As previously state, the results of the study reflect the upper limit of the marginal contribution of quarterly reports. The evaluation of the usefulness of quarterly accounting reports will not be complete before the contribution of <u>all</u> complementary sources of information is studied. In terms of the present methodology, this means that more macro-economic variables (some possibly on the industry level) might be introduced along with additional macro-based prediction models (only a few forecast formulations are applied to the macro data in the present study). Micro-economic data should also be considered; however, because of the enormous difficulties in identifying and quantifying such data, it is suggested that only a small number of companies will be examined to estimate the predictive ability of such publicly available company-related information.

A worthwhile research effort would be to assess the marginal contribution of quarterly reports through their impact on financial analysts' forecasts. This would require comparison of forecasts made before and immediately after the quarterly announcements. Despite the methodological difficulties, this approach offers a measurement of usefulness devoid of any assumption on the way (or ways) investors do actually forecast.

Another aspect of usefulness not addressed by the present study is the degree by which quarterly reports convey new information on the covariability between the earnings of the individual company and the market. This covariability is directly associated with the stock risk. The evidence that quarterly reports retain the commonality property found in annual numbers indicates that quarterly information is potentially useful in predicting such co-movement patterns.

The investigation of the inter-quarters relati nship is of a tentative.nature. Two findings at least seem to deserve a more thorough look; the unexplained large variability in the first and last quarters and the relatively high earnings reported in the last quarter. It would be instructive to test the existence of a smoothing effect in the last quarter results by employing a wider set of smoothing hypotheses. One could also examine the impact of intentional "rear loading" of income during the year on the sales and earnings in the last quarter. With respect to the first quarter volatility, an intriguing hypothesis to test would be that the first quarter results represent, to some degree, management reaction to the preceding annual announcement. The methodology, adopted by Brown and Ball (1967) and by Brown and Kennelly (1972) appears to best fit this research question.

Implementation of any of the above suggestions may shed some light on only few aspects of the behavior of quarterly accounting numbers. Ideally, the researcher of the area would like to identify the system of forces and factors underlying the observed behavior. Given the state of the art on one hand and the complexity of the issues involved, on the other hand, it is the piece-by-piece approach which seems to be the most promising.

APPENDIX A

VARIABLE DEFINITIONS

Earnings per Share (Primary) - Excluding Extraordinary Items

A. This item represents the primary earnings per share figure as reported by the company.

B. As outlined in APB Opinion 15, primary earnings figures should be reported by the company after the effect of conversion of convertible preferred, convertible debentures and options and warrants which have been identified as common stock equivalents and before extraordinary items.

C. This figure may differ from company reports in the following instances:

   1. Company report included extraordinary items
   2. Company reported before the equity in earnings of non-consolidated subsidiaries (which was flowed through to retained earnings).

Net Income

"Net Income" represents income after all operating and non-operating income and expense and miniority interest, but before preferred and common dividends. It is stated after extraordinary items which are not net of applicable taxes. However, net income is before all extraordinary items that are listed in the company's public reports as being net of taxes. In addition, net income is stated before appropriations for general contingencies. These items are treated as surplus adjustments.

Assets (Total)/Liabilities and Net Worth (Total)

A. Total Assets represent current assets plus net plant plus other non-current assets (including intangible assets and deferred items).

B. U. S. Government securities that have been netted by the company in its public reports against tax liability on the current liability side of the balance sheet are considered as current assets.

C. Total Liabilities and Net Worth represent current liabilities plus long-term liabilities plus stockholders equity.

Sales - Net

1. Annual Data

   A. Sales represent gross sales and other operating revenue less discounts, returns and allowances.

   B. Royalty income is included (when considered operating income).

   C. For retail companies, sales of leased departments are included when corresponding costs are available and included in expenses.

   D. For shipping companies, income on reserve fund securities is included when shown separately.

   E. For shipping companies, operating differential subsidies are included.

   F. For finance companies, earned insurance premiums are included.

   G. For finance companies, sales are after deducting net loses on factored receivables purchased.

   H. For airline companies, net material aid assistance is included.

   I. For cigar, cigarette, oil, rubber and liquor companies, net sales are after deducting excise taxes.

   J. Income derived from equipment rental is considered part of operating revenue.

2. Quarterly Data

   A. Net Sales include other income for these companies which do not report other income separately on a quarterly basis.

   B. Net Sales include excise taxes for those companies which do not report excise taxes separately on a quarterly basis.

   C. Differences between annual and quarterly sales are indicated in the quarterly footnote field of the tapes.

APPENDIX B

LIST OF COMPANIES

Serial Number in the Sample	Industry	
6	28	American Cynamid
38	10	American Smelting & Refining
20	33	Anaconda Copper
44	32	Anchor Hocking Glass
19	33	Bethlehem Steel
26	35	Burroughs
25	35	Chicago Pneumatic Tool
24	35	Clark Equipment
43	23	Cluett, Peabody & Corp.
46	35	Combustion Engineering
12	29	Continential Oil of Delaware
21	33	Copper Range
31	10	Dome Mines
7	28	DuPont
29	45	Eastern Airlines
30	56	Edison Bros. Stores
47	35	Foster Wheeler
18	32	General Portland Cement
10	28	Gillette
34	29	Gulf Oil Corp
40	20	Helme Products
32	20	Hershey Chocolate
2	10	Hudson Bay Mining & Smelting
22	33	Inspiration Consolidated Copper
48	35	International Business Machines
1	10	International Nickel of Canada
3	20	Interstate Brands
16	29	Johns Manville Corp.
35	37	Libbey-Owens-Ford Glass
27	36	Maytag Company (The)
5	27	McGraw Hill
39	10	McIntyre Procupine Mines
17	29	National Gypsum
50	45	Pan American World
33	20	Pepsico
8	28	Pfizer
32	33	Pittsburgh Steel Co
41	21	Philip Morris
28	37	Pullman Inc.
13	29	Quaker State Oil
42	21	Reynolds (PF) Tobacco
49	38	Robertshaw-Fulton Controls
14	29	Skelly Oil Corp
9	28	Sterling Drug Inc.
11	28	Sun Chemical Corp.
23	34	Sunshine Mining
36	37	Timken Roller
15	29	Union Oil of California
4	20	Wrigley
45	33	Youngstown Sheet and Tube

APPENDIX C

CORRELATION COEFFICIENTS BETWEEN SALES, NI, NIDIV AND SPSAD

Company	Sales-NI	NI-EPSAD	EPS-NIDIV
1	.872	.990	.178
2	.552	.994	.804
3	.523	.990	-.004
4	.816	.993	.378
5	.855	.981	.550
6	.926	.983	.697
7	.546	.926	.639
8	.986	.996	- .463
9	.975	.999	.659
10	.938	.976	- .397
11	.654	.961	.586
12	.958	.981	- .509
13	.963	.997	.630
14	.568	.953	- .066
15	.894	.982	.268
16	.875	.953	.435
17	.723	.758	.700
18	.567	.909	.350
19	.576	.989	.795
20	.428	.970	.881
21	.452	.991	.779
22	.853	.999	.925
23	.388	.993	.702
24	.941	.984	- .060
25	.902	.849	- .036
26	.874	.992	.174
27	.924	.999	.554
28	.742	.964	.710
29	.109	.941	.840
30	n.a.	n.a.	n.a.
31	n.a.	.876	.530
32	n.a.	.992	.352
33	n.a.	.967	.062
34	n.a.	.998	- .288
35	n.a.	.979	.454
36	n.a.	.999	.431
37	.620	.876	.949
38	.765	.987	.804
39	-.680	.999	.955
40	n.a.	.923	.486
41	.989	.996	.617
42	.926	.984	.762
43	.819	.928	.645
44	n.a.	.996	.358
45	.648	.998	.639
46	.953	.974	.297
47	.635	.990	.883
48	.997	.999	.498
49	.718	.888	.229
50	.058	.991	.923

APPENDIX D

THE X-11 PROGRAM

Moving Averages

Variable Trend-Cycle Curve Routine

In X-11, the moving average used to estimate the trend-cycle component is selected on the basis of the amplitude of irregular variations in the data relative to the amplitude of long-term systematic variations. This routine selects a moving average that provides a suitable compromise between the need to smooth the irregular with a long-term inflexible moving average and the need to accurately reproduce the systematic element with a short-term flexible moving average. For many series, the average chosen in X-11 has about the same smoothing power as those used in earlier versions of Method II. For highly irregular or very smooth series, a more appropriate average is chosen, thereby extending the range of series which can be well adjusted by Method II.

The selection of the appropriate moving average for estimating the trend-cycle component is made on the basis of a preliminary estimate of the I/C ratio (the ratio of the average absolute month-to-month change in the irregular to that in the trend-cycle). A 13-term Henderson average of the preliminary seasonally adjusted series is used as the preliminary estimate of the trend-cycle, and the ratio of the preliminary seasonally adjusted series to the 13-term average is used as the preliminary estimate of the irregular. The appropriate average selected for a given value of I/C is given in the following table:

I/C	Length of moving average selected
0.00-0.99	9-term Henderson
1.00-3.49	13-term Henderson
3.50 and over	23-term Henderson

The three new weighted moving averages in the variable trend-cycle routine replace the weighted 15-term Spencer average used in earlier versions of Method II. They were developed by Robert Henderson and are described in Macaulay. The new averages meet the same criterion of smoothness as the 15-term Spencer average; i.e. they minimize the sum of squares of the third differences of the curve. The distinctive feature in X-11 is the introduction of a 9-term moving average for smooth series and a 23-term moving average for highly irregular series. (A 5-term Henderson average is used for all quarterly series).

Seasonal-Factor Curve Routine

The S-I ratios for each month are smoothed by a 3x5-term moving average (a 3-term average of a 5-germ average) to estimate final seasonal factors. In the X-9 version, S-I ratios were smoothed with a 3x3-term or a 3x5-term average depending on the value of I. The weights for extending the 3x5 average at the ends of series in X-11 technique of using the same moving average regardless of the value of I reduces revisions in seasonal factors when additional data are added to series.

Optionally, the user may specify any of the following seasonal factor curves to compute final season factors for any particular month: 3-, 3x3-, 3x5-, 3x9-, n-term, where "n" is the number of years of data in a particular month (i.e., a stable seasonal).

Graduate Treatment of Extremes

Many economic series contain extreme values which must be modifed or removed before adequate estimates of the seasonal, trading-day, and trend-cycle components can be made. These extremes may reflect economic developments, such as strikes, reactions to unexpected political events; unseasonable weather; errors of measurements; etc. In many instances, allowance for extremes can be made by the user before the data are submitted for seasonal adjustment. However, it is generally more feasible to rely upon the computerized statistical tests provided in Method II to detect and remove extremes.

Previous techniques are replaced in X-11 with a new scheme that tests each value of a preliminary irregular component against a standard deviation computed over a moving 5-year period (60 months or 20 quarters). For example, the irregulars in 1952 are tested for extremeness by comparing them with a computed 1950 to 1954. A preliminary is computed values beyond 2.5σ are removed, and σ is recomputed. Values outside 2.5σ are considered extreme and are assigned a zero (0.0) weight. Values inside 1.5σ receive full weight (1.0). Values between 2.5 and 1.5σ receive partial weight, graduated linearity from zero at 2.5σ to full weight at 1.5σ.

Test for the Existence of Stable Seasonality

An analysis-of-variance F-test for the existence of stable seasonality is applied to the final unmodified S-1 ratios. The theoretical basis for the F-test is given in Scheffe (1959).

Let SI_{ij} ($i = 1, ---, N_j$; $j = 1, ---, 4$) denote the final unmodified S-I ratios, where N_j is the number of years of available data for quarter j.

Let $\hat{SI}_j$ denote the quarterly means of the S-I ratios; i.e.,

$$SI_j = \frac{1}{N_j} \sum_{1}^{N_j} SI_{ij} \quad (j = 1, ---, 4),$$

Let $\hat{\hat{SI}}$ denote the grand mean of the S-I ratios, i.e.,

$$SI = \frac{1}{N} \sum_{1}^{4} \sum_{1}^{N_j} SI_{ij}$$, where N is the total number of quarters of available data.

Calculate the "between quarters" variance

$$\sigma_Q^2 = \frac{1}{3} \sum_{1}^{4} N_j (SI_j - \hat{\hat{SI}})^2 ,$$

the "residual" variance $\sigma_R^2 \frac{1}{N-4} \sum_{1}^{4} \sum_{1}^{N_j} (SI_{ij} - SI_j)^2$ and Total Varience

$$= \sigma_T^2 = \frac{1}{N-1} \sum_{1}^{4} \sum_{1}^{N_j} (SI_{ij} - \hat{\hat{SI}})^2.$$

Compute $F = \sigma_Q^2 / \sigma_R^2$ and compare with the tabled F-distribution for the appropriate degrees of freedom. If the computed F is greater than the tabled F at the percent level "Stable Seasonality Present at the Percent Level" is printed out. In the X-11 program, the computed F is compared to 2.41 (the 1 percent value for a 10-year series) regardless of the length of the series, since the differences in tabled F for series of different lengths are minuscule.

Print out the following analysis-of-variance table:

Source of Variation	Sum of Squares(SS)	Degrees of Freedom (DF)	Mean Square (variance= σ^2)	F
Between quarters	$\sum_{1}^{4} N_j(\hat{SI}_j-\hat{\hat{SI}})^2$	3	$SS_Q/DF_M = \sigma_0^2$	σ_0^2/σ_R^2
Residual	$\sum_{1}^{4} \sum_{1}^{N_j}(SI_{ij}-\hat{SI}_j)^2$	N-4	$SS_R/DF_R = \sigma_R^2$	----
Total	$\sum_{1}^{4} \sum_{1}^{N_j}(SI_{ij}-SI)^2$		-----	----

The F-test is based on the following assumptions:

(1) $SI_{ij} = \hat{SI}_j + I_{ij}$ $(i=1,---,N_j\ ;\ j=1,---,4)$, where

$\hat{SI}_j$ represents the stble seasonal for quarter j and

I_{ij} represents the irregular for quarter j and year i ;

(2) $E(SI_{ij}) = \hat{SI}_j$ $(i=1,---,N_j\ ;\ j=1,---,4)$;

(3) $V(I_{ij}) = \sigma^2 (i=1,---,N_j\ ;\ j=1,---,4)$, where σ^2 is the variance of the irregular ; ie., the irregular is homoscedastic;

(4) $C(I_{ij})_{(ij)'} = 0$ $(ij \neq (ij)'\ ;\ i=1,---,N_j\ ;\ j=1,---,4)$;
i.e., the irregular is a random series;

(5) The I_{ij} are normally distributed.

The F-test tests the hypothesis that

$$H_Q : \hat{SI}_1 = \hat{SI}_2 = --- = \hat{SI}_4 = \hat{SI}$$

against the alternative that the SI are not all equal.

Experience has shown that assumptions 2 to 5 are not seriously violated, since the F-test is relatively robust against violations of these assumptions. Assumption 1 may be slightly violated when S and I are related multiplicatively, but the disparity between $SI = S/I$ and $SI^{*} = S$ is relatively small when S and I are in the 90 to 110 range. However, assumption 1 is seriously violated when the seasonal pattern changes over time. In such instances, the hypothesis H_0 is not appropriate for testing for the existence of seasonality. Research is presently underway to develop a moving seasonality test as a companion to the X-11 stable seasonality test.

APPENDIX E

RESULTS OF TESTS FOR SEASONALITY BY COMPANY (99% SIGNIFICANT LEVEL)

X = significant seasonality ; o = no seasonality

Company*	X=11			Trend=Polynomial			Trend=Moving Ave.		
	Sales	PSAD	NIDIV	Sales	EPSAD	NIDIV	Sales	EPSAD	NIDIV
1	X	X	X	X	X	X	X	X	X
2	O	X	X	O	X	X	O	X	X
3	X	X	X	X	O	X	X	X	X
4	X	X	X	X	X	X	X	X	X
5	X	X	X	X	X	X	X	X	X
6	X	X	X	O	X	X	X	X	X
7	X	X	O	X	X	X	X	X	X
8	X	X	X	X	X	X	X	X	X
9	X	X	X	X	X	X	X	X	X
10	x	x	x	O	X	X	X	X	X
11	X	X	X	X	X	X	X	X	X
12	X	O	O	X	O	O	X	O	O
13	O	X	X	O	X	X	O	X	X
14	X	X	X	X	X	X	X	X	Y
15	O	O	X	O	X	X	O	X	X
16	X	X	X	X	X	X	X	X	X
17	X	X	X	X	X	X	X	X	X
18	X	X	X	X	X	X	X	X	X
19	X	X	X	X	X	X	X	X	X
20	X	X	X	X	O	X	O	X	X
21	O	O	O	O	O	O	O	O	O
22	O	X	X	O	X	X	X	X	X
23	O	O	O	X	X	O	X	O	O
24	X	X	X	X	X	X	X	O	X
25	X	X	X	X	X	X	X	X	X
26	X	X	X	X	X	X	X	X	X
27	X	X	X	X	X	X	X	X	X
28	O	X	X	X	X	X	X	X	X
29	X	X	X	X	X	X	X	X	X
30	X	n.a.	n.a.	X	n.a.	n.a.	X	n.a.	n.a.
31	n.a.	X	X	n.a.	X	X	n.a.	X	X
32	n.a.	X	X	n.a.	X	X	n.a.	X	X
33	n.a.	X	X	n.a.	X	X	n.a.	X	X
34	n.a.	X	X	n.a.	O	X	n.a.	X	X
35	n.a.	X	X	n.a.	X	X	n.a.	X	X
36	n.a.	X	X	n.a.	X	X	n.a.	X	X
37	X	X	X	O	X	X	O	X	X
38	X	X	X	X	O	X	X	X	X
39	X	O	X	X	O	X	X	X	X
40	n.a.	X	X	n.a.	O	O	n.a.	X	X
41	X	X	X	X	X	X	X	X	X
42	X	X	X	X	X	X	X	X	X
43	X	X	X	X	X	X	X	X	X

*For the names of the companies see Appendix B.

Company	X-11			Trend-Polynomial			Trend-moving Av.		
	Sales	EPSAD	NIDIV	Sales	EPSAD	NIDIV	Sales	EPSAD	NIDIV
44	n.a.	X	X	n.a.	X	X	n.a.	0	X
45	X	X	X	X	X	X	X	X	X
46	X	X	X	X	X	X	X	X	X
47	X	0	0	0	0	0	X	0	0
48	X	X	X	X	X	0	X	X	0
49	X	X	X	X	X	X	X	X	X
50	X	X	X	X	X	X	X	X	X

APPENDIX F

RANK OF QUARTERS BY COMPANY

(based on the average value of the seasonal factor produced by the X-11 Program)

Company*	Sales Q_1	Sales Q_2	Sales Q_3	Sales Q_4	EPSAD Q_1	EPSAD Q_2	EPSAD Q_3	EPSAD Q_4
1	2	1	4	3	1	2	4	3
2	4	1	3	2	4	1	3	2
3	1	2	3	4	2	1	4	3
4	3	2	1	4	2	3	1	4
5	4	3	2	1	3	4	1	2
6	2	1	4	3	1	2	4	3
7	2	3	4	1	4	2	3	1
8	4	1	3	2	4	1	2	3
9	4	1	3	2	3	4	1	2
10	3	1	4	2	4	3	1	2
11	3	4	2	1	4	3	2	1
12	4	2	3	1	4	3	1	2
13	3	2	1	4	2	3	4	1
14	4	1	3	2	4	1	3	2
15	3	2	4	1	3	2	4	1
16	3	2	4	1	2	3	4	1
17	3	2	4	1	3	2	4	1
18	2	3	4	1	2	3	4	1
19	2	1	3	4	4	2	1	3
20	2	3	3	1	2	4	1	3
21	2	1	4	3	2	4	3	1
22	4	2	1	3	2	4	3	1
23		n.a.				n.a.		
24	2	3	1	4	4	2	3	1
25	2	4	1	3	4	2	3	1
26	4	2	3	1	4	2	3	1
27	4	1	3	2	4	1	3	2
28	2	4	1	3	2	4	1	3
29	1	2	3	4	1	2	4	3
30	4	2	3	1		n.a.		
31		n.a.			4	2	3	1
32		n.a.			3	1	4	2
33		n.a.			3	2	4	1
34		n.a.			4	1	3	2
35		n.a.			4	1	2	3
36		n.a.			2	1	4	3
37	2	1	4	3	1	2	4	3
38	1	2	4	3	4	1	2	3
39	2	4	3	1	4	3	2	1
40		n.a.			4	1	3	2

*for the names of companies see Appendix B.

Company	Sales Q_1	Sales Q_2	Sales Q_3	Sales Q_4	EPSAD Q_1	EPSAD Q_2	EPSAD Q_3	EPSAD Q_4
41	3				3	2	4	1
42	3				3	2	4	1
43	4				4	3	1	2
44		n.a.			4	1	2	3
45	2	1	3	4	3	1	2	3
46	4	2	3	1	4	2	1	3
47	4	2	3	1	4	2	1	3
48	4	2	3	1	4	3	1	2
49	1	4	2	3	2	1	4	3
50	3	2	4	1	3	2	4	1
Average rank	2.83	2.10	2.85	2.22	3.06	2.14	2.79	2.01

APPENDIX G

THE CONSTRUCTION OF MARKET AND INDUSTRY INDICES

The source for the averages is the COMPUSTAT industrial file.

The following definitions are used:

(1) $$\text{Average Sales}_t = \sum_{k=1}^{K_t} \text{Sales } k,t$$

(2) $$\text{Average EPSAD}_t = \frac{\sum_{k=1}^{K_t} \left[(\text{EPSAD}_{k,t} * (\text{No of shares})_{k,t} * (\text{Adjustment Factor})_{k,t}\right]}{\sum_{k=1}^{K_t} (\text{No. of shares})_{k,t} * (\text{Adjustment factor})_{k,t})}$$

(3) $$\text{Average Net Income}_t \quad \frac{\sum_{k=1}^{K_{-t}} NI_{k,t}}{K_t}$$

where k = company subscript

K = number of companies

t = the time period measured in quarters

The series of the averages extends over the period April 1964 to December 1972 (thirty-five quarters). Included in the average are only those companies which were on file on April 1964. Companies which entered the file later are excluded because they were found to be of smaller size thus causing the averages (indices) to decrease over time. To allow the inclusion of fiscal year companies all fiscal quarters are translated into calendar year quarters (i.e. the first fiscal quarter is considered as the third calendar quarter, etc.). Companies with reporting period that cannot be translated into calendar quarters are excluded. Missing data in a given quarter are treated by eliminating the company involved from both numerator and denominator of the averages semi-annual data is considered as missing data.

APPENDIX H

RANK OF QUARTERS BY INDUSTRY

(based on the average value of the seasonal factor in X-11 and on the value of the coefficient in the regression models)

1. Sales

Group in COMPUSTAT	X-11				Trend=Polynominal				Trend=Moving Average			
	Q_1	Q_2	Q_3	Q_4	Q_1	Q_2	Q_3	Q_4	Q_1	Q_2	Q_3	Q_4
All companies	3	2	4	1	2	3	4	1	2	3	4	1
Industry 10	2	1	4	3	2	1	4	3	2	1	4	3
20	4	3	2	1	4	3	2	1	4	3	2	1
28	4	3	2	1	4	2	3	1	4	3	2	1
29	2	3	4	1	2	3	4	1	2	3	4	1
33	2	1	4	3	2	1	4	3	3	1	4	2
35	4	2	3	1	4	2	3	1	4	2	3	1

2. EPSAD

Group in COMPUSTAT												
All companies	3	2	4	1	3	2	4	1	3	2	4	1
Industry 10	2	1	4	3	3	1	4	2	3	1	4	2
20	4	2	3	1	4	3	2	1	4	3	2	1
28	4	2	3	1	4	2	3	1	4	2	3	1
29	2	4	3	1	3	4	2	1	2	4	3	1
33	3	2	4	1	3	1	4	2	3	1	4	2
35	4	3	2	1	4	2	3	1	4	2	3	1

Net Income

Group in COMPUSTAT												
All companies	3	2	4	1	3	2	4	1	3	2	4	1
Industry 10	2	1	4	3	2	1	4	3	3	1	4	2
20	4	2	3	1	4	2	3	1	4	3	2	1
28	4	2	3	1	4	2	3	1	4	2	3	1
29	2	4	3	1	2	4	3	1	2	4	3	1
33	3	1	4	2	3	1	4	2	3	1	4	2
35	4	2	3	1	4	2	3	1	4	2	3	1

APPENDIX I

CORRELATION COEFFICIENT BETWEEN QUARTER-TO-YEAR RATIOS OF SALES AND NET INCOME

Company*	Quarter 1	Quarter 2	Quarter 3	Quarter 4
1	.916	.804	.746	.695
2	.221	.235	.206	.222
3	-.017	.419	.514	.214
4	.359	.359	.548	.435
5	.840	.557	.698	.624
6	.417	.192	.635	.320
7	.741	.716	.654	.495
8	.800	.092	.747	.381
9	.449	.258	.657	.539
10	.249	.394	.549	.602
11	.610	.514	.678	- .076
12	.150	.279	.319	.679
13	.422	.146	.282	.203
14	.727	.192	.544	.398
15	.373	.225	.258	- .076
16	.809	.761	.414	.591
17	.842	.660	.749	.377
18	.830	.562	.901	.403
19	.687	.547	.470	.646
20	.287	.251	.470	.122
21	.260	.214	.345	.105
22	.575	.452	.480	.315
23	.275	.173	.054	.199
24	.611	.777	.726	.756
25	.454	.377	.404	.163
26	.587	.457	.241	.739
27	.698	.340	.453	.570
28	.705	.099	.271	.447
29	.037	-.091	.152	.141
30	.151	.073	- .050	.008
31		n.a.		
32		n.a.		
33		n.a.		
34		n.a.		
35		n.a.		
36		n.a.		
37	.295	.341	.179	.379
38	.562	.618	.583	.424
39	.491	.566	.729	.386
40		n.a.		
41	.528	.628	.124	.404
42	.445	.301	.223	.004
43	.441	.221	.406	.598
44		n.a.		
45	.857	.522	.542	.631
46	.681	.253	.304	.518
47	.724	- .088	.134	.401
48		n.a.		
49	.467	.630	.229	.332
50	.182	- .050	.338	- .067

*For the names of the companies see Appendix B.

APPENDIX J

A NOTE ON THE STATISTICAL RELATIONSHIP BETWEEN SALES, EXPENSE AND INCOME

Lets denote Sales by x, Expense by y and Income by v, v = x-y.

$$\rho(v,x) = \frac{cov(v,x)}{\sigma_v \sigma_x}$$

and

$$COV(v,x) = \sum_i [(x_i-y_i) - (x-y)] \cdot (x_i-x)$$

$$= \sum_i [(x_i-x) - (y_i-y)] \cdot (x_i-x)$$

$$= \sum_i (x_i-x)^2 - (y_i-y)(x_i-x)$$

$$= V(x) - COV(x,y)$$

Also, $V(v) = V(x-y) = V(x) + V(y) - 2COV(x,y)$.

$\rho(v,x)$ can therefore be written as

$$\frac{V(x) - COV(x,y)}{\left\{[V(x)+V(y) - 2COV(x,y)]\ V(x)\right\}^{1/2}}$$

It can be seen that in general $\rho(v,x)$, the correlation between sales and income, is negatively associated with cov(x,y), the covariability of sales and expense.

APPENDIX K

QUARTERS OF HIGHEST AND SECOND-TO-HIGHEST STANDARD DEVIATION OF QUARTER-TO-YEAR RATIO*

Company**	Sales		N I	
	Highest	Second to Highest	Highest	Second to Highest
1	1	4	1	4*
2	2	4	1	4*
3	4	1*	1	4*
4	1	4*	1	4*
5	4	3*	3	4*
6	2	1*	4	2*
7	4	1*	4	1,2*
8	4	1	4	1
9	4	3*	4	1,2*
10	1	2	4	3
11	3	2	3	4*
12	4	1*	4	1
13	1	3*	4	1
14	1	4*	4	1
15	1	4*	1	4
16	4	1*	4	1
17	4	1*	4	1
18	4	3	1	4
19	2	3	4	1
20	n.a.	n.a.	1	4
21	4	1*	4	1
22	4	2	4	1*
23	4	1*	4	2
24	1	4	1	4
25	1	4*	4	1
26	4	1,2,3*	4	1*
27	2	4	4	1*
28	2	1*	4	1*
29	4	3*	4	2*
30	2	1*	n.a.	
31	n.a.		4	3*
32	n.a.		4	1*
33	n.a.		2	4*
34	n.a.		4	1*
35	n.a.		4	2*
36	n.a.		4	1
37	1	3	2	1
38	1	4	2	4
39	4	1*	4	1
40	n.a.		4	1

41	1	4	4	1
42	1	4	4	3
43	3	4	4	3
44	n.a.		4	1*
45	4	3	4	1*
46	4	1 *	4	3
47	4	1	4	3
48	4	3	4	3
49	4	1,2	4	2*
50	3	1,4	4	2*

*Significant difference between the two quarters is significant at the 99% level. Significance was established using Cochrans tests for homogeneity of variances (see Guenther (1964) pp 21-22) and Pitman test for correlated variences (see Snedecor and Cochran (1967) pp. 195-198). The two tests produced similar results.

**For the names of the companies see Appendix B.

APPENDIX L

CORRELATION COEFFICIENT BETWEEN THE IRREGULAR MOVEMENTS (Trend based on 12 term moving average)

Company*	Fourth quarter against the sum of the first Three quarters			First quarter against the some of the last three Quarters		
	Sales	EPSAD	NIDIV	Sales	EPSAD	NIDIV
1	.132	.676	.532	.217	.440	.425
2	.721	.873	.868	.919	.830	.770
3	.211	.297	.634	.686	.338	.401
4	.417	.218	.117	.467	.108	.115
5	.265	-.130	.171	-.117	.120	.236
6	.508	.547	.595	.581	.489	.882
7	.429	.152	.634	.552	.213	.653
8	.196	.673	.086	.106	.007	.052
9	.064	.046	.147	.071	.495	.416
10	-.106	.379	-.111	.830	.766	.494
11	.459	.593	.602	.681	.840	.578
12	.225	.782	-.107	.464	.898	.410
13	.270	.528	.297	.194	.289	.207
14	.359	.431	.860	.436	.535	.793
15	.285	.553	-.476	-.428	.078	-.024
16	.725	.736	.590	.860	.785	.694
17	.134	-.205	-.323	-.219	.192	.183
18	.112	.537	.643	.263	.379	.631
19	.358	.380	.426	.228	.205	.322
20	.432	.431	.424	.259	.713	.792
21	.252	.635	.123	.265	.397	.259
22	.773	.822	.810	.512	.785	.836
23	.335	-.456	-.078	-.205	-.374	-.050
24	.857	.624	-.359	.753	.323	-.005
25	.412	-.003	.590	.489	.208	.714
26	.692	.552	.500	.590	.699	.806
27	.093	.436	.570	.809	.519	.720
28	.540	.537	.493	.575	.753	.557
29	-.025	-.314	-.244	.283	.487	.495
30	-.416	n.a.	n.a.	-.519	n.a.	n.a.
31	n.a.	-.678	.150	n.a.	-.219	.294
32	n.a.	.303	.446	n.a.	.464	.777
33	n.a.	-.291	-.019	n.a.	-.521	.341
34	n.a.	.244	.050	n.a.	.365	.430
35	n.a.	-.057	.105	n.a.	.326	.669
36	n.a.	.638	.554	n.a.	.854	.739
37	.502	.700	.728	.363	.421	.497
38	.783	.457	.226	.786	.827	.523
39	.508	.490	.259	.764	.351	.347
40	n.a.	-.155	-.111	n.a.	-.203	-.209

*For the names of the companies see Appendix B.

41	.819	.342	-.264	.645	.625	.197
42	-.386	.235	.318	-.402	.472	.405
43	.427	.322	.136	.309	.493	.560
44	n.a.	-.071	-.127	n.a.	.436	.319
45	.459	.280	.349	.405	.243	.381
46	.576	.567	.483	.323	.654	.375
47	.425	-.144	-.076	.874	-.450	-.462
48	.955	.639	.369	.789	.138	.268
49	.706	.488	.614	.727	.748	.784
50	.797	-.025	.125	.706	.567	.196

*For the names of the companies see Appendix B.

APPENDIX M

SELECTED RESULTS OF BROWN AND BALL STUDY (1967

TABLE 28

COEFFICIENT OF SIMPLE CORRELATION BETWEEN INDUSTRY AND MARKET INDICES BY VARIABLE

Industry Number	Variable: Operating Income	Net Income	EPSAD
20	.97	.90	.82
26	.97	.97	.85
28	1.00	.99	.97
29	..99	.98	.96
32	.95	.92	.88
33	..78	.68	.59
34	..76	.57	.39
35	.98	.98	.96
36	.96	.96	.94
37	.94	.94	.94

Source: Ibid, Table 2 , p. 63.

TABLE

LIST OF MEAN COEFFICIENTS OF SQUARE CORRELATION AVERAGED OVER 316 FIRMS, BY VARIABLE

Variable	Market Mean	Multiple Mean
Operating Income	.62	.71
Net Income	.55	.66
EPSAD	.46	.59

Source: Ibid, Table 4 , p. 64.

APPENDIX N

COMMONALITY BEFORE THE ELIMINATION OF AUTOCORRELATION

TABLE 30

COEFFICIENT OF SIMPLE CORRELATION BETWEEN INDUSTRY INDICES AND MARKET INDICES BY VARIABLE

Industry Number	Variables Sales	NI	EPSAD
10	.873	.000	.000
20	.942	.825	.547
28	.982	.861	.745
29	.984	.754	.547
33	.740	.064	.118
35	.987	.883	.702

TABLE 31

COEFFICIENTS OF DETERMINATION-SUMMARY RESULTS FOR GROUP OF THIRTY-FIVE COMPANIES, BY VARIABLE AND INDUSTRY

Industry Numbers	Average r^2(Firm,Market) Sales	NI	EPSAD	Average Multiple R^2(Firm, ϵ^KMarket) Sales	NI	EPSAD
10	.357	.203	.161	.495	.338	.405
20	n.a.	.408	.250	n.a.	.467	.419
28	.921	.497	.273	.922	.555	.408
29	.877	.299	.220	.904	.415	.377
33	.271	.133	.048	.517	.364	.358
35	.857	.496	.433	.876	.637	.626
All groups	.678	.340	.232	.760	.465	.432

APPENDIX O

SPECIFICATION OF THE PREDICTION MODELS

Notations

A_m = Actual EPSAD of year m

$Q_{m,n}$ = Quarterly EPSAD of quarter n of year n

$S_{m,n}$ = Sales of quarter n of year m

$\hat{A}_m(n)$ = Predicted EPSAD of year m, at the end of quarter n (n = 1,2,3,4).

Models using all available quarterly accounting data

Model 1

$$\hat{A}_m(1) = 4\,Q_{m,1}$$

$$\hat{A}_m(2) = Q_{m1} + 3Q_{m2}$$

$$\hat{A}_m(3) = Q_{m1} + Q_{m2} + 2Q_{m3}$$

Model 2 Same as Model 1, with a provision for additive trend C, based on the average quarterly change in EPSAD over the most recent 56 quarters (a moving base period of 14 years).

Model 3* Same as Model 1 with a provision for multiplicative trend P, based on the average rate of change in EPSAD over the most recent 56 quarters (a moving base period of 14 years).

Model 4

$$\hat{A}_m(1) = 4\,(Q_{m1}-Q_{m-1,1}) + A_{m-1}$$

$$\hat{A}_m(2) = 2\left[(Q_{m1}+Q_{m2}) - (Q_{m-1,1}+Q_{m-1,2})\right] + A_{m-1}$$

$$\hat{A}_m(3) = 4/3\left[(Q_{m1}+Q_{m2}+Q_{m3}) - (Q_{m-1,1}+Q_{m-2,2}+Q_{m-2,3})\right] + A_{m-1}$$

*Models 3,7,8,9,11,12, were not applied to companies with negative quarterly earning and Models 16, 17 were not applied to companies with negative annual earnings.

Model 5 $\hat{A}_m(1) = Q_{m1} + Q_{m-1,2} + Q_{m-1,3} + Q_{m-1,4}$

$\hat{A}_m(2) = Q_{m1} + Q_{m2} + Q_{m-1,3} + Q_{m-1,4}$

$\hat{A}_m(3) = Q_{m1} + Q_{m2} + Q_{m3} + Q_{m-1,4}$

Model 6 Same as Model 5, with an allowance for additive trend (see Model 2)

Model 7* Same as Model 5, with an allowance for multiplicative trend (see model 3)

Model 8* $\hat{A}_m(1) = (Q_{m1}/Q_{m-1,1})\, A_{m-1}$

$\hat{A}_m(2) = [(Q_{m1}+Q_{m2})/(Q_{m-1,1}+Q_{m-1,2})]\, A_{m-1}$

$\hat{A}_m(3) = [(Q_{m1}+Q_{m2}+Q_{m3})/(Q_{m-1,1}+Q_{m-1,2}+Q_{m-1})]\, A_{m-1}$

Model 9* Model 9 is identical to Model 3 (The model appears twice to facilitate the computer program).

Model 10 Same as Model 8, but Smn (Sales) replaces Qmn (EPSAD).

Model 11* Same as Model 8 but Net Income divided by Assets replaces Qmn (EPSAD).

Model 12* $\hat{A}_m(n) = \rho_n Q_{mn}$, where ρ_n = MEAN (A/Q_n) based on the most recent 14 years (the moving base period)

Model 13 $\hat{A}_m(n) = \sum_{i=1}^{n} Q_{mi}$

where $Q_{mi} = \alpha + \beta_{mi1}\sqrt{m} + \beta_{mi2}\, m + \beta_{mi3}\, m^2$

(a time-series regression).

The β_j, are estimated from cumulative past data and updated every quarter.

*See ibid.

Models using past annual accounting data

Model 14 $\hat{A}_m = A_{m-1}$

Model 15 $\hat{A}_m = A_{m-1}$ + (additive trend based on the most recent 14 years)

Model 16* $\hat{A}_m = A_{m-1}$ x (multiplication trend based on the most recent 14 years)

Model 17* $\hat{A}_m = A_{m-1}(A_{m-1}/A_{m-2})$

Model 18 $\hat{A}_m = A_{m-1} + (A_{m-1} - A_{m-2})$

Model 19 $\hat{A}_m = A_{m-1} + \left\{ \left[(A_{m-1} - A_{m-2}) + (A_{m-2} - A_{m-3}) \right] /2 \right\}$

Model 20 $\hat{A}_m = A_{m-1} \cdot \left\{ \left[(A_{m-1}/A_{m-2}) + (A_{m-2} - A_{m-3}) \right] /2 \right\}$

Model 21 $\hat{A}_m = A_{m-1} \cdot (S_{m-1}/S_{m-2})$

Model 22 $\hat{A}_m = A_{m-1} \cdot \left\{ \left[(S_{m-1}/S_{m-2}) + (S_{m-2}/S_{m-2}) \right] /2 \right\}$

Model 23 $\hat{A}_m = \alpha' + \beta'_{m1} \sqrt{m} + \beta'_{m2}\ m + \beta'_{m3}\ m^2$

(see also model 13)

Models using past annual accounting data plus recent macro-economic data

Model 24 Same as 8 with quarterly GNP replacing Q_{mn} (quarterly EPSAD)

Model 25 Same as 8 with quarterly corporate profits after tax replacing Q_{mn}

Model 26 Same as Model 8 with Industrial Production replacing Q_{mn}

Model 27 Same as Model 8 with Total Manusfacturing Sales replacing Q_{mn}

Model 28** Same as Model 20, with GNP replacing A_{mm}

Model 29 Same as Model 28, with Corporate Profits after Tax

*see ibid.

**Models 28 to 31 are included only in the extended set.

Model 30 Same as Model 28, with Industrial Production

Model 31 Same as Model 28 with total Manufacturing Sales

Models using past quarterly accountin data plus recent macro-economic data

Model 32

$$\hat{A}_m(1) = A_{m-1}\,(GNP_{m1}/GNP_{m-1,1})$$

$$\hat{A}_m(2) = Q_{m,1} + \left[(GNP_{m1} + GNP_{m2})/(GNP_{m-1,1}+GNP_{m-1,2})\right] \cdot (Q_{m-1,2} + Q_{m-1,3} + Q_{m-1,4})$$

$$\hat{A}_m(3) = Q_{m1}+Q_{m2}+ \left[(GNP_{m1}+GNP_{m2}+GNP_{m3})/(GNP_{m-1,1}+GNP_{m-1,2} + GNP_{m-1,3})\right] (Q_{m-1,3}+Q_{m-1,4})$$

Model 33 Same as Model 32 with Corporate Profits after Tax

Model 34 Same as Model 32 with Industrial Production

Model 35 Same as Model 32 with Total Manufacturing Sales.

APPENDIX P

COMPARIATIVE LIST OF ACCOUNTING-DATA MODELS

Model Number in this Study	Models included only in the extension	Green and Segall (1967)	Brown and Niederhoffer (1967)	Reilly et al (1973)	Coates (1973) and Barnea et al(1972)
1		I_1	Q_1		RW_1
2					RW_3
3					RW_3**
4	x			I_3	
5		I_4	Q_3		QRW_1
6					QRW_2
7					QRW_3**
8		I_2	Q_2	I_1	MRW
9	x				
10					MRW
11	x				
12	x	I_3*		I_4*, I_5*	
13	x				
14		A_1	A_1		x
15				A_4	x
16					x**
17		A_3	A_3		x**
18		A_2	A_2		x**
19	x				
20	x				
21	x				
22	x				
23	x				
Models not used in the study		none	$A_{5,6,7}$	I_2	none

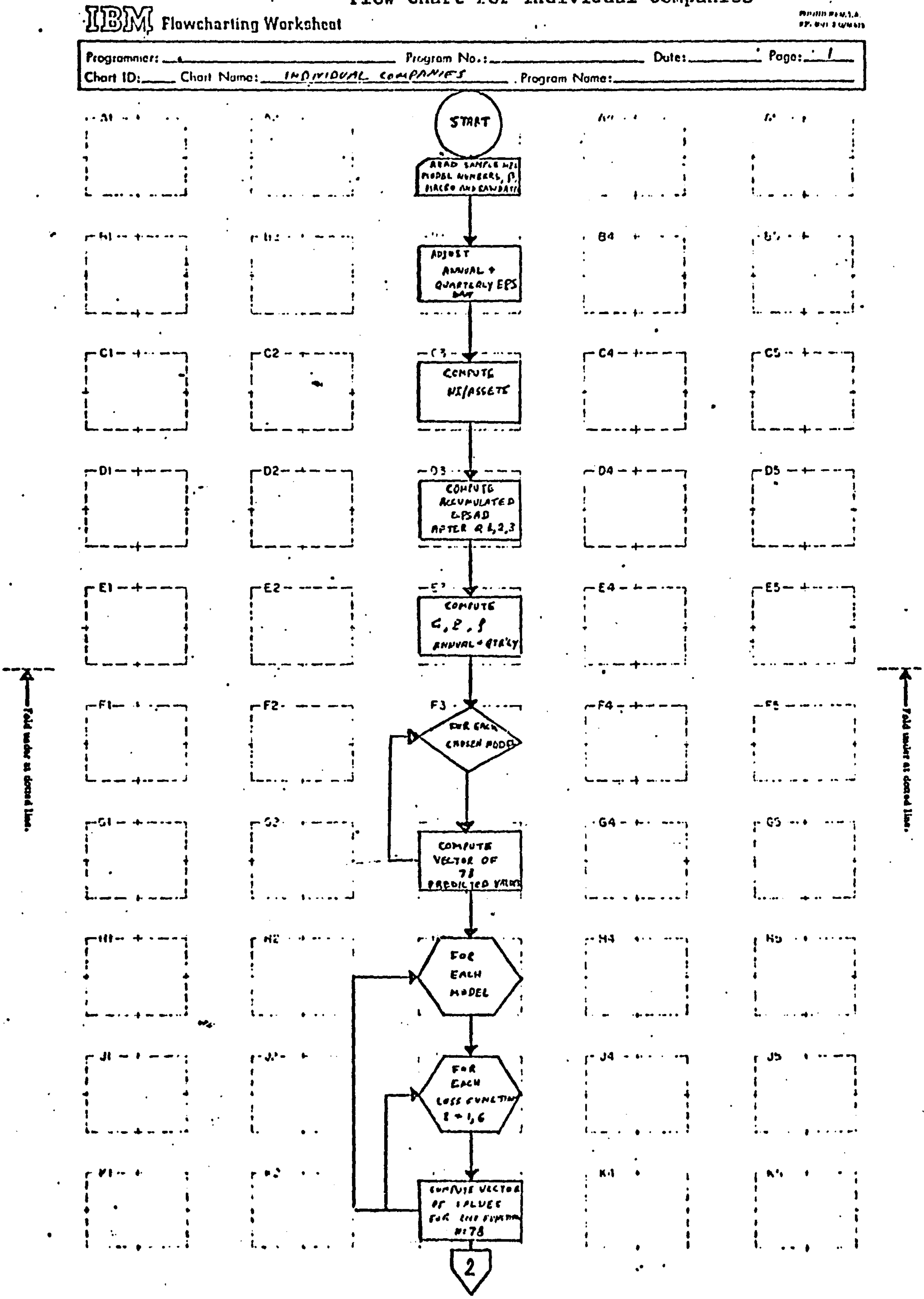
*Not completely comparable

**Used by Coates only.

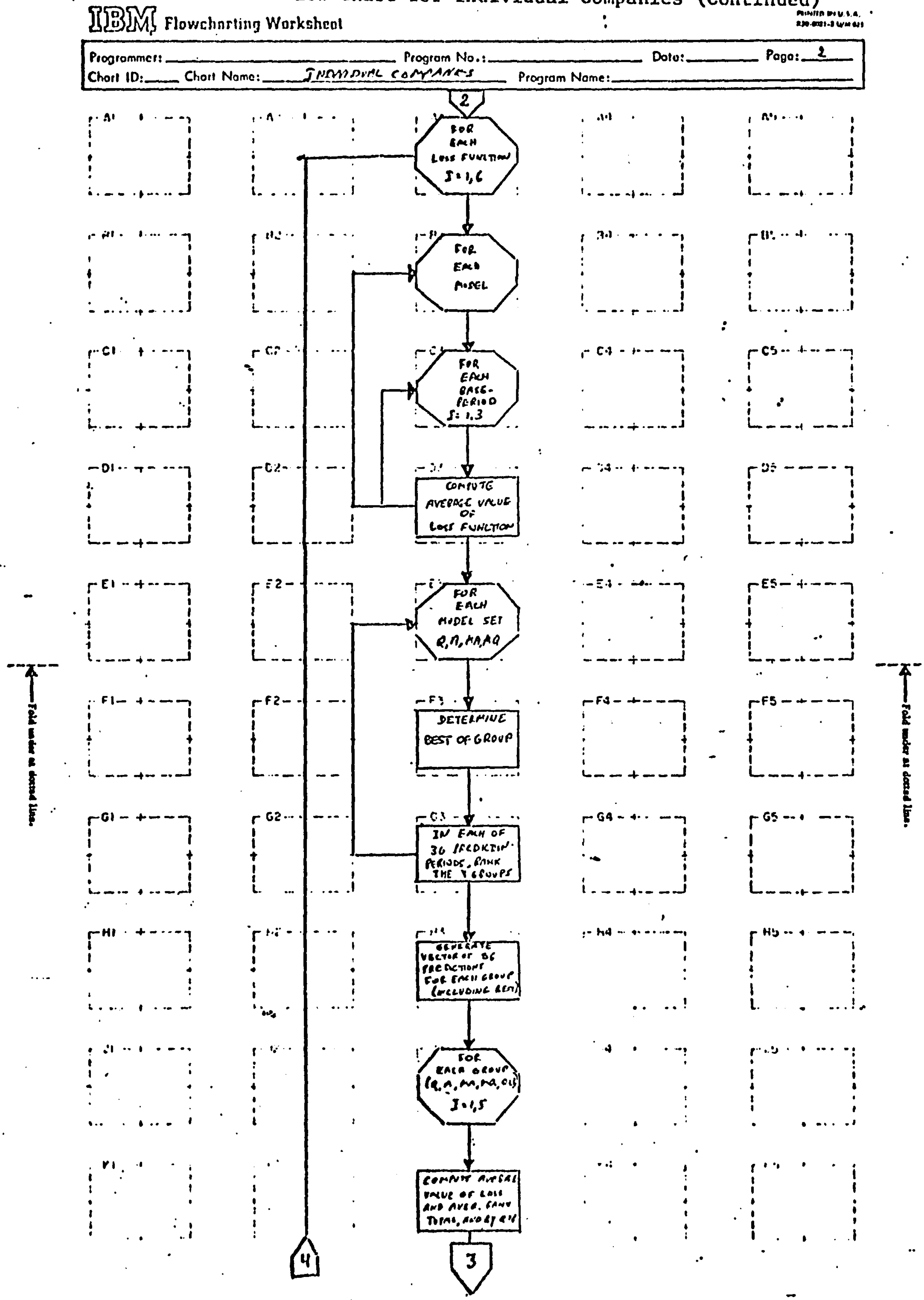
APPENDIX Q

PREDICTION PERFORMANCE–FLOW CHART OF THE COMPUTER PROGRAM AND SAMPLE OUTPUT

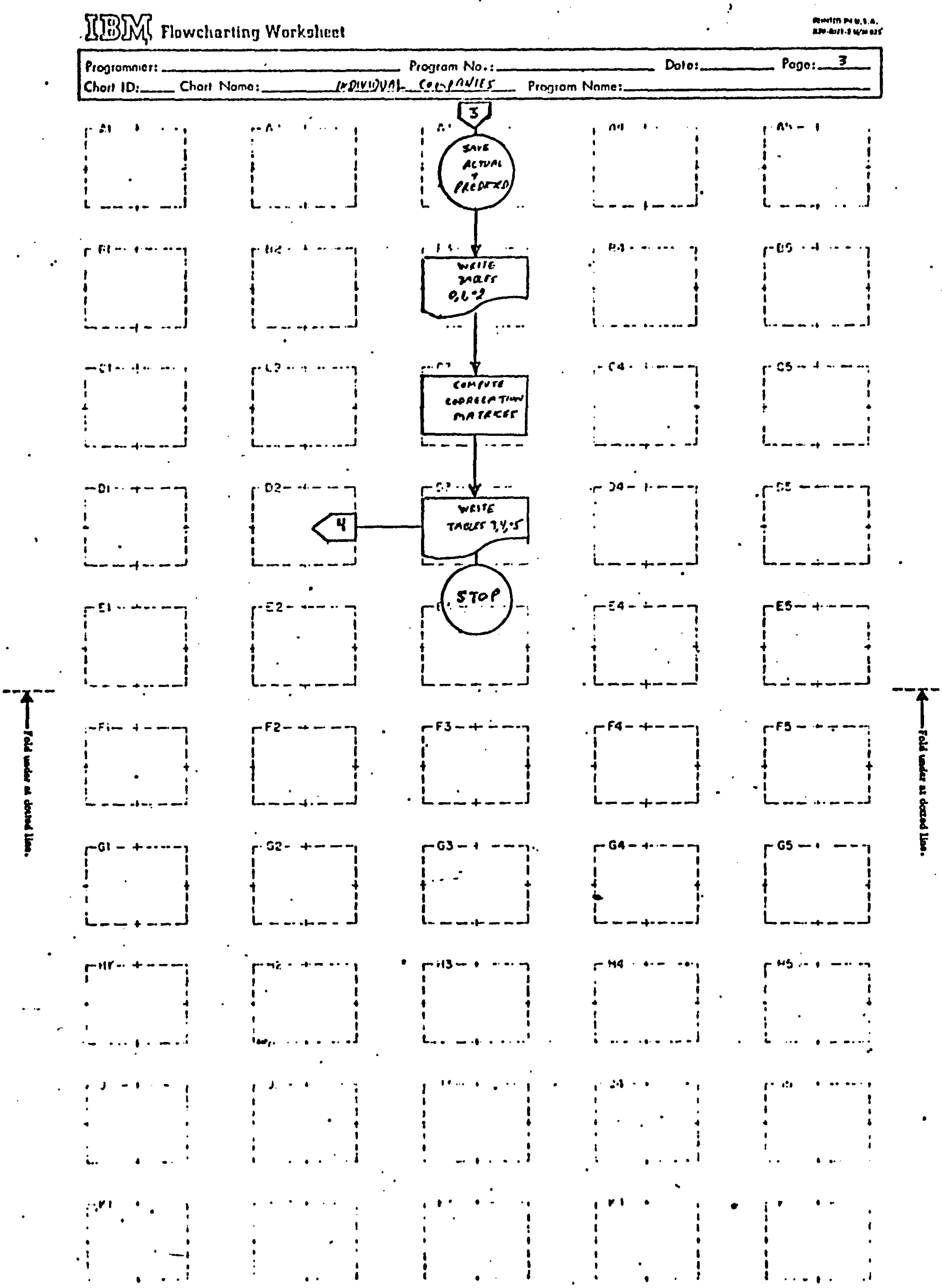
Flow Chart for Individual Companies



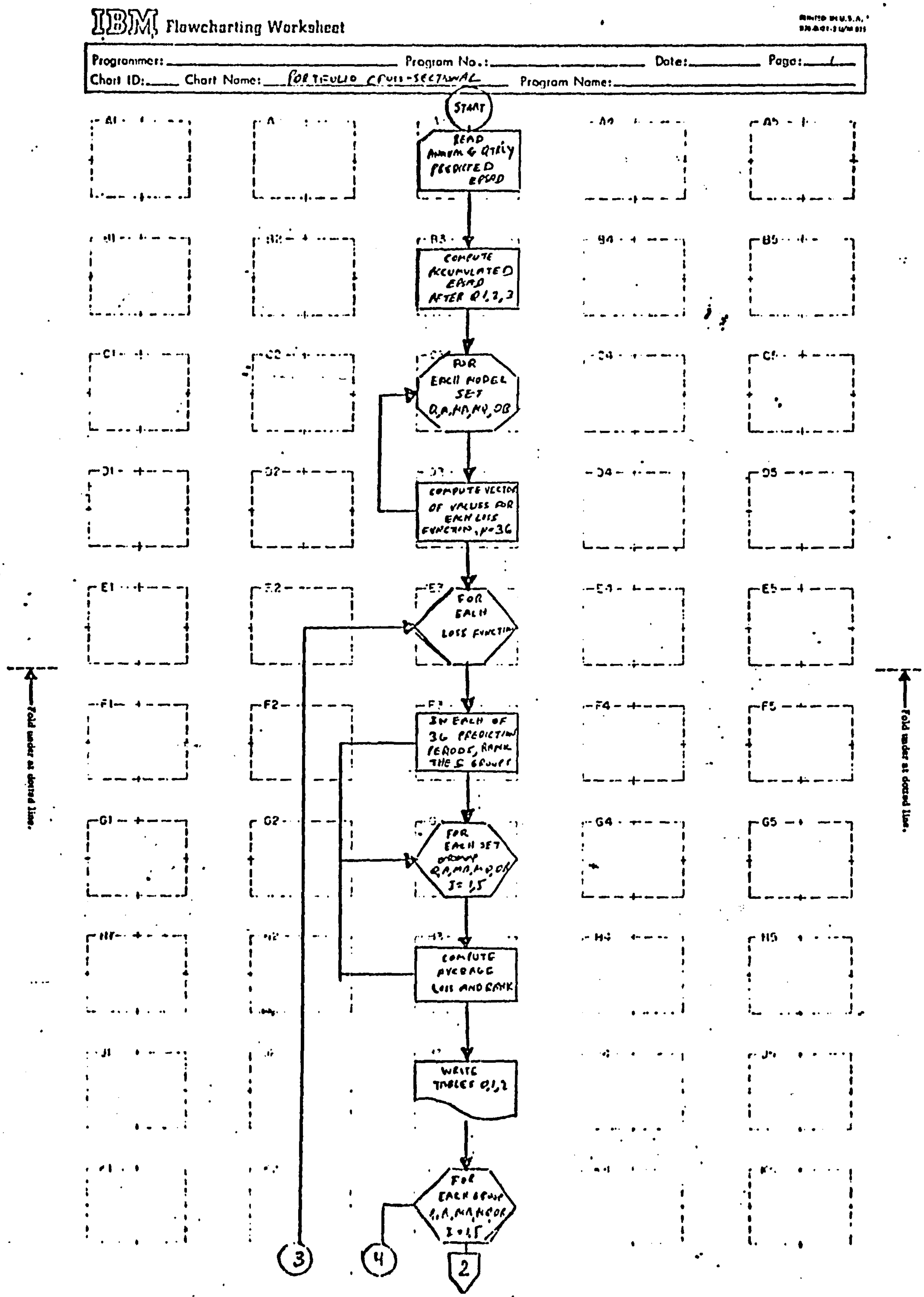
Flow Chart for Individual Companies (Continued)



Flow Chart for Individual Companies (Continued)



Flow Chart for Portfolio Cross-section

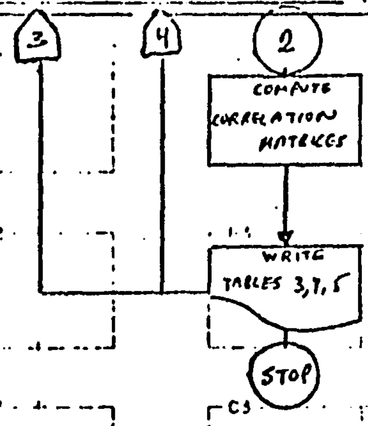


Flow Chart for Portfolio Cross-Section (Continued)

IBM Flowcharting Worksheet

Programmer: ______ Program No.: ______ Date: ______ Page: 2

Chart ID: ______ Chart Name: Portfolio Cross-Section Program Name: ______



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SAMPLE OUTPUT

LOSS FUNCTION 1
COMPANY---INTERNATIONAL NICKEL
TABLE 0

YEAR/QUARTER	ACTUAL ANNUAL EPS	PREDICTED UNDER BEST O	PREDICTED UNDER BEST A	PREDICTED UNDER BEST MA	PREDICTED UNDER BEST MO
1961/1	1.208	1.016	1.104	0.932	0.932
1961/2	1.208	1.016	1.104	0.989	0.937
1961/3	1.208	1.040	1.104	1.056	0.994
1962/1	1.276	1.324	1.208	1.520	1.520
1962/2	1.276	1.404	1.208	1.465	1.526
1962/3	1.276	1.392	1.208	1.431	1.532
1963/1	1.440	1.248	1.276	1.293	1.293
1963/2	1.440	1.288	1.276	1.324	1.282
1963/3	1.440	1.348	1.276	1.335	1.314
1964/1	1.836	1.576	1.440	1.746	1.746
1964/2	1.836	1.684	1.440	1.710	1.783
1964/3	1.836	1.776	1.440	1.700	1.815
1965/1	1.940	2.016	1.836	2.167	2.167
1965/2	1.940	2.064	1.836	2.182	2.125
1965/3	1.940	1.888	1.836	2.179	2.064
1966/1	1.592	2.096	1.940	2.171	2.171
1966/2	1.592	1.928	1.940	2.146	2.113
1966/3	1.592	1.416	1.940	2.139	2.002
1967/1	1.904	1.776	1.592	1.461	1.461
1967/2	1.904	1.824	1.592	1.461	1.424
1967/3	1.904	1.760	1.592	1.458	1.453
1968/1	1.930	1.984	1.904	1.962	1.962
1968/2	1.930	1.472	1.904	1.979	2.013
1968/3	1.930	1.828	1.904	1.970	2.023
1969/1	1.560	2.160	1.930	1.942	1.942
1969/2	1.560	2.160	1.930	1.906	1.954
1969/3	1.560	1.520	1.930	1.857	1.984
1970/1	2.800	2.360	1.560	1.343	1.343
1970/2	2.800	2.930	1.560	1.333	1.461
1970/3	2.800	2.950	1.560	1.367	1.791
1971/1	1.260	1.960	2.800	3.006	3.006
1971/2	1.260	1.540	2.800	3.170	2.992
1971/3	1.260	1.460	2.800	3.259	2.504
1972/1	1.470	1.000	1.260	1.502	1.502
1972/2	1.470	1.450	1.260	1.464	1.145
1972/3	1.470	1.550	1.260	1.452	1.134

SAMPLE OUTPUT (continued)

LOSS FUNCTION 1
COMPANY---INTERNATIONAL NICKEL
TABLE 1

YEAR/QUARTER	BEST MODEL OF GROUP Q		BEST MODEL OF GROUP A		BEST MODEL OF GROUP MA		BEST MODEL OF GROUP MQ		BEST OF BEST		GROUP RANK			
	MODEL	VALUE OF LOSSF	MODEL	VALUE OF LOSSF	MODEL	VALUE OF LOSSF	MODEL	VALUE OF LOSSF	MODEL	VALUE OF LOSSF	Q	A	MA	MQ
1961/1	5	0.037	14	0.011	25	0.076	33	0.076	14	0.011	2	1	3	4
1961/2	5	0.037	14	0.011	25	0.048	33	0.073	14	0.011	2	1	3	4
1961/3	5	0.028	14	0.011	25	0.023	33	0.046	14	0.011	3	1	2	4
1962/1	5	0.002	14	0.005	25	0.059	33	0.059	5	0.002	1	2	3	4
1962/2	5	0.016	14	0.005	25	0.036	33	0.063	14	0.005	2	1	3	4
1962/3	5	0.013	14	0.005	25	0.024	33	0.065	14	0.005	2	1	3	4
1963/1	5	0.037	14	0.027	25	0.022	33	0.022	33	0.022	4	3	2	1
1963/2	5	0.023	14	0.027	25	0.014	33	0.025	25	0.014	2	4	1	3
1963/3	5	0.008	14	0.027	25	0.011	33	0.016	5	0.008	1	4	2	3
1964/1	5	0.068	14	0.157	25	0.008	33	0.008	33	0.008	3	4	2	1
1964/2	5	0.023	14	0.157	25	0.016	33	0.003	33	0.003	3	4	2	1
1964/3	5	0.004	14	0.157	25	0.018	33	0.000	33	0.000	2	4	3	1
1965/1	1	0.006	14	0.011	25	0.052	33	0.052	1	0.006	1	2	3	4
1965/2	1	0.015	14	0.011	25	0.059	33	0.034	14	0.011	2	1	4	3
1965/3	1	0.003	14	0.011	25	0.057	33	0.015	1	0.003	1	2	4	3
1966/1	1	0.254	14	0.121	25	0.335	33	0.335	14	0.121	2	1	3	4
1966/2	1	0.113	14	0.121	25	0.307	33	0.271	1	0.113	1	2	4	3
1966/3	1	0.031	14	0.121	25	0.299	33	0.169	1	0.031	1	2	4	3
1967/1	1	0.016	14	0.097	25	0.196	33	0.196	1	0.016	1	2	3	4
1967/2	1	0.006	14	0.097	25	0.196	33	0.230	1	0.006	1	2	3	4
1967/3	1	0.021	14	0.097	25	0.199	33	0.203	1	0.021	1	2	3	4
1968/1	1	0.003	14	0.001	25	0.001	33	0.001	14	0.001	4	1	2	3
1968/2	1	0.002	14	0.001	25	0.002	33	0.007	14	0.001	2	1	3	4
1968/3	1	0.010	14	0.001	25	0.002	33	0.009	14	0.001	4	1	2	3
1969/1	1	0.360	14	0.137	25	0.146	33	0.146	14	0.137	4	1	2	3
1969/2	1	0.360	14	0.137	25	0.119	33	0.155	25	0.119	4	2	1	3
1969/3	1	0.002	14	0.137	25	0.088	33	0.180	1	0.002	1	3	2	4
1970/1	1	0.194	14	1.538	25	2.123	33	2.123	1	0.194	1	2	3	4
1970/2	1	0.017	14	1.538	25	2.153	33	1.792	1	0.017	1	2	4	3
1970/3	1	0.022	14	1.538	25	2.054	33	1.019	1	0.022	1	3	4	2
1971/1	1	0.490	14	2.372	25	3.048	33	3.048	1	0.490	1	2	3	4
1971/2	1	0.078	14	2.372	25	3.647	33	2.999	1	0.078	1	2	4	3
1971/3	1	0.040	14	2.372	25	3.996	33	1.548	1	0.040	1	3	4	2
1972/1	1	0.221	14	0.044	25	0.001	33	0.001	25	0.001	4	3	1	2
1972/2	1	0.000	14	0.044	25	0.000	33	0.106	25	0.000	2	3	1	4
1972/3	1	0.006	14	0.044	25	0.000	33	0.113	25	0.000	2	3	1	4
TOTAL		2.57		13.56		19.44		15.21		1.53	71	78	97	114
AVERAGE		0.071		0.377		0.540		0.423		0.042	2.0	2.2	2.7	3.2

SAMPLE OUTPUT (continued)

LOSS FUNCTION 1
COMPANY---INTERNATIONAL NICKEL
TABLE 2

PREDICTION MADE AFTER	FIRST QUARTER			SECOND QUARTER			THIRD QUARTER			ALL PREDICTIONS		
GROUP	AVER. VALUE LOSSF	NO.OF TIMES FIRST	AVER. RANK	AVER. VALUE LOSSF	NO.OF TIMES FIRST	AVER. RANK	AVER. VALUE LOSSF	NO.OF TIMES FIRST	AVER. RANK	AVER. VALUE LOSSF	NO.OF TIMES FIRST	AVER. RANK
Q	0.141	5	2.3	0.058	4	1.9	0.016	7	1.7	0.071	16	2.0
A	0.377	4	2.0	0.377	4	2.1	0.377	3	2.4	0.377	11	2.2
MA	0.506	1	2.5	0.550	3	2.8	0.564	1	2.8	0.540	5	2.7
MO	0.506	2	3.2	0.480	1	3.3	0.282	1	3.1	0.423	4	3.2
BEST	0.084	12	1.0	0.031	12	1.0	0.012	12	1.0	0.042	36	1.0

LOSS FUNCTION 1
COMPANY---INTERNATIONAL NICKEL
TABLE 3

GROUP 1

PREDICTION MADE AFTER THE	FIRST QUARTER	SECOND QUARTER	THIRD QUARTER
	1.00000	0.86374	0.61900
		1.00000	0.88434
			1.00000

GROUP 2

PREDICTION MADE AFTER THE	FIRST QUARTER	SECOND QUARTER	THIRD QUARTER
	1.00000	1.00000	1.00000
		1.00000	1.00000
			1.00000

GROUP 3

PREDICTION MADE AFTER THE	FIRST QUARTER	SECOND QUARTER	THIRD QUARTER
	1.00000	0.99577	0.98817
		1.00000	0.99783
			1.00000

GROUP 4

PREDICTION MADE AFTER THE	FIRST QUARTER	SECOND QUARTER	THIRD QUARTER
	1.00000	0.97839	0.90367
		1.00000	0.95952
			1.00000

GROUP 5

PREDICTION MADE AFTER THE	FIRST QUARTER	SECOND QUARTER	THIRD QUARTER
	1.00000	0.89214	0.78536
		1.00000	0.93030
			1.00000

SAMPLE OUTPUT (continued)

LOSS FUNCTION 1
COMPANY---INTERNATIONAL NICKEL
TABLE 4

QUARTER 1

PREDICTION UNDER	GROUP	Q-GROUP	A-GROUP	MA-GROUP	MQ-BEST
	1.00000	0.72571	0.95464	0.97006	0.91353
		1.00000	0.89140	0.87141	0.96721
			1.00000	0.98975	0.86810
				1.00000	0.85055
					1.00000

QUARTER 2

PREDICTION UNDER	GROUP	Q-GROUP	A-GROUP	MA-GROUP	MQ-BEST
	1.00000	0.20072	0.30355	0.40658	0.89288
		1.00000	0.90254	0.92105	0.11753
			1.00000	0.98276	0.17922
				1.00000	0.30304
					1.00000

QUARTER 3

PREDICTION UNDER	GROUP	Q-GROUP	A-GROUP	MA-GROUP	MQ-BEST
	1.00000	-0.10703	-0.33245	-0.10443	0.95391
		1.00000	0.96210	0.95993	-0.19437
			1.00000	0.91924	-0.40293
				1.00000	-0.15499
					1.00000

LOSS FUNCTION 1
COMPANY---INTERNATIONAL NICKEL
TABLE 5

ALL QUARTERS

PREDICTION UNDER	GROUP	Q-GROUP	A-GROUP	MA-GROUP	MQ-BEST
	1.00000	0.35086	0.70264	0.35633	0.96019
		1.00000	0.94348	0.92369	0.31170
			1.00000	0.94879	0.16714
				1.00000	0.32134
					1.00000

APPENDIX R

FORECAST PERFORMANCE

BREAKDOWN BY COMPANY

TABLE 32
AVERAGE ERROR BY COMPANY, LOSS FUNCTION AND MODEL SET

		Loss Function 1				Loss Function 4			
Industry	Company	Q	A	MA	MQ	Q	A	MA	MQ
10	American Smelt.	.199	.359	.410	.238	14.643	25.751	20.755	17.691
10	Int'l Nickel	.071	.377	.540	.423	12.069	24.697	28.795	27.801
10	Hudson Bay	.094	.488	.485	.259	21.400	61.995	68.169	40.613
10	Dome Mines	.037	.069	.063	.051	5.813	8.388	6.938	6.470
10	McIntyre	.496	1.469	1.353	.936	23.894	43.753	42.879	33.774
20	Inters. Brands	.123	.212	.242	.181	19.888	25.024	26.782	23.072
20	Helm Products	.030	.040	.037	.030	11.339	11.020	10.783	9.780
20	Hershey Choc.	.031	.067	.082	.056	9.223	13.996	14.877	11.547
20	Wrigley	.059	.084	.066	.056	5.108	6.963	5.373	4.920
20	Pepsico	.034	.014	.015	.019	7.058	3.391	5.297	5.798
21	Philip Morris	.016	.025	.126	.078	3.868	5.831	10.423	8.017
21	Reyn. Tobacco	.029	.083	.092	.062	2.700	6.673	6.451	4.888
23	Cluett	.051	.117	.092	.066	12.378	23.066	13.878	12.393
27	McGraw-Hill	.011	.023	.017	.010	10.394	12.468	10.824	8.571
28	Amer. Cynamid	.030	.064	.034	.038	8.111	11.554	8.796	7.911
28	DuPont	.475	.831	1.004	.766	7.363	9.970	10.802	9.375
28	Pfizer	.001	.004	.005	.003	3.660	6.109	6.203	5.007
28	Sterling Drugs	.000	.001	.002	.001	2.137	2.433	5.045	3.749
28	Gillette	.039	.034	.026	.034	8.125	7.983	8.843	7.327
28	Sun Chem.	.047	.092	.083	.064	16.511	25.027	24.079	20.230
29	Continental Oil	.057	.074	.072	.060	6.999	9.787	8.393	7.335
29	Quaker Oil	.003	.005	.010	.007	10.809	17.456	17.474	13.809
29	Skel-Oil	.040	.082	.094	.053	6.104	8.857	10.737	7.265
29	Union Oil	.384	.384	.180	.157	9.618	15.426	10.660	8.791
29	Gulf Oil	.033	.075	.064	.042	5.525	7.790	7.735	5.729
29	John Manville	.039	.080	.045	.037	7.178	11.687	8.479	9.480
29	Nat'l Gyps.	.089	.083	.082	.054	15.864	16.279	19.485	14.533
32	Anchor Glass	.051	.136	.098	.063	9.262	15.336	11.729	8.577
32	General Portland	.017	.038	.048	.035	7.250	11.471	13.688	11.461
33	Youngstown	.319	.583	.625	.580	16.040	17.002	14.897	17.193
33	Pittsburgh Steel	.697	.493	.572	.625	N.A.	N.A.	N.A.	N.A.
33	Bethlehem Steel	.456	.553	.549	.581	22.571	22.444	23.847	26.816
33	Copper Range	1.922	6.713	6.659	5.293	N.A.	N.A.	N.A.	N.A.
33	Anaconda	.529	2.526	2.335	1.763	31.197	100.000	100.000	100.000
33	Inspiration Cons.	1.742	3.066	3.744	2.704	35.506	44.295	40.435	40.321
34	Sunshine Min.	.040	.067	.066	.050	66.164	87.646	82.315	65.035
35	Combustion Eng.	.090	.097	.084	.062	9.141	13.310	10.114	9.020
35	Foster Wheeler	.076	.641	.667	.476	16.632	58.146	65.378	50.345
35	Clark Equipment	.123	.209	.173	.123	11.987	18.992	15.970	14.342
35	Chicago Pneom.	.060	.247	.121	.086	7.734	16.235	9.397	7.788
35	Burroughs	.075	.119	.207	.150	16.883	15.602	19.443	17.743
35	I.B.M.	.182	.352	.404	.271	6.746	11.712	11.446	9.225
36	Maytag	.027	.195	.177	.079	15.457	20.282	17.783	11.691
37	Libbey Owens	.334	.922	.834	.582	15.437	24.253	22.331	17.521
37	Pullman	.239	1.308	1.142	.536	13.843	35.406	33.444	21.214
37	Timken Rollers	.181	.444	.174	.139	11.577	17.925	10.894	9.651
38	Robert Fulton	.046	.143	.122	.089	15.310	21.649	24.617	18.791
45	Eastern Airlines	1.660	3.591	3.975	2.447	N.A.	N.A.	N.A.	N.A.
45	PanAm	.321	.584	.605	.475	43.396	53.281	55.018	51.334
56	Edison Bros.	.089	.095	.089	.951	11.990	14.965	11.717	45.384

TABLE 33

RANK MEASURES - BY COMPANY, LOSS FUNCTION AND MODEL SET

		Average Rank								Number of Times First			
		Loss Function 1				Loss Function 2				(loss function 2)			
Industry	Company	Q	A	MA	MQ	Q	A	MA	MQ	Q	A	MA	MQ
10	American Smelt.	2.1	3.3	2.3	2.3	2.0	3.3	2.4	2.3	18	2	8	7
10	Int'l Nickel	2.0	2.2	2.7	3.2	1.8	2.2	2.8	3.2	19	11	4	2
10	Hudson Bay	1.7	3.3	2.7	2.4	1.5	3.1	3.0	2.7	25	0	2	9
10	Dome Mines	2.2	3.2	2.3	2.3	2.3	3.1	2.3	2.4	14	4	11	7
10	McIntyre	1.9	3.1	2.5	2.4	1.8	3.1	2.3	2.3	22	2	3	4
20	Inters. Brands	1.7	2.7	3.0	2.7	2.0	2.6	2.9	2.6	21	7	4	4
20	Helm Products	2.6	2.8	2.4	2.3	2.6	2.8	2.4	2.3	11	8	7	10
20	Hershey Choc.	2.0	2.4	3.1	2.5	3.3	2.3	3.2	2.3	15	13	4	4
20	Wrigley	2.3	3.3	2.2	2.2	2.3	3.3	2.2	2.2	17	1	11	7
20	Pepsico	2.6	2.6	2.3	2.4	2.6	2.1	2.6	2.7	5	20	6	5
21	Philip Morris	1.8	2.3	3.3	2.6	1.8	2.3	3.3	2.6	18	2	0	6
21	Reyn. Tobacco	2.0	3.1	2.6	2.3	1.7	3.3	2.8	2.2	24	1	4	7
23	Cluett	2.1	2.8	2.8	2.3	2.1	3.1	2.5	2.3	13	5	10	8
27	McGraw-Hill	2.2	2.7	2.7	2.4	2.2	2.7	2.7	2.4	16	7	7	6
28	Amer. Cynamid	2.3	2.9	2.4	2.4	2.2	3.1	2.4	2.4	12	7	8	9
28	DuPont	2.1	2.7	2.6	2.7	2.4	2.5	2.6	2.6	16	8	7	5
28	Pfizer	1.8	1.0	3.3	3.0	1.0	2.5	3.0	2.6	20	11	1	4
28	Sterling Drugs	2.0	2.0	3.4	2.5	2.2	2.0	3.3	.25	14	17	0	5
28	Gillette	2.1	3.1	2.6	2.3	2.2	2.5	3.0	2.2	17	10	3	6
28	Sun Chem.	1.8	3.4	2.6	2.2	1.8	3.2	2.8	2.1	20	3	5	8
29	Continental Oil	2.0	2.8	3.0	2.2	2.2	2.1	2.5	2.2	12	5	9	10
29	Quaker Oil	1.7	3.2	3.0	2.2	1.7	3.1	3.1	2.2	22	5	2	7
29	Skel Oil	2.0	2.6	3.1	2.3	2.0	2.8	2.8	2.4	15	7	6	8
29	Union Oil	2.0	3.5	2.3	2.2	2.0	3.5	2.4	2.2	19	1	7	9
29	Gulf Oil	2.4	2.6	2.9	2.2	2.2	2.9	2.8	2.1	13	6	3	14
29	John Manville	2.2	3.3	2.4	2.2	2.2	3.1	2.3	2.4	10	6	13	7
29	Nat'l Gyps.	2.1	2.6	2.7	2.6	2.1	2.6	2.8	2.5	19	10	4	4
32	Anchor Glass	2.3	3.2	2.5	2.0	2.3	3.2	2.6	2.0	15	5	6	10
32	General Portland	1.7	2.5	3.0	2.8	1.7	2.5	3.0	2.8	26	7	3	0
33	Youngstown	2.3	3.0	2.2	2.6	2.2	3.0	2.3	2.6	19	3	11	3
33	Pittsburgh Steel	3.2	2.2	2.2	.24	3.1	2.2	2.3	2.5	1	12	4	4
33	Bethlehem Steel	2.3	2.6	2.6	2.6	2.1	2.7	2.5	2.6	13	11	5	7
33	Copper Range	2.0	2.9	2.4	2.8	1.9	2.6	2.7	2.8	21	8	4	3
33	Anaconda	2.1	3.1	2.3	2.1	3.1	2.4	2.3	2.3	20	3	7	6
33	Inspiration Cons.	2.0	3.2	2.5	2.3	2.1	3.2	2.5	2.3	19	1	7	9
34	Sunshine Min.	2.0	3.1	2.8	2.1	2.3	3.2	2.6	1.0	15	3	3	5
35	Combustion Eng.	2.2	2.9	2.6	2.4	2.1	3.2	2.5	2.2	18	18	8	9
35	Foster Wheeler	2.0	2.8	2.9	2.3	1.7	2.8	3.0	2.5	23.	2	4	7
35	Clark Equipment	1.9	3.2	2.5	2.4	1.9	4.1	2.6	2.3	17	6	4	9
35	Chicago Pneom.	2.3	3.4	2.3	2.0	2.3	3.5	2.3	2.1	14	6	7	9
35	Burroughs	2.1	2.6	2.7	2.6	2.1	2.6	2.7	2.6	16	9	6	5
35	I.B.M.	1.8	2.8	2.9	2.4	1.8	2.0	2.4	2.4	17	5	6	8
36	Maytag	2.0	3.3	2.3	2.4	2.6	3.1	2.2	2.1	13	3	13	7
37	Libbey Owens	2.1	2.5	2.6	2.5	2.1	2.9	2.7	2.3	12	8	8	8
37	Pullman	1.6	3.4	3.0	2.0	1.6	3.4	3.1	2.0	23	2	1	10
37	Timken Rollers	2.4	3.3	2.4	2.0	2.4	3.3	2.4	2.0	12	6	7	11
38	Robert Fulton	2.1	3.0	2.5	2.4	1.9	3.0	2.4	2.2	20	6	3	7
45	Eastern Airlines	2.1	2.7	2.4	2.4	2.0	2.6	2.9	2.4	19	7	4	6
45	PanAm	2.0	2.6	2.8	2.6	2.1	2.7	2.6	2.6	17	8	5	6
56	Edison Bros.	2.1	2.6	2.3	3.0	2.1	3.0	2.1	29	17	0	14	5

TABLE 34

AVERAGE SQUARED ERROR (LOSS FUNCTIN 1) By COMPANY, MODEL SET AND QUARTER OF PREDICTION

		MODEL SET									
		A				MA			MQ		
Industry	Company	A	Q(1)	Q(2)	Q(3)	MA(1)	MA(2)	MA(3)	MQ(1)	MQ(2)	MQ(3)
10	American Smelt.	.356	.309	.258	.031	.355	.417	.458	.355	.196	.164
10	Int'l Nickel	.377	.141	.058	.016	.506	.550	.564	.306	.480	.282
10	Hudson Bay	.488	.145	.121	.017	.451	.485	.515	.451	.237	.093
10	Dome Mines	.069	.067	.034	.009	.066	.063	.061	.066	.056	.030
10	McIntyre	1.369	.947	.423	.118	1.291	1.361	1.406	1.374	1.003	.429
20	Inters. Brands	.212	.204	.102	.061	.234	.242	.241	.234	.182	.124
20	Helm Products	.040	.048	.029	.013	.037	.037	.038	.037	.032	.021
20	Hershey Choc.	.067	.038	.041	.005	.082	.081	.082	.082	0.51	.030
20	Wrigley	.084	.094	.059	.022	.070	.067	.062	.070	.067	.031
20	Pepsico	.014	.053	.020	.020	.015	.014	.014	.015	.022	.019
21	Philip Morris	.025	.027	.013	.008	.128	.126	.124	.128	.079	.033
21	Reyn. Tobacco	.083	.032	.020	.093	.092	.090	.090	.089	.051	.041
23	Cluett	.117	.083	.041	.028	.099	.081	.086	.099	.060	.039
27	McGraw-Hill	.023	.020	.007	.007	.017	.017	.017	.117	.010	.004
28	Amer. Cynamid	.064	.052	.027	.011	.043	.034	.034	.053	.039	.022
28	DuPont	.831	.797	.411	.211	1.036	.998	.979	1.036	.785	.476
28	Pfizer	.004	.002	.001	.001	.005	.005	.005	.005	.003	.002
28	Sterling Drugs	.001	.001.	.000	.000	.002	.002	.002	.002	.001	.001
28	Gillette	.034	.044	.040	.033	.027	.026	.025	.027	.038	.035
28	Sun Chem.	.092	.084	.037	.020	.086	.082	.083	.082	.075	.036
29	Continental Oil	.074	.071	.051	.048	.081	.070	.064	.064	.067	.048
29	Quaker Oil	.005	.008	.001	.001	.011	.010	.009	.011	.006	.003
29	Skel Oil	.082	.062	.036	.024	.109	.091	.087	.072	.056	.032
29	Union Oil	.384	1.065	.010	.186	.179	.174	.186	.221	.221	.065
29	Gulf Oil	.075	.067	.024	.101	.064	.064	.064	.061	.045	.019
29	John Manville	.080	.059	.037	.020	.055	.041	.039	.037	.036	.027
29	Nat'l Gyps.	.083	.213	.031	.024	.082	.081	.081	.082	.039	.031
32	Anchor Glass	.136	.111	.031	.010	.098	.098	.098	.098	.070	.020
32	General Portland	.038	.036	.012	.004	.048	.048	.049	.048	.041	.015
33	Youngstown	.583	.534	.309	.115	.039	.624	.617	.639	.702	.400
33	Pittsburgh Steel	.443	.732	.681	.677	.576	.573	.566	.576	.602	.697
33	Bethlehem Steel	.553	.702	.467	.198	.574	.546	.526	.544	.716	.484
33	Copper Range	6.713	3.397	1.973	.394	6.413	6.666	6.897	6.413	5.197	4.268
33	Anaconda	2.526	.830	.683	.072	2.218	2.348	2.438	2.218	1.875	1.195
33	Inspiration Cons.	3.066	3.044	1.696	.586	3.426	3.811	3.995	3.426	2.545	2.143
34	Sunshine Min.	.067	.064	.028	.028	.065	.066	.066	.066	.054	.026
35	Combustion Eng.	.097	.128	.056	.085	.085	.083	.083	.085	.054	.046
35	Foster Wheeler	.097	.128	.056	.085	.085	.083	.083	.085	.054	.036
35	Clark Equipment	.641	.118	.072	.037	.667	.667	.667	.757	.408	.263
35	Chicago Pneom.	.209	.299	.052	.018	.142	.177	.201	.142	.165	.064
35	Burroughs	.247	.084	.065	.026	.095	.122	.146	.095	.091	.073
35	I.B.M.	.119	.116	.063	.035	.247	.250	.215	.197	.163	.690
36	Maytag	.195	.057	.019	.004	.177	.176	.176	.177	.054	.006
37	Libbey Owens	.922	.455	.381	.175	.886	.808	.809	.886	.459	.394
37	Pullman	1.308	.430	.155	.132	1.080	1.145	1.200	.905	.522	.183
37	Timken Rollers	.444	.251	.243	.048	.188	.168	.166	.185	.136	.092
38	Robert Fulton	.143	.069	.034	.034	.124	.122	.121	.121	.194	.048
45	Eastern Airlines	3.580	1.898	1.410	1.682	4.016	3.065	3.940	3.808	2.030	1.502
45	PanAm	.584	.470	.310	.182	.618	.605	.590	.618	.578	.328
56	Edison Bros.	.095	.170	.050	.045	.092	.083	.087	N.A.	N.A.	N.A.

TABLE 35

AVERAGE RELATIVE ABSOLUTE ERROR (LOSS FUNCTION 4) BY COMPANY, MODEL SET AND QUARTER OR PREDICTION

		Model Set									
			Q			MA			MQ		
Industry	Company	A	Q(1)	Q(2)	Q(3)	MA(1)	MA(2)	MA(3)	MQ(1)	MQ(2)	MQ(3)
10	American Smelt.	25.75	18.68	17.01	8.22	19.83	20.65	21.77	19.83	16.80	16.43
10	Int'l Nickel	24.69	18.92	11.01	6.27	28.95	28.95	28.48	28.95	30.02	24.42
10	Hudson Bay	61.99	21.87	33.01	9.30	66.47	68.33	69.69	65.54	40.57	15.69
10	Dome Mines	8.38	7.26	5.83	4.34	7.16	6.93	6.71	7.16	6.78	5.46
10	McIntyre	43.75	35.11	23.89	12.67	42.86	42.86	52.86	42.86	34.87	23.58
20	Inters. Brands	25.02	26.83	19.95	12.88	26.39	26.74	27.20	26.39	23.09	19.73
20	Helm Products	11.02	14.57	11.45	7.80	10.73	10.79	10.82	10.82	10.73	8.11
20	Hershey Choc.	13.96	11.68	11.39	4.48	15.14	14.83	14.65	14.30	11.30	3.52
20	Wrigley	6.96	6.86	5.16	3.29	5.64	5.35	5.11	5.63	5.07	4.03
20	Pepsico	3.39	7.00	6.45	7.71	5.62	5.30	4.96	5.78	6.15	5.45
21	Philip Morris	5.83	5.42	3.87	2.31	10.57	10.41	10.27	10.57	7.96	5.51
21	Reyn. Tobacco	6.67	3.10	3.23	1.76	6.57	6.45	6.41	5.98	4.69	3. 8
23	Cluett	23.06	15.94	11.56	9.62	15.18	13.14	13.04	15.18	11.67	10.31
27	McGraw-Hill	12.46	15.84	8.64	6.69	10.77	10.85	10.84	10.77	8.70	6.23
28	Amer. Cynamid	11.55	11.08	8.45	4.86	9.15	8.77	8.45	9.15	8.16	6.41
28	DuPont	9.97	9.83	8.61	3.64	11.09	10.70	10.56	10.73	10.03	7.38
28	Pfizer	6.10	5.00	3.11	2.86	6.29	6.18	6.12	6.29	5.34	3.37
28	Sterling Drugs	2.43	3.74	1.54	1.11	5.15	5.04	5.93	5.15	3.42	2.57
28	Gillette	7.98	10.31	9.20	4.85	9.12	8.83	8.57	7.96	7.85	6.18
28	Sun Chem.	25.02	22.42	15.58	11.52	23.98	24.05	24.20	24.13	21.72	14.83
29	Continental Oil	9.78	8.12	6.53	6.34	8.83	8.34	8.00	8.07	7.75	0.17
29	Quaker Oil	17.45	18.22	8.93	5.26	17.72	17.37	17.32	17.72	13.13	10.56
29	Skel Oil	8.85	7.95	5.83	4.52	11.69	10.67	9.84	8.74	7.87	5.17
29	Union Oil	15.42	17.38	7.47	3.99	11.10	10.62	10.25	11.10	4.46	5.81
29	Gulf Oil	7.79	7.71	5.90	2.95	8.12	7.66	7.41	7.97	5.44	3.77
29	John Manville	11.68	8.81	6.88	5.83	9.51	7.81	8.10	10.37	9.57	8.10
29	Nat'l Gyps.	16.27	26.75	11.25	9.54	20.33	18.93	19.11	17.73	14.29	11.56
32	Anchor Glass	15.33	15.84	7.28	4.65	11.60	11.69	11.79	11.69	8.87	5.16
32	General Portland	11.47	10.27	7.12	4.35	13.67	13.67	13.71	13.67	12.80	7.90
33	Youngstown	17.00	27.40	11.90	13.81	15.18	14.27	15.27	15.18	20.29	16.09
33	Pittsburgh Steel	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
33	Bethlehem Steel	22.44	29.20	23.95	14.55	24.74	23.81	22.98	25.16	30.63	24.65
33	Copper Range	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
33	Anaconda	NA	29.36	46.30	17.86	NA	NA	NA	NA	NA	NA
33	Inspiration Cons.	44.29	35.42	33.54	12.55	38.57	50.66	42.66	38.57	40.95	41.44
34	Sunshine Min.	87.64	63.51	73.80	61.23	32.32	33.26	31.35	31.35	62.57	51.17
35	Combustion Eng.	13.31	11.22	8.87	7.31	10.30	10.08	9.94	10.30	8.59	8.15
35	Foster Wheeler	58.14	21.03	18.09	10.19	67.01	65.21	63.90	67.01	43.55	35.75
35	Clark Equipment	18.99	21.40	9.50	5.13	15.34	16.25	16.31	15.34	16.19	11.49
35	Chicago Pneom.	16.23	9.42	8.30	4.96	8.36	9.33	10.48	8.36	7.66	7.33
35	Burroughs	15.60	19.85	14.33	11.46	19.70	19.44	19.18	19.70	18.38	15.14
35	I.B.M.	11.71	9.44	6.06	4.73	11.13	11.46	11.63	11.63	9.47	6.56
36	Maytag	20.82	16.93	24.12	5.33	17.93	17.76	17.65	17.93	11.75	5.39
37	Libbey Owens	24.25	17.34	16.81	12.12	22.89	21.84	22.76	21.81	14.81	15.81
37	Pullman	34.50	19.71	11.57	10.23	32.15	33.35	34.81	30.11	20.96	17.55
37	Timken Rollers	7.92	15.30	13.32	5.99	10.51	10.68	11.48	10.51	9.64	8.79
38	Robert Fulton	21.64	19.65	13.50	13.37	25.74	24.45	23.66	21.21	19.87	15.28
45	Eastern Airlines	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
45	PanAm	53.28	52.61	45.64	31.77	55.78	54.45	54.45	55.75	52.54	45.87
56	Edison Bros.	14.96	15.60	10.58	9.78	11.84	11.70	11.59	NA	NA	NA

APPENDIX S

SUMMARY RESULTS FOR THE SAMPLE

TABLE 36

AVERAGE ERROR IN THE SAMPLE
by Period, Model SE7 and Quarter by Prediction

Quarter/yr.	Q	A	MA	MQ	OB
I/1961	0.206480	0.178596	0.164654	0.158100	0.097312
	0.082624	0.178596	0.162514	0.169943	0.023054
	0.044636	0.178596	0.168099	0.160305	0.02346
	0.174208	0.128437	0.118052	0.116080	0.05284
	0.085348	0.128437	0.109244	0.114616	0.02039
	0.151020	0.128437	0.105347	0.084415	0.01735
	0.210543	0.163686	0.158851	0.154001	0.06863
	0.073833	0.163686	0.150986	0.146756	0.04584
	0.232420	0.163686	0.148550	0.077713	0.01834
	0.197815	0.375903	0.388384	0.354903	0.13806
	0.161157	0.375903	0.379208	0.231109	0.09386
	0.094351	0.375903	0.375611	0.210177	0.06269
	0.500205	0.739139	0.692677	0.687793	0.22365
	0.124014	0.739139	0.695015	0.423715	0.06404
	0.068979	0.739139	0.696967	0.183122	0.02938
	0.266890	0.354896	0.338572	0.337891	0.16137
	0.147060	0.354896	0.332219	0.269564	0.07365
	0.046743	0.354896	0.328719	0.174832	0.01519
	0.523425	0.585972	0.499717	0.490647	0.33303
	0.517417	0.585972	0.493771	0.511814	0.30527
	0.075626	0.585972	0.488232	0.453882	0.05483
	0.769287	0.755870	0.790638	0.785780	0.20195
	0.197981	0.755870	0.790155	0.672612	0.13247
	0.084156	0.755870	0.791738	0.611597	0.05865
	0.350938	0.649019	0.634835	0.634362	0.29263
	0.250658	0.649019	0.655479	0.413853	0.15510
	0.160568	0.649019	0.689040	0.259772	0.09039
	0.606164	0.650864	0.514879	0.519792	0.24184
	0.238370	0.650864	0.513096	0.449432	0.12834
	0.080075	0.650864	0.515854	0.327651	0.06207
	0.649528	1.901242	2.148832	2.145009	0.53857
	0.644784	1.901242	2.381185	1.412846	0.58095
	0.161642	1.901242	2.518680	0.821153	0.11451
	0.138398	0.505921	0.454734	0.454569	0.10550
	0.103676	0.505921	0.450526	0.243496	0.06148
	0.046514	0.505921	0.448447	0.187376	0.02823
AVERAGE	0.235	0.582	0.591	0.429	0.13

PREDICITION MADE AFTER

MODEL SET	QUARTER 1	QUARTER 2	QUARTER 3
Q	0.382823	0.218910	0.103994
A	0.582462	0.582462	0.582462
MA	0.575402	0.592783	0.606214
MQ	0.569911	0.421646	0.296000
BEST	0.204620	0.140375	0.047929

TABLE 37

AVERAGE ERROR IN THE SAMPLE

BY PERIOD, MODEL SET AND QUARTER OF PREDICTION

(loss function 4)

Quarter/year	Q	A	MA	MQ	OB
I/1961	20.722262	19.763365	20.516235	20.308019	11.48718
	17.449828	19.763365	19.456821	20.347858	8.83598
	11.956504	19.763365	19.432316	17.767739	7.83334
	19.744224	19.344677	21.278266	19.545014	11.16854
	12.892357	19.344677	20.150414	16.691982	6.49556
	12.569062	19.344677	19.535574	15.197444	6.99687
	16.956449	14.355741	14.891641	14.751724	9.42977
	13.082796	14.355741	14.276544	14.152791	7.58497
	11.743029	14.355741	14.131986	10.087308	5.09973
	18.604050	19.632601	18.128543	17.042749	11.72565
	12.934688	19.632601	18.049453	13.981135	7.66682
	11.780786	19.632601	18.049214	13.908185	7.06481
	16.965301	20.120756	17.031590	16.949594	10.84234
	13.072706	20.120756	16.992235	14.771891	7.63157
	10.387129	20.120756	16.966113	12.278106	6.61058
	16.205097	15.952920	15.231984	15.372995	10.21321
	11.495497	15.952920	15.273812	13.121743	6.94372
	7.556024	15.952920	15.309475	11.361670	3.91160
	18.651080	19.309484	18.614501	18.833081	13.41610
	14.777009	19.309484	18.586593	18.141186	9.92110
	9.700907	19.309484	18.573792	14.142459	5.76713
	17.994862	19.063358	18.655959	18.523395	11.99040
	13.382530	19.063358	18.582958	17.262610	9.22334
	8.203479	19.063358	18.620668	13.858970	6.21688
	15.441162	18.686671	17.682972	17.471427	12.40337
	13.501881	18.686671	17.873936	15.825969	9.72523
	9.120931	18.686671	18.207774	12.854205	7.28894
	22.014331	25.658284	23.947709	24.811865	16.73260
	17.390053	25.658284	23.839137	20.246868	12.72145
	11.248596	25.658284	24.025753	17.493020	9.53388
	26.694630	32.383522	31.007333	30.852435	22.14193
	26.342636	32.383522	31.229240	30.031305	20.77884
	17.941962	32.383522	31.440709	25.605751	13.70959
	15.219036	22.900513	23.184453	23.056048	12.69072
	13.198061	22.900513	22.648875	18.474803	10.61466
III/1972	9.732904	22.900513	22.523720	15.010357	7.85032
AVERAGE	14.908	20.597	19.831	17.503	10.007
	14.908	20.597	19.831	17.503	10.007

MODEL SET	PREDICTION MADE AFTER QUARTER 1	QUARTER 2	QUARTER 3
Q	18.790646	14.972007	11.001180
A	20.597611	20.597611	20.597611
MA	20.045309	19.777945	19.766208
MQ	19.823902	17.778034	14.978865

TABLE 38

MARGINAL REDUCTION IN THE AVERAGE ERROR* DUE TO NEW QUARTERLY INFORMATION, BY INDUSTRY (As a percentage of the initial error)

	COMPARISON**		
	Q(1) - MQ(1)	Q(2) - MQ(2)	Q(3) - MQ(3)
All Companies	5.2	15.8	26.6
Industry			
10	21.1	20.4	43.6
20	0.0	0.0	18.0
28	0.1	17.3	29.2
29	0.0	21.8	24.8
33	3.7	18.8	25.1
35	10.3	30.6	25.0

*Simple average over the sampel (or the industry group) of the relative absolute error.

**The comparison becomes Q(n) - Q(n-1) where MQ9n) produces larger error than Q(n-1).

APPENDIX T

SUMMARY RESULTS FOR THE SAMPLE
(APPLICATION OF THE EXTENDED SET OF MODELS)

TABLE 39

AVERAGE ERROR IN THE SAMPLE
BY PERIOD, MODEL SET AND QUARTER OF PREDICTION

	Q	A	MA	MQ	OB
Quarter/year I/1961	0.120939	0.090540	0.156065	0.161498	0.0432
	0.152792	0.090540	0.157318	0.151093	0.0346
	0.073112	0.090540	0.170310	0.158736	0.0254
	0.054372	0.198678	0.108733	0.138009	0.0270
	0.045792	0.198678	0.102810	0.084814	0.0040
	0.060582	0.198678	0.097015	0.095830	0.0041
	0.098867	0.136951	0.157394	0.154552	0.0368
	0.047729	0.136951	0.151088	0.138279	0.0200
	0.030831	0.136951	0.148945	0.081220	0.0081
	0.176065	0.246105	0.386664	0.345185	0.1129
	0.104043	0.246105	0.378591	0.232440	0.0770
	0.030989	0.246105	0.374268	0.213149	0.0248
	0.252171	0.498089	0.691490	0.687793	0.1935
	0.094160	0.498089	0.693907	0.420991	0.0671
	0.027941	0.498089	0.696144	0.181005	0.0209
	0.141575	0.210120	0 340920	0.337891	0.0886
	0.057402	0.210120	0.334290	0.266781	0.0312
	0.036684	0.210120	0.330236	0.177780	0.0233
	0.405929	0.197758	0.495366	0.490647	0.1434
	0.354769	0.197758	0.489313	0.515584	0.1131
	0.062874	0.197758	0.483859	0.465186	0.0485
	0.671025	0.210685	0.799555	0.785780	0.1060
	0.129797	0.210685	0.801106	0.677941	0.0729
	0.040145	0.210685	0.803230	0.614933	0.0305
	0.234878	0.303647	0.635769	0.633932	0.1878
	0.190274	0.303647	0.656635	0.413602	0.1340
	0.081727	0.303647	0.690084	0.259248	0.0648
	0.348678	0.348237	0.504720	0.493517	0.1469
	0.220642	0.348237	0.501450	0.435615	0.0837
	0.119239	0.348237	0.502900	0.334297	0.0498
	0.459376	0.978881	2.170254	2.140288	0.3842
	0.333642	0.978881	2.404461	1.409863	0.2880
	0.080049	0.978881	2.543614	0.831221	0.0584
	0.257595	0.351362	0.486102	0.464217	0.0940
	0.116514	0.351362	0.485589	0.247551	0.0556
	0.075085	0.351362	0.487002	0.186397	0.0271
AVERAGE	0.160	0.314	0.594	0.428	0.081

PREDICTION MADE AFTER

MODEL SET	QUARTER 1	QUARTER 2	QUARTER 3
Q	0.268456	0.153963	0.059938
A	0.314254	0.314254	0.314254
MA	0.577752	0.596380	0.610634
MQ	0.569442	0.416213	0.299917
[illegible]	[illegible]	[illegible]	[illegible]

TABLE 40

AVERAGE ERROR IN THE SAMPLE

BY PERIOD, MODEL SET AND QUARTER OF PREDICTION

(loss function 4)

	Q	A	MA	MQ	OB
	11.687108	12.579252	19.495925	20.308019	8.43337
	13.782234	12.579252	19.097764	19.621674	6.730591
	9.981537	12.579252	20.064310	17.705573	5.89340
	9.664761	11.847736	19.402317	19.545014	6.07427
	8.715594	11.847736	18.760771	15.836553	3.32840
	8.602926	11.847736	19.315958	15.158468	4.83524
	11.145141	13.235543	14.624955	14.751724	7.73698
	8.645242	13.235543	14.187465	13.726700	6.07125
	7.143316	13.235543	14.017517	10.223456	3.33044
	16.644795	16.013487	18.375180	17.042749	11.19139
	13.431102	16.013487	18.326626	14.157974	9.31409
	9.273102	16.013487	18.069496	14.083463	6.63211
	12.516439	15.443767	17.138256	17.196767	9.38919
	11.458779	15.443767	17.107359	14.707984	7.59979
	8.528708	15.443767	17.032867	12.325448	5.38047
	11.767070	11.535749	15.064812	15.301221	7.11856
	8.429901	11.535749	15.091104	12.969755	4.68964
	6.891220	11.535749	15.186867	11.428145	3.78336
	16.545329	15.001125	19.336426	18.540919	11.18761
	12.588370	15.001125	19.305835	17.981797	8.27291
	8.828865	15.001125	19.345878	14.292359	5.87519
	15.855628	12.255800	18.514782	18.537354	9.016491
	11.277882	12.255800	18.468554	17.420614	6.74073
	5.797172	12.255800	18.514129	14.076948	4.08768
	11.613214	14.784699	17.604524	17.471427	9.29556
	10.785056	14.784699	17.812024	15.804607	8.68155
	7.267386	14.784699	18.182795	12.763413	5.97097
	16.367601	18.824386	24.340568	24.811865	11.99900
	12.847360	18.824386	24.231169	20.351723	9.22246
	9.821869	18.824386	24.513252	17.856668	7.59104
	23.404508	28.226816	31.833830	30.852435	18.92382
	19.093699	28.226816	32.138472	30.096503	15.12344
	14.886134	28.226816	32.458854	25.935999	11.82988
	19.289093	19.099411	23.596247	23.056048	13.24352
	14.642138	19.099411	23.085006	18.593351	10.48550
	12.296250	19.099411	22.892525	14.838753	8.05080
AVERAGE	11. 986	15.732	19.903	17.482	

PREDICTION MADE AFTER

Mode Set	QUARTER 1	QUARTER 2	QUARTER 3
Q	14.723121	12.150388	9.114373
A	15.732838	15.732838	15.732838
MA	19.975614	19.833137	19.998675
MQ	19.815290	17.628720	15.073114
[illegible]	[illegible]	[illegible]	[illegible]

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