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THE EFFECT OF THREE FACTORS ON THE ACCURACY OF UNIVARIATE TIME-SERIES FORECASTS OF QUARTERLY EARNINGS

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# The Effect of Three Factors on the Accuracy of Univariate Time-Series Forecasts of Quarterly Earnings

by

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# ABSTRACT

This study examines the effect of industry concentration, diversification, and product type on the accuracy of univariate time-series forecasts of quarterly earnings. The purpose of this study is to test these three factors for their ability to affect firms' earnings streams in such a way as to improve the accuracy of univariate time-series forecasts.

In using the univariate time-series method, many observations are required to insure the accuracy of the estimated parameters. To use annual earnings in conjunction with this forecasting method severely increases the risk of the earnings stream properties changing over time. This can seriously affect the accuracy of the forecasts generated by these models. To limit this risk, the accounting-finance literatures have focused on using quarterly earnings announcements in univariate time-series modeling. This study incorporates two model specifications, the Brown and Rozeff model and the Griffin-Watts model, which have been found to reasonably model the behavior of quarterly earnings.

The three factors are selected because of their ability to cause certain patterns in the earnings streams. The patterns which these factors introduce are hypothesized to improve the

modeling of, and subsequently the forecasting of, quarterly earnings. Two groups of firms are formed for each factor. These groups of firms are then used to generate forecasts. From these forecasts, accuracy measures are computed. These forecasts are generated using both univariate time-series models, for three different forecast horizons, for five separate time periods.

The univariate z-test for differences in two group means is used to test the equality of the two group's mean accuracy measures. The results of these tests show:

1) Firms in less concentrated industries produce more accurate forecasts than firms in more highly concentrated industries.

2) Firms which produce and/or sell non-durable products have more accurate forecasts than firms involved in durable product markets.

3) No measurable difference in forecast accuracy could be found for highly diversified firms versus firms in which little diversification has taken place.

These findings are of importance to accounting information users interested in generating and using these forecasts of earnings.

# Chapter One

## Introduction

The principle objective of this study is to examine the affect on earnings forecastability of three financial-economic factors. The factors examined are:

1) Industry Concentration;
2) Diversification; and
3) Product Type.

Many different forms and types of forecast models have been examined in the context of generating earnings forecasts. This study focuses on one of these forecasting methods, univariate time-series forecasts of earnings, to examine the impact these three factors have on quarterly earnings forecast accuracy.

The choice of this forecasting model class is driven by the means by which univariate time-series earnings forecasts are generated. The univariate time-series approach examines the past relationships within the earnings streams, then these relationships are used to develop forecasts. In this way, the forecasts are based solely on the statistical trends which are present in the past earnings stream. Any factor which has a prolonged impact on the earnings stream should then impact the accuracy of these univariate time-series forecasts. If the factor affects the earnings streams in a manner which makes past trends more pronounced, the univariate time-series earnings forecasts should be more accurate, provided that the relationship(s) remain constant. On the other hand, if the factor introduces more noise into the earnings stream, then less accurate forecasts would be expected.

Past research on quarterly earnings forecasting, employing the univariate time-series approach, has identified two specifications which produce reasonably accurate forecasts. These two specifications are:

1) The Griffin, Watts Model; and
2) The Brown-Rozeff Model.

These two model specifications have been extensively analyzed in the hope that one of these models would prove to be the best alternative. However, this has not happened. Both of these models prove to be reasonably accurate, and there is little evidence indicating one to be superior. With these results in mind, this study examines forecasts produced by both of these models, for three different forecasting horizons; one, four, and eight quarters ahead.

The three factors which are analyzed (industry concentration, diversification, and product type) are selected because of their ability to induce certain earnings stream properties. The three hypotheses examined are as follows.

1) Earnings forecasts will be more accurate for firms in high concentration industries as compared to earnings forecasts for firms in low concentration industries.

2) Firms which are highly diversified should produce more accurate earnings forecasts than firms in which little diversification has taken place.

3) Firms with product lines of a non-durable nature will have their earnings forecasted more accurately than firms with durable product lines.

The basis for each of these hypotheses comes from past theoretical and empirical research in the accounting, finance, and economic literatures.

Past research has found industry concentration to be highly correlated with firm earnings. This relationship has been substantiated using different measures for both industry concentration and firm profits. The rational for this relationship is straight forward. All firms can exert some control over their cost structures, however, firms in highly concentrated industries can also control their revenue structure to some degree. This gives these firms more control over earnings than firms in more competitive industries.

This study ranks the available firms from high concentration to very little concentration using both the four and eight firm concentration ratios. The concentration ratios are taken from the 1964, 1968, and 1973 Census of Manufacturers. Using these ratios, two groups of firms which consistently rank as high or low on the industry concentration factor are established.

Diversification, as developed in the portfolio management area of finance, is a method of reducing the riskiness of investments by forming portfolios of uncorrelated assets. This principle can also be applied within the firm. The firm, by diversifying its internal investments, can reduce the risk associated with its operations. If one particular product line has a down period, this could have severe implications for the firm's earnings if this is the firm's only product line. On the other hand, if the firm is diversified, the impact of this down period will be far less severe.

The measurement of diversification used in this study employs the familiar market model. The market model associates the return of an asset to the return on the market portfolio. This study replaces the return of an asset with an accounting measure of earnings. From the resulting estimation, the $R^2$ statistic reports the amount of correlation between the firm's earnings and the earnings of a market portfolio. This is used to rank firms from high to low on the diversification factor. The higher the correlation, the more diversified the firm. Two separate groups, high and low, are then established.

The product type factor is an attempt to relate firm earnings to the demand for two separate classifications of products. These classifications are durable and non-durable products. Past research in macro-economic theory has found that the consumer uses transitory income to purchase his stock of durable goods. The income used to purchase non-durable goods is permanent in nature. This behavior on the part of consumers makes the demand for durable goods much more variable than the demand for non-durable goods. With demand for durables being more random than that for non-durables, firms with durable product lines would find earnings much more variable than firms with non-durable product lines.

In order to differentiate these two types of firms, the durable products and non-durable products classification codes published by the Department of Labor Statistics are used. For a firm to be classified as non-durable its SIC Codes (Standard Industrial Classification Codes, the codes indicating the product markets the firm operates in) must all be non-durable. The same is true for a firm to be classified as durable. Any firm with both durable and non-durable codes is eliminated.

After the firms for each factor are identified, the two univariate time-series models are estimated and forecasts are made for one, four, and eight quarters ahead. Absolute percentage errors and squared percentage errors are calculated. These errors are then used as observations in a z-test of differnces between their means. This leads to the analysis being conducted for the two univariate time-series models, for five different time periods, as well as for three separate forecast horizons.

The results of this research are mixed. The concentration factor yields more accurate forecasts when firms in low concentration indutries are forecasted as opposed to the hypothesized relationship which states that firms in high concentration industries should produce more accurate forecasts. The product type and diversification factors produce results consistent with the hypothesized relationships. However, while the direction of the effect of these factors is as hypothesized, the number of significant differences is lower than would be expected.

The remainder of this dissertation discusses the various aspects of this research in more detail. Chapter two outlines the past research using and developing the univariate time-series forecasts of earnings. Chapter three develops the factors which are examined in this study. Chapter four presents the research methodology; the z-test of differences in means. Chapter five reports the results of the data analysis. Chapter six contains a discussion of the results and oppurtunities for future research.

## Chapter Two

## Univariate Earnings Time-Series Modeling

The univariate time-series approach to forecasting has become quite popular over the past 15 years. The use of univariate time-series analysis to examine accounting earnings has also developed during this period. Beaver (1970) points out three accounting issues for which information on the univariate time-series behavior of earnings could have a benefical impact:

1) Income smoothing;
2) Relative forecast ability of alternative income measurements; and
3) Interim reporting.

Based upon these premises, as well as many others, research has investigated the univariate time-series behavior of annual and quarterly accounting earnings.

In general, the univariate time-series research concerning accounting earnings has dealt with identifying the Box-Jenkins models which produce the most accurate forecasts of annual and/or quarterly earnings. The Box-Jenkins approach to univariate time-series model identification is an iterative process. By examining the autocorrelation function (ACF) and partial autocorrelation (PACF) of the series being examined, the researcher can identify the model which best fits the series. This is done by matching the observed ACF and PACF functions to the theoretical ACF and PACF functions of the many possible models. The accounting earnings univariate time-series research has dealt with both individual firm's earnings series as well as cross-sectional analysis aggregating many firm's earnings streams. This has been done not only to learn more about the statistical properties of accounting earnings, but also to aid the user of accounting earnings who may wish to generate forecasting models.

The remainder of this chapter focuses on the accounting earnings univariate time-series research. Selected studies are reviewed which lay the groundwork for the current study. This review is not intended to be exhaustive in nature, but rather, is intended to give the general progression of this research and to show how the current study adds to this body of knowledge.

## Annual Earnings Univariate Time-Series Modeling

Time-series analysis of accounting earnings measures was first conducted on annual earnings data. Because of the vast amount of research analyzing the use and nature of annual accounting earnings, the initial examination of time-series modeling of annual earnings is an appropriate starting point.

The Ball and Watts (1972) study provides a comprehensive examination of cross-sectional annual earnings univariate time-series behavior. They examine approximately 700 firms, the exact number varying according to the earnings form used.

The study encompassed the 1947-1966 time period. They examine four different forms of earnings:

1) Net income after taxes;
2) Adjusted earnings per share;
3) Net income deflated by total assets; and
4) Net sales.

Net sales is examined to investigate the possibility that "smoothing" of earnings by firms may occur. Several different types of tests are used to examine the independence or non-independence of successive earnings observations.

Using the net income and earnings per share measures, Ball and Watts find that the sample firms exhibit an upward trend in earnings. After calculating the year to year earnings changes, the signs of these earnings changes are then examined using a cross-sectional "runs" test. They find that the number of runs (positive and negative) for the sample firms are very close to the total expected assuming independence within the streams. Next, the autocorrelation functions for the sample firms are examined for net income and earnings per share. Ball and Watts find that 50% of the firms have average autocorrelations for lags one through five that are very close to zero. This result implies a random-walk model may be appropriate for these cross-sectional earnings streams.

One final test Ball and Watts use incorporates the following exponential smoothing forecasting model:

$$\hat{y}_t = Ay_{t-1} + (1-A)\hat{y}_{t-1}$$

where:

1) $y_t$ is earnings in period t
2) $y_{t-1}$ is earnings in period t-1

This model uses successive values for A between 0 and 1 incremented by .05. Using mean absolute errors, the optimum value of A (value resulting in lowest mean absolute errors) is given below:

| | |
|---|---|
| Net income | A = .95 |
| Earnings per share | A = .95 |
| Net income/total assets | A = .85 |

Given A equal to 1, the above forecasting model simplifies to

$$\hat{y}_t = y_{t-1}$$

This is the classic random walk model. The closeness of their optimum A values to one, would imply that the random-walk model reasonably describes the nature of annual earnings and annual earnings per share. However, the deflated earnings, standardized by total assets, do not fit the random-walk model as well.

Similar cross-sectional results, as those reported by Ball and Watts, have been found by other authors. Little and Raynor (1966) and Brealey (1969) support the random-walk findings of Ball and Watts using the net income and earnings per share measures. Beaver (1970) and Lookabill (1976) find that the random-walk model may not be appropriate when examining the standardized or deflated earnings streams. These cross-sectional examinations into the statistical properties of accounting earnings do not completely answer the question of which model(s) provide the best (most accurate) annual earnings forecasts. In order to address this issue, studies which examine the relative forecast accuracy of different forecasting models must be undertaken.

A study by Albrecht, Lookabill, and McKeown (1977) compares three annual earnings forecasting models. These models are:

1) Individual firm Box-Jenkins specified models;
2) Random-walk model; and
3) Random-walk with a drift term model.

They examine the use of these three models for both deflated and nondeflated earnings. The error metrics, and their computations, used to determine the most accurate model(s) are detailed below.

1) Mean percentage error:

$$MPE = \frac{1}{N}\sum_{t=1}^{N} \frac{E(X_t) - X_t}{X_t}$$

2) Mean absolute percentage error:

$$MAPE = \frac{1}{N}\sum_{t=1}^{N} \frac{|E(X_t) - X_t|}{X_t}$$

3) Mean squared percentage error:

$$MSPE = \frac{1}{N}\sum_{t=1}^{N} \frac{(E(X_t) - X_t)^2}{X_t}$$

In each case, $X_t$ is the earnings variable of interest They examine three different forecast horizons and three different model estimation time periods.

Their results show that for nondeflated earnings it is difficult to distinguish between the random-walk with drift and individual firm Box-Jenkins models. Both are superior, however, to the simple random-walk model. For deflated earnings, the random-walk and individual firm Box-Jenkins models both outperform the random-walk with drift model, but are themselves indiscernible.

An independent study by Watts and Leftwich (1977) verifies the results of Albrecht, Lookabill, and McKeown. Examination of the individual firm models which are identified by these two seperate studies, indicates that an autoregressive model of order 1 (AR(1)) is frequently specified as the appropriate firm model. This AR(1) model has also received some support as an appropriate forecasting model for annual earnings (Watts and Leftwich (1977) and Lev (1983)).

Two problems are encountered when using the time-series methodology in conjunction with annual earnings. The univariate time-series approach, particularly in the model identification stage, is most efficient when there are large numbers of observations (over 50). To obtain a sample of firms with 50 annual observations of earnings would surely enter a "survivor" bias into the sample. Also, and perhaps more importantly, the earnings generating process is certainly not stationary throughout this length of time. These problems can cause serious difficulties in estimating the model parameters.

With these data problems in mind, the univariate time-series research of accounting earnings began to focus on the modeling of quarterly accounting earnings. While this change to quarterly data from annual data does not completely eliminate the difficulties, it certainly reduces the amount of care which is necessary when using this methodology. Lorek (1979) shows empirically that predicting annual earnings using quarterly forecasting models can improve upon the desired annual earnings forecasts. Hopwood, McKeown, and Newbold (1982) also illustrate that quarterly earnings contain much more information than annual earnings which is useful in generating annual earnings forecasts. By using the estimated coefficients of quarterly models to derive the coefficients of annual models, forecast accuracy was better than estimating the annual model coefficients with annual data or using the simple random-walk model. So that the movement to examination of quarterly earnings was an obvious and necessary extension to the earlier annual earnings examinations.

## Quarterly Earnings Univariate Time-Series Modeling

The quarterly earnings univariate time-series studies generally examine the forecasting ability of different model specifications. Three "general" (i.e., not firm specific) time-series models have been hypothesized to be reasonable quarterly earnings forecasting models. Most of the quarterly earnings research has focused upon combinations of these three models and individual firm Box-Jenkins specifications. These three general models are those suggested in:

1) Griffin (1977) - Watts (1975);

2) Foster (1977); and

3) Brown and Rozeff (1978).

The above mentioned studies examine the forecasting ability of their respective general models compared with individual firm Box-Jenkins specifications. Later studies, such as Collins and Hopwood (1980), have attempted to provide evidence which differentiates between these general model's forecasting ability.

The quarterly earnings time-series studies all follow a similar methodology. Quarterly earnings per share is the earnings measure almost exclusively (one exception is Foster (1977) which analyzes sales and income). Several error metric measures have been used to judge the relative forecasting accuracy of these quarterly models. The most commonly used are the mean absolute percentage error and the mean squared percentage error. Short-term forecasts (one quarter ahead), medium-term forecasts (four quarters ahead), and long-term forecasts (eight quarters ahead) have become the common forecast horizons. In addition, many different types of tests of significance have been used to judge the relative forecasting accuracy of these models. While there are some contradictory findings, general conclusions emerge from these many similar studies.

First, the time and resources necessary to develop the individual firm Box-Jenkins models does not appear to be warranted. Forecasts developed by the general models prove to be as accurate as the individually specified models. Thus, the costly iterative process of individual firm specifications can be avoided. Not only is this a time consuming process, but extreme caution and knowledge is necessary when there are less than 50 observations used in model identification. With few observations, the ACF and PACF functions contain noise which makes their use more difficult. This finding is very important to the user group primarily interested in generating earnings forecasts.

Secondly, the Foster (1977) model does not contain a seasonal component which Lorek (1979), Brown and Rozeff (1978), and Collins and Hopwood (1980) have found to be important. The Foster model is a special case of the more general Brown and Rozeff (1978) specification which contains this seasonal component. Empirical results have shown that the Brown and Rozeff model yields better forecasts than the Foster model. Given this information, and the fact that the Foster model is not less difficult to use, the Brown and Rozeff model would appear to be preferred.[1]

Finally, there is no consensus in the choice between the Griffin-Watts and the Brown and Rozeff models. There is some evidence that the Griffin-Watts model is better for shorter forecast horizons, while the Brown and Rozeff model is more accurate for longer forecast horizons. However, this is far

1. Empirical studies such as Brown and Rozeff (1978), Brown and Rozeff (1979), and Collins and Hopwood (1980) lead to these general conclusions concerning these univariate time-series models.

from conclusive. All of this available research would indicate that both the Brown and Rozeff and the Griffin-Watts models should be estimated when generating univariate time-series forecasts of quarterly earnings per share. These two models are specified as follows:

Griffin-Watts Model:

$$(1-B)(1-B^4)X_t = (1-WB)(1-YB^4)Z_t$$

Brown and Rozeff Model:

$$(1-WB)(1-B^4)X_t = (1-YB^4)Z_t$$

where:

1) $X_t$ denotes quarterly earnings per share
2) $Z_t$ is a mean zero random process
3) B is the backshift operator on the time unit
4) W and Y are estimated parameters

The accounting earnings univariate time-series studies discussed to this point are concerned with identifying the statistical processes which generate the firm's earnings streams. The main approach used is to verify the selection of identified models by measuring forecast accuracy. These past studies are all similar in that they are concerned only with the statistical properties of accounting earnings. They do not investigate the firm properties or accounting treatments which cause the earnings to have certain statistical properties. Given certain firm properties, will a firm be easier or more difficult to forecast than a firm without such properties? The identification of such properties potentially can improve the overall forecasting of firm's accounting earnings or indicate when certain time-series models would be preferred.

## Homogeneous Groups and Earnings Forecasting

There have been a few studies examining the effect of partitioning the samples of firms used in earnings forecasting research into homogeneous groups based on some firm specific characteristics. After partitioning these stratified samples, they may be used to test when certain models may be more accurate, or, show when certain models are more appropriate. The idea of partitioning firms to be used to develop forecasts has been employed with success in past research.

The creation of homogeneous groups of firms before testing economic hypotheses has been proposed by Elton and Gruber (1970). They suggest three major reasons for grouping firms:

1) Isolation of units which should, for economic reasons, act similarly;

2) Ability to hold constant the effect of omitted variables; and

3) Identification of homogeneous relationships between the variables included in the model being designed and tested.

While all three of these factors affect the design of the current study, the first and third rationales seem most appropriate. The current study examines the affect of three financial-economic variables on earnings time-series prediction. To examine these relationships, homogeneous groups are formed based on the financial-economic factor analyzed. In this way, similar economic units are grouped by each factor to determine if different earnings time-series prediction can be achieved across these homogeneous groups. Thus, the possibility of a different relationship for each group is examined.

Elton and Gruber (1971) utilize this grouping methodology to examine earnings per share prediction. They select 23 accounting-type variables which are related to changes in earnings per share. These variables measure areas such as liquidity, growth rates, profitability, sources of funds, and uses of funds. After randomly selecting a large sample of firms, principal components analysis is used to identify homogeneous groups of firms based on these variables. This procedure groups firms with similar earnings growth patterns over time.

A cross-sectional step-wise regression model is used to develop earnings forecasts for these homogeneous groups. Elton and Gruber conclude that this grouping procedure produces better forecasts than grouping on the traditional Standard Industrial Classification (SIC) Codes. These group forecasts also compare favorably with analyst's forecasts. So that by grouping, relationships are identified for each group which lead to more accurate forecasts.

Two studies which examine the impact of economic factors on the univariate time-series behavior of earnings through the creation of homogeneous groups are conducted by Lev (1978 and 1983). Lev (1978) analyzes five variables for their impact on the univariate time-series behavior of earnings:

1) Size;

2) Rank within industry class;

3) Owner control;

4) Product type; and

5) Competition-barriers to entry.

After discussing the significance of these factors on earnings, Lev develops the measures used as surrogates for these factors. Lev's analysis divides the sample firms across one and sometimes two factors. The autocorrelations for earnings changes and/or return on equity (depending on the factor being analyzed) for one and two lags are computed. The number of significant autocorrelations is examined across these factors to determine if these factors appear to affect the number of significant autocorrelations found. In this way, Lev analyzes the ability of these factors to cause earnings to behave in systematic fashions. From this analysis Lev concludes that product type and competition-barriers to entry have a significant impact on the number of significant autocorrelations found.

Lev (1983) examines these same properties in a slightly different fashion. The factors examined are:

1) Product type;

2) Competition - barriers to entry;

3) Size; and

4) Capital intensity.

Lev's initial analysis uses these factors as independent variables in cross-sectional multiple regression tests. Six seperate dependent variables are used, first and second order autocorrelation coefficients for changes in earnings, changes in earnings/equity, and changes in sales. Lev finds that product type and competition-barriers to entry have a significant impact on all of the autocorrelations examined, while size and capital intensity do not.

Lev also wishes to examine the affect of these factors on earnings variability apart from their effect on autocorrelations. Lev uses both an AR(1) with a drift model and an AR(2) model as the changes in earnings and changes in earnings/equity generating processes. From these modeling processes, the residual standard deviations are computed. These residual standard deviations along with the standard deviations of the raw series serve as dependent variables. The previously discussed factors again serve as independent variables in cross-sectional multiple regression tests. Lev finds that size dominates the three regressions analyzing variability of earnings. When examining the variability of earnings/equity, product type and size are both significant.

## Summary

This review illustrates the general progression of the past univariate time-series accounting earnings research. This research initially used cross sectional analysis to validate the usefulness and appropriateness of this methodology's use with annual accounting earnings. Next, the focus moved to identification of specific models which are consistent with the observed annual and quartery earnings series behavior. While certain models have gained in popularity, no one model seems adequate for all observed earnings series.

Thus, the need to identify financial-economic factors which impact the types of series being observed appears to be warranted. This may indicate the circumstances under which these models are most appropriate and also identify specific cases when certain models are more accurate estimations of the series and when they are not.

Lev's examinations provide a sound basis for the current research. First, Lev provides some justification for two of the factors to be studied. However, Lev's analyses are conducted on annual earnings data, not on the series which contains more modeling information based on previous empirical work, quarterly earnings streams. Second, an obvious extention is to determine if the presence of these factors yields systematic differences in quarterly earnings forecast model accuracy. Extending this type of analysis to quarterly earnings univariate time-series based forecast accuracy, should provide information which is more useful to forecast generating users.

## Chapter Three

## Background and Development of Factors Examined

The current study examines the relationship between three firm specific factors and the ability of the Griffin-Watts and Brown-Rozeff quarterly earnings models to predict company earnings. The factors tested in this study are:

1) Industry Concentration;
2) Product Type; and
3) Diversification.

Firms with varying levels of each factor are examined to determine if the forecasting accuracy of time-series models is related to these factors. For example, does a firm from a highly concentrated industry have an earnings stream which can produuce more accurate time-series forecasts than a firm operating in a low concentration industry? Significant results from this study would indicate when these forecasting models can and cannot be used succesfully. Alternatively, results may show when greater confidence can be placed in the forecasts these models generate.

This research uses five separate forecast model estimation periods. These time periods are:

1) 1962 - 1974;
2) 1963 - 1975
3) 1964 - 1976
4) 1965 - 1977
5) 1966 - 1978

In developing the factor measurements used, these available forecast model estimation periods are taken into consideration.

The remainder of this chapter is devoted to more closely examining each of the factors used in this study. Past development of the factors and their anticipated impact on the present research is developed. The measurement of the three factors is also addressed.

## Industry Concentration

Industry concentration is a measure of the degree of competition within an industry. The degree of competition within an industry can impact not only prices but also the quantity of output from an industry. These points have been illustrated in various theoretical analyses in the fields of micro-economic and industrial organization. As the degree of competition within an industry changes, the firm's power within the industry changes as well. Every firm has some control over costs, so that as the firm's environment changes, the cost structures within the firm can be adjusted. However, the firm without market power can only adjust its cost structures, while the firm with market power is able to control both costs and revenues. This gives the firm with market power more control over earnings than an identical firm without market power.

The firm in a perfectly competitive industry faces a demand situation in which neither buyer or seller can control the market price. Since the market perceives the products of these many sellers as homogeneous, any attempt by a single seller to raise the price leads buyers to switch to another supplier. Likewise, the seller has no incentive to lower the price because he is able to sell all he wishes at the higher market clearing price. The firm in this industry is "purely" a price taker. It cannot affect market prices, and can operate at any level of output it chooses while still only earning a "normal" profit.

The firm which operates as a pure monopoly should behave quite differently from the perfectly competitive firm. If profit maximization is the firm's goal, the monopolist sets the price according to his marginal cost curve. The monopolist produces at that quantity which maximizes the "excess" profit which he can earn. However, firm goals may not always be met if this course of action is always followed. If profits remain too high for too long a period, competition from other industries or firms may develop. So that generating the maximum "excess" profit may not always be in the monopolists best interest. The important point is that the monopolist is free to set any price which is consistent with the firm's present goals. This is quite a different situation from that faced by the firm operating in a perfectly competitive industry.

The above examples illustrate the extremes in industry market power. In actuality these extremes are hard to find. Market power, the ability to set prices, should be used to the advantage of any firm with such power. If the firm's environment changes in the short-run, the firm with market power is able to adjust prices and costs so as to best meet firm goals. The firm without such power must adjust to these random shocks by adjusting only the cost structure. The degree of industry concentration is one indication of how much market power exists with the firms in the industry.

There are numerous studies which link firm profits and industry concentratiion. The general form of these studies is to correlate an industry concentration measure with a measure of firm profitability. These studies generally find a positive relationship between concentration measures and firm profitability. The exact form of the relationship (linear vs. non-linear) has not yet been established, however, the basic relationship has been tested quite extensively under many different assumptions.

Rhoades and Cleaver (1973) examine this relationship by associating price/cost margins and concentration. They associate four firm concentration ratios as well as dummy variables representing many different levels of concentration with price/cost margins. Their results show a positive relationship between these factors. At higher levels of concentration these findings are stronger than for lower levels of concentration. Kilpatrick (1976) correlates three measures of before tax profitability with concentration. He finds that correlations between these measures and concentration are all significant at the 95% level or higher. These studies report findings which are representative of the results of many others. Thus, the relationship between firm profits and industry concentration is well supported theoretically and empirically.

The measurement of industry concentration has also been extensively developed over the past 30 years. Many different types of measures have been developed and applied. Graphical presentations, summary statistics of graphical presentations, as well as ratios have all been suggested as possible summary statistics for quantifying industry concentration. In the industrial organization literature, the four and eight firm concentration ratios have been most popular.

The overall use of the four and eight firm concentration ratios is based primarily on certain empirical advantages. First, they are published for manufacturing firms in the Census of Manufacturers which is prepared by the Department of Commerce so that the individual user does not need to compute the measure with incomplete data. Secondly, they are of a form which leads to easy usage. Their interpretation is straight forward; the higher the ratio, the higher the industry concentration. N-firm concentration ratios are computed as follows:

$$\sum_{i=1}^{N} \frac{X_i}{T}$$

where:

1) $X_i$ is the firms measure of size;

2) T is the measure of size for the industry; and

3) N = 4, 8.

Many different measures of firm size have been examined. Assets, accounting income, accounting rates of return, sales, and value of shipments have all been used with similar empirical results.

This research uses both the four and eight firm concentration ratios. These measures should provide representative classifications of relative industry concentration. Previous research, such as Nelson (1963), Scherer (1980), Kilpatrick (1967), and Schmalensee (1977), demonstrates that the many different concentration measures are highly correlated. This implies that using the four and eight firm concentration ratios should not lead to classifications which differ significantly from those of other measures of industry concentration.

These reported ratios from the 1963, 1967, and 1972 Census of Manufacturers are used to classify 4 digit SIC manufacturing industries into high, medium, and low concentration groups. Manufacturing firms are the only firms used for two reasons. First, some broad industry classifications do not have the concentration ratios reported for them (mining). Secondly, reported concentration ratios on a national basis are not always an accurate description of the true market power setting (service industries).

The available manufacturing firms are classified into 4 digit SIC industries, so that they can then be placed into the appropriate (high, medium, or low) concentration group. Standard and Poor's Register of Corporations provides the SIC industry codes in which the firms are most active. The Register of Corporations is used to check each firm's industry classification for 1964, 1968, and 1973. These years are subsequent to the years used to obtain the measures of industry concentration. This allows the Register of Corporation to classify firms under the updated SIC codes which are used in the Census of Manufacturing the previous year. Also, this allows the researcher to properly identify the firm before conducting time-series analysis. Any SIC industry in which the available sample firms are classified provides one four and one eight firm concentration ratio. All of the four and eight firm concentration ratios represented in the sample of firms are ranked in descending order for 1963, 1967, and 1972. The highest 40% of the ratios are then classified as high concentration, the middle 20% as medium concentration, and the lowest 40% as low concentration. These percentages are used to achieve the desired number of sample firms. After this process is completed, there are two classifications for each industry (one four firm and one eight firm) for each of the three years of reported Census data.

Once the SIC codes have been classified as high, medium, or low, it is a relatively simple procedure to associate an individual firm with its SIC code concentration ranking. For each year of the Census reports, the classification of each firm's SIC code is made using both the four and eight firm concentration rankings. An example may be helpful at this point. In 1964 the Register of Corporations lists company A as being in industry xxxx. A ranking of the available 1963 Census of Manufacturers lists industry xxxx as low for both the four and eight firm concentration ratios. The 1968 industry for company A is reported as xyxy. When the industry rankings for 1967 are checked, xyxy is classified as low on concentration. If the same is true for the corresponding 1973 and 1972 data, company A is classified as a low concentration firm. For a firm to be classified in the low or high concentration groups, the following conditions must be met:

1) For any one year of Census concentration data, the firm must operate in a four digit SIC industry which is ranked as low or high for both the four and eight firm concentration ratios; and

2) For all three years of Census data, the firm must be consistently ranked as low or high. If for all three years the firm is ranked as low, it becomes a low concentration firm. The same follows for high concentration firms.

This classification scheme provides concentration groups (low and high) which should be substantially different. Not only are these groups quite different for any one year, this difference is sustained for all three Census years as well. These two groups should provide for a strong test of the ability of concentration to be a factor in describing time-series earnings forecasting accuracy.

Product Type

Much of the earlier work in macro-economic theory deals with the relationship between business cycles and the demand for durable and non-durable goods. Generally, purchases of non-durable goods have been found to be far less cyclical than durable goods purchases. It is the affect of this cyclical behavior in the purchases of durable goods which the current study examines in the context of the accuracy of earnings forecasting.

The use of this dichotimization in demand for durable and non-durable goods has occured mainly in macro-economic model building. Changes in the inventory stocks of durable goods has been used extensively as a general economy wide indicator. Zarnowitz (1962) reports on the association of the cyclical nature of durable goods purchases and the overall "health" of the economy.

Two more recent studies which illustrate the rational for the highly cyclical nature of the demand for durable goods are Smith (1962) and Darby (1972). Smith begins by focusing on the estimation of durable goods consumption. By building a simultaneous equations model which includes such variables as private consumption of durables, private consumption of non-durables, real per capita expected income, real per capita transitory income, as well as others, he finds that demand for durables is more closely related to transitory income than to permanent income. To further verify this result, he estimates the relationship between private consumption of durables and disposable income. This estimation finds little, if any, connection between these two variables.

Darby, using a similar methodology to Smith's, also finds that durable goods demand is related to transitory income. Darby's findings go one step further in stating that transitory income is used almost entirely to purchase durable goods. Darby also finds that consumption of non-durables is associated with permanent income. These findings lead to the conclusion that demand for non-durables will be more steady over time, while durables demand will exhibit a highly cyclic nature.

This cyclic demand for durables should lead to a very cyclical pattern in the earnings streams of durable goods producers and sellers. This cyclical behavior is not a predictable process, i.e., the occurence of the peaks and valleys in economic activity is quite stochastic. For example, Dauten and Valentine (1978) report that 28 business cycles have occurred between 1854 and 1975. They find that these cycles vary in length and that the contraction and expansion periods are not uniform. The following table gives an indication of this phenomenon:

Table 3-1
Business Cycles Length

| | Shortest Period | Longest Period | Average Period |
|---|---|---|---|
| Full Cycle | 28 Months | 117 Months | 52 Months |
| Expansion Periods | 10 Months | 106 Months | 33 Months |
| Contraction Periods | 7 Months | 65 Months | 17 Months |

Time-series modeling of the durable earnings streams should be much more difficult than modeling the smoother, less stochastic, earnings streams produced by non-durable firms. It is this relationship which is tested.

To test the hypothesis that non-durable firm's earnings streams are more easily forecasted than their durable firm counterparts, the sample is divided into a durable group and a non-durable group. As in the case of industry concentration, as "clean" a dichotimization as is possible is desirable. To rank firms, many of which are quite diversified, along the spectrum of entirely durable to entirely non-durable is quite difficult. Therefore, the major task is to produce a substantial number of firms in each category without clouding the sample with firms difficult to classify.

The Bureau of Labor Statistics provides a durable vs. non-durable classification scheme which is used. This scheme classifies manufacturing two digit SIC codes as durable or non-durable. As before, the SIC codes are provided in the Standard and Poor's Register of Corporations. The Register provides a comprehensive list of all four digit SIC code classifications in which each firm is actively involved.

All manufacturing firms in the initial sample will be checked for all years 1962-1978 (a total of 17 years) in the Register of Corporations. Each firm is analyzed to determine if it is involved in durable or non-durable product markets. For a firm to be included in either the durable or non-durable group, the firm must have all disclosed industry codes for one of the 13 consecutive years used in model estimation as either durable or non-durable. Any firm with even one nonmatching code is eliminated. This elimination process is followed for each of the five estimation periods.

This sample selection procedure should yield two homogeneous groups of firms, while eliminating any firm for which classification would be the least bit ambiguous. This sample selection process should provide a strong test of the desired hypothesis.

## Diversification

Diversification is a concept that has been fully developed in the fields of security analysis and portfolio formation. Simply stated, diversification is a process by which unsystematic variance (risk) is removed from security returns by the formation of portfolios of securities. This concept is useful in describing why firms may be active in more than one market setting.

The security analysis area has focused upon the mean and variance of returns in pricing investments. Each security, given an expected return (mean) has an appropriate amount risk (variance). Total risk is composed of two seperate components: 1) systematic risk and 2) unsystematic risk. Through diversification, unsystematic risk can be virtually eliminated.

While portfolio theory initially stated that diversification could be best carried out by the investor, this contention was based on the assumption of no transactions costs. If transactions costs are included, then diversification may be best (less costly) achieved by the firm, not each individual investor. So that from the investor's standpoint, diversification within the firm may be the preferred method of diversifying risk.

Diversification within the firm may also lead to a favorable outcome from management's view. By diversifying its internal investments, the firm may also be eliminating unsystematic variation from its earnings stream. This process may take two or more uncorrelated earnings streams, which by themselves are highly variable and/or cyclic, but, when combined produce an earnings stream which is much more stable and predictable. The managers of the firm may also benefit from diversifying their earnings stream. By diversifying the firm's earnings' stream, the managers reduce the risk of very bad poor years making them appear to be inadequate managers of the firm's assets. Thus, diversification of the earnings stream of the firm provides a needed function to the owners and may be beneficial to the managers as well.

In the accounting discipline, diversification typically is measured more simplistically than in finance. As discussed above, finance places more emphasis on the correlation between the cash flow streams of two assets in measuring diversification. The accounting discipline, in describing diversification within the firm, looks more towards the class of customer that is served. If two different sets of customers are serviced by the firm, then the firm would be comprised of two industry segments. In determining the number of segments within the firm, the correlation between segment income (or sales) is not considered.

Both of these measurement approaches have appeal for the current research. Classifying company A (servicing four different classes of customers) as more diversified than company B (servicing two classes of customers) appears to be the proper classification. However, if the earnings generated by the four segments in company A are highly correlated, while company B's segments' earnings are negatively correlated, simply using the number of segments to determine diversification may lead to an improper classification. The problem becomes one of selecting a procedure by which attributes of both of these approaches can be incorporated in classifying the sample firms as highly diversified or not diversified.

Barnea and Logue (1973) find that the measurement of diversification is a somewhat arbitrary process. They find that deciding which units within the firm to count or correlate cannot be done objectively. They propose the use of the market model (Sharpe (1963)) as a method of determining the degree of diversification. The market model is specified as:

$$\tilde{R}_{it} = a_i + b_i\tilde{R}_{mt} + e_{it}$$

where:

1) $\tilde{R}_{it}$ is the return on the individual asset i;
2) $\tilde{R}_{mt}$ is the return on the market portfolio;
3) $a_i$ and $b_i$ are estimated regression coefficients; and
4) $e_{it}$ is the error term.

Barnea and Logue examine this relationship in the following fashion. The market return ($\tilde{R}_{mt}$), as proposed in theory, contains all possible investment oppurtunities, therefore, it is the benchmark by which diversification is measured. The market model relates $\tilde{R}_{it}$ (the return on the individual investment) to $\tilde{R}_{mt}$ and this relationship can be used to determine the degree of diversification in $\tilde{R}_{it}$. The more diversified $\tilde{R}_{it}$ becomes the higher the correlation between it and $\tilde{R}_{mt}$. The measure of diversification is the coefficient of determination ($R^2$). The higher the value of $R^2$, the more diversified the firm.

Amihud and Lev (1981) utilize this approach to diversification proposed by Barnea and Logue. However, they replace stock returns with an accounting measure of rate of return (income/equity). While Amihud and Lev do not provide any defense for this substitution, one explanation is the following. The objective is to measure diversification within the firm. Managers are interested in diversifying the firm's investments (segments or units) in a manner similar to the diversification problem faced by the investor. This diversification of earnings reduces the risk associated with the manager's position. So that the substitution of earnings for returns would seem to be an appropriate procedure.

For the purposes of the current study, examining the effect of diversification on earnings forecastability, the Amihud and Lev procedure for measuring diversification has appeal. The resulting $R^2$ from the estimation of the market model using an accounting rate of return variable is used to measure each firm's diversification. Because of the great divergence in the types of firms this study employs, the sample firms have quite diverse capital structures. In order to minimize any leverage effect, a more standard variable across the sample than equity is preferred. An earnings/total assets standardization is used to yield the accounting rate of return measure that is used. Firms with a higher $R^2$ are considered more diversified than firms with a lower $R^2$.

One potential problem in the application of the market model is that of stationarity. The resulting $b_i$, from the estimation of the market model, has been shown to vary greatly depending on the periods used in estimation (Blume (1975), Bogue (1972), and Gonedes (1973)). To reduce the possibility that this measurement of diversification is affected by this problem, five different time periods are examined. These time periods coincide with the years used to estimate the univariate time-series models. These time periods are:

1) 1962-1973
2) 1963-1974
3) 1964-1975
4) 1965-1976
5) 1966-1977

For each of the time periods, the sample firms are rated as high, medium, or low on the diversification factor, $R^2$. This rating is achieved by dividing the rankings of $R^2$s into three equal portions. The firms which rank as low or high for the diversification factor in for any of these time periods, are then used in the low or high diversification group for that period's forecasts.

## Summary

This chapter discusses the three factors which are examined in this research. These factors are being used to determine if time-series forecasts of earnings vary in accuracy depending upon attributes of the firms being forecasted. This chapter has hypothesized that forecasts should be more accurate when:

1) Forecasts are made for firms from highly concentrated industries versus firms from industries of lower concentration;

2) The firm being forecasted operates in a non-durable industry versus the firm from a durable industry; and

3) A diversified firm is forecasted rather than a non-diversified firm.

The next chapter explains the methodology which this study utilizes to test the hypothesized relationships.

# Chapter Four

## Methodology

This research examines three factors; industry concentration, product type, and diversification, for their ability to affect the predictability of a firm's earnings stream. These three factors are hypothesized to affect the accuracy of time-series forecasts. The previously stated hypotheses are:

1) Earnings of firms in high concentration industries are more accurately forecasted than earnings of firms in low concentration industries.

2) Earnings of firms in non-durable product industries are more easily forecasted than earnings of firms in durable product industries.

3) The more highly diversified the firm, the more accurate the univariate time-series forecasts of earnings will be.

In order to examine each of these hypotheses, tests for differences in forecast accuracy are performed. These tests examine the forecast accuracy between two groups of firms. The groups used differ along each of the factors examined. This design begins with by identifying two separate groups of firms for each hypothesis. After forecasts for the firms in each of the groups are made and accuracy measures computed, these measures are then used to determine if the two groups have accuracy measures which are statistically different.

Sample Description

The first step in testing the desired hypotheses is to obtain a universe of firms meeting certain data restrictions from which samples of firms can be identified as fitting into one of the two groups being used for each of the factors examined. Once the firms for each group are determined, the earnings series of these firms are used to develop univariate time-series forecasts. A 225 firm universe is secured by identifying firms which meet the following data qualifications:

1) All firms are listed on the New York Stock Exchange;
2) All firms have a December fiscal year closing;
3) Quarterly earnings are available from first quarter of 1962 through fourth quarter of 1980; and
4) None of the sample firms are classified by Standard and Poors as utility firms.[1]

The firms' quarterly earnings are obtained from three separate sources. First, quarterly earnings for 1972 through 1980 are obtained from the Compustat Quarterly Industrial Tapes. Quarterly earnings for 1962 through 1971 are converted from the Compustat Prices-Dividends-Earnings Tapes. An attempt is made to find any missing information from the quarterly earnings published in the Value Line Investment Services Report.

Using the factor measurement methods discussed in chapter three, the firms in the universe are rated on each of the factor scales. Once this is done, two groups of firms are identified for each factor. These groups contain firms with

1. This is done to eliminate firms whose earnings are regulated by government agencies.

extreme scale measures in order to gaurantee that the two groups of firms are different for each of the factors.

## Results of Factor Measurement

As discussed in chapter three, ideas developed in the portfolio theory area of the finance literature are used to measure diversification. The market model is estimated using 13 years of annual earnings. These years coincide with the 13 years of quarterly earnings values used to estimate the time-series models. For the five test periods used, these measurements are rolled forward one year at a time. The $R^2$s of each model estimation is then used as the measure of diversification. In order to be classified as highly diversified, the firm's $R^2$ must be in the upper 20% of all 225 sample firms in a given test period. To be classified as low, the bottom 20% is used. The following numbers of firms are classified as high and low for each test period:[2]

Table 4-1
Numbers of Firms Used for Diversification

| Periods | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| High Firms | 44 | 46 | 43 | 43 | 45 |
| Low Firms | 47 | 44 | 45 | 45 | 45 |

The concentration factor is measured using both the four and eight firm concentration ratios published in the Census of Manufacturing. For a firm to be a high concentration firm, the

2. These numbers are not always 45 (20% of 225) because of rounding. The number was kept as close as possible to 45.

four and eight firm concentration ratios must both be in the upper 40% for all three of the sample years (1964, 1968, and 1973) in which these concentration measures are available.[3] The same is true for the low concentration firms; they must rank in the lowest 40%. The firms in each group are identical for all five test periods. This process leads to 45 firms identified as high concentration firms and 43 firms as low concentration firms.

The product type factor uses each firm's Standard Industrial Classification (SIC) Codes as published by Standard and Poors. If all of the product market codes for a firm are durable in each of the 13 years used to estimate the time-series models, then the firm becomes durable for that test period. On the other hand, if all of a firm's product codes are non-durable, then the firm joins the non-durable group. If for any one year the firm has a mix of durable and non-durable codes, then the firm is not considered either a durable or a non-durable firm. This classification scheme, while allowing for different firms in each test period, did not result in any firms entering or leaving the groups after the initial test period. The total firms classified as durable and non-durable are 41 and 39 respectively.

In order to insure that any significant differences found for these factors are not forecast specific, three seperate forecast horizons are employed. One, four, and eight quarters

3. The census data of 1977 would not have been available before the 1978 forecast date, and so it is not used.

ahead are utilized to simulate short-term, medium-term, and long-term forecasts. The following table defines the test periods to be examined:

Table 4-2
Test Periods Examined

| Test Period | Years Used To Estimate Time-Series Models | Forecasts Made |
|---|---|---|
| 1 | 1962-1974 | 1st and 4th qtr. 1975<br>4th qtr. 1976 |
| 2 | 1963-1975 | 1st and 4th qtr. 1976<br>4th qtr. 1977 |
| 3 | 1964-1976 | 1st and 4th qtr. 1977<br>4th qtr. 1978 |
| 4 | 1965-1977 | 1st and 4th qtr. 1978<br>4th qtr. 1979 |
| 5 | 1966-1978 | 1st and 4th qtr. 1979<br>4th qtr. 1980 |

Following the selection of the firms to be used in the six groups, two univariate time-series models (Griffin-Watts and Brown and Rozeff) are estimated for each of the five test periods. Absolute percentage errors (APEs) are computed for each forecast made.[4] For each of the two time-series models used to generate forecasts, there are three different forecasting horizons used (one, four, and eight quarters ahead).

This results in 30 (three forecast horizons times two models times five forecast dates) individual difference tests for each factor examined. These 30 tests are broken down as follows:

4. Mean square percentage errors were also analyzed. The results were similar to those with absolute percentage errors. Throughout the remaining chapters, absolute percentage errors are employed.

Table 4-3
Tests to be Done

| Forecast Horizons | Brown and Rozeff Model | Griffin-Watts Model |
|---|---|---|
| One Quarter Ahead | 5 Difference Tests | 5 Difference Tests |
| Four Quarter Ahead | 5 Difference Tests | 5 Difference Tests |
| Eight Quarter Ahead | 5 Difference Tests | 5 Difference Tests |

These test procedures provide for an analysis of the factors' effect over time, with different forecast horizons, as well as across the two forecast models. The following tables illustrate the groupings and tests which are conducted for each of the univariate time-series models and each forecast horizon:

Table 4-4
Numbers of Firms and Groupings of Firms

High versus Low Diversification

| Periods | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| High | 44 APEs | 46 APEs | 43 APEs | 43 APEs | 45 APEs |
| | versus | versus | versus | versus | versus |
| Low | 47 APEs | 44 APEs | 45 APEs | 45 APEs | 45 APEs |

High versus Low Concentration

| Periods | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| High | 45 APEs | 45 APEs | 45 APEs | 45 APEs | 45 APEs |
| | versus | versus | versus | versus | versus |
| Low | 43 APEs | 43 APEs | 43 APEs | 43 APEs | 43 APEs |

Durable versus Non-Durable

| Periods | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Durable | 41 APEs | 41 APEs | 41 APEs | 41 APEs | 41 APEs |
| | versus | versus | versus | versus | versus |
| Non-Dur. | 39 APEs | 39 APEs | 39 APEs | 39 APEs | 39 APEs |

Test Used

The test used for each of these test groups is a two population z-test. This test examines the two groups for a significant difference in the means of the two groups' observations. The observations used are the APEs for each of the forecasted values.

The two population z-test is developed as a test of the two population means. The following notation is used to develop and explain the z-test:

$U_a$ = Mean of Sample Group A;

$U_b$ = Mean of Sample Group B;

$S_a$ = Standard Deviation of Sample Group A;

$S_b$ = Standard Deviation of Sample Group B;

$N_a$ = Number of Observations in Sample Group A; and

$N_b$ = Number of Observations in Sample Group B.

The z-test examines the two means for a significant difference in their values. This test can be formalized by setting:

$$D = U_a - U_b$$

The test compares D to a critical value, $D^*$. $D^*$ is computed as:

$$D^* = Z_d \left[ \frac{S_a{}^2}{N_a} + \frac{S_b{}^2}{N_b} \right]^{\frac{1}{2}}$$

where $Z_d$ is the critical region used under the normal curve given a significance level of d. If the observations in group A are hypothesized to be greater than those in group B, then the accept/reject decision is decided as,

$$H_o : D > D^*$$

and

$$H_1 : D \leqslant D^*.$$

In designing the testing methodology to be used in this study, three alternatives could be used:

1. Multivariate Tests;
2. Univariate Tests; and
3. Nonparametric Tests.

In determining the best alternative certain constraints have to be considered. In other types of accounting-finance related market based research, the number of firms that can be used is limited by the number of firms for which data is available on the Compustat or CRSP Tapes. In selecting a time-series modeling methodology, the data availability problem becomes more severe. By using quarterly earnings it becomes necessary for all firms to provide quarterly earnings at approximately the same point in time. This means that firms should have the same fiscal year closing so that each quarterly earnings observation represents the same quarter following closing for all firms used to insure that comparisons remain on equal terms.

Another concern in using the time-series forecasting approach is the quantity of data needed to estimate the models. The 52 observations which this study uses is considered sufficient to insure accuracy in estimating the parameters the models use to generate forecasts. Using 5 test periods and allowing for reestimation of the models for each test period, the number of firms available for the tests are reduced drastically as compared to other accounting-finance related research.

Starting from a reduced universe position, because of the time-series methodology, the partitioning of the available firms for each factor magnifies this small universe condition. The use of a multivariate test would require that all firms used receive a value for each factor tested. With only a total sample of 225 firms, the likelihood that these firms could all be used for each factor is small. With the univariate z-test groups, approximately 80 firms out of the total 225 are useable for each factor's test. If identical firms were required across all three factors, the total number of firms used would be reduced significantly. With these data availability problems the use of a univariate test seems appropriate.

Working within these data availability constraints, the most powerful test available is the univariate z-test. As long as the samples used meet the normality assumption on which this test is based, the z-test is a more powerful test than any nonparametric test that might be used. To insure a powerful test of the differences stated in the hypotheses, the z-test is preferred. The z-test allows for larger samples than would a multivariate test making it a more powerful test. In comparison to nonparametric alternatives, if the normality assumption is met, the z-test is again the more powerful test. The z-test for differences in group means appears to be the best of the available testing methodologies.

## Summary

This chapter has had two primary purposes. First, the results of the factor grouping procedures are reported. Secondly, the univariate test to be used to test this study's hypotheses has been developed and explained. The test this research uses, the z-test, is a univariate two population test. The use of this test versus a multivariate test or a nonparametric test is based upon the data availability problem as well as the desire to use the most powerful design and test. Chapter five presents the results of the z-tests for each factor's impact on predictive ability.

# Chapter Five

# Results of Data Analysis

This chapter reports the results of the data analysis described in chapter 4. This report is contained in three separate sections coinciding with the three factors examined. Before turning to the analysis of forecast accuracy, an investigation of the appropriateness of the significance test employed in this thesis is conducted. The primary assumption which is made when using the z-test methodology is that the populations be normally distributed. The appropriateness of this assumption is examined for each of the samples used, and the results of this analysis are first reported.

## Normality Tests

The principle assumption in using the parametric z-test methodology is that the samples are drawn from normal populations. The variable being used in this analysis is the absolute percentage error (APEs) of the time-series forecasts. This error measure, as well as a squared percentage error, is a proportional measure. This has the advantage of weighting the errors for the actual earnings encountered. If, however, the actual earnings for any given period becomes particularly small, the error measure becomes excessively large. This would imply a "fat-tailed" or skewed distribution relative to the normal. As these errors become larger, they become less interpretable. Because of this interpretation difficulty, past time-series research has truncated these percentage errors to 100% of actual earnings (see Brown and Rozeff (1979)).

In examining the normality assumption, the APEs are examined with and without this truncation. The test used to examine the normality assumption is the studentized range test described by Fama (1976). The studentized range statistic (SR) is computed as follows:

$$SR = \frac{Max(X_i) - Min(X_i)}{s(X)}$$

where:

$X_i$ = observation from sample and

$s(X)$ = sample standard deviation of $(X)$

The SR value is then compared to a critical value to determine the acceptance or rejection of the normality assumption.

The assumption of normality is accepted in an overwhelming number of instances when using the truncated APEs. When using the untruncated values, the samples are accepted as normal in approximately 65% of the cases. The major result of the truncation of the APEs is to take slightly skewed distributions and to normalize them somewhat. The following tables specify the number of errors which are truncated in each case, as well as the samples which remain non-normal after truncating.

Table 5-1
Number of Truncated Errors
Griffin-Watts Model

| Periods | 1 | 2 | 3 | 4 | 5 | Concen. Avgs. |
|---|---|---|---|---|---|---|
| One Quarter Ahead Forecasts: | | | | | | |
| High Concentration Firms | 12 | 3 | 0 | 5 | 2 | 4.4 |
| Low Concentration Firms | 9 | 1 | 1 | 3 | 3 | 3.4 |
| Period Averages | 10.5 | 2 | .5 | 4 | 2.5 | |
| Four Quarter Ahead Forecasts: | | | | | | |
| High Concentration Firms | 7 | 2 | 4 | 5 | 4 | 4.4 |
| Low Concentration Firms | 7 | 6 | 3 | 6 | 5 | 5.4 |
| Period Averages | 7 | 4 | 3.5 | 5.5 | 4.5 | |
| Eight Quarter Ahead Forecasts: | | | | | | |
| High Concentration Firms | 9 | 6 | 5 | 4 | 3 | 5.4 |
| Low Concentration Firms | 10 | 7 | 5 | 5 | 7 | 6.8 |
| Period Averages | 9.5 | 7.5 | 5 | 4.5 | 5 | |

Table 5-2
Number of Truncated Errors
Brown and Rozeff Model

| Periods | 1 | 2 | 3 | 4 | 5 | Concen. Avgs. |
|---|---|---|---|---|---|---|
| One Quarter Ahead Forecasts: | | | | | | |
| High Concentration Firms | 9 | 1* | 0 | 5 | 3* | 3.6 |
| Low Concentration Firms | 8 | 0* | 2 | 2 | 3* | 3 |
| Period Averages | 8.5 | .5 | 1 | 3.5 | 3 | |
| Four Quarter Ahead Forecasts: | | | | | | |
| High Concentration Firms | 5 | 1 | 3 | 4 | 6 | 3.8 |
| Low Concentration Firms | 3 | 4 | 6 | 3 | 4 | 4 |
| Period Averages | 4 | 2.5 | 4.5 | 3.5 | 5 | |
| Eight Quarter Ahead Forecasts: | | | | | | |
| High Concentration Firms | 2 | 3 | 4 | 2 | 5 | 3.2 |
| Low Concentration Firms | 5 | 5 | 4 | 3 | 5 | 4.4 |
| Period Averages | 3.5 | 4 | 4 | 2.5 | 5 | |

* signifies a non-normal sample

Table 5-3
Number of Truncated Errors
Griffin-Watts Model

| Periods | 1 | 2 | 3 | 4 | 5 | Div. Avgs. |
|---|---|---|---|---|---|---|
| One Quarter Ahead Forecasts: | | | | | | |
| High Diversification Firms | 4 | 2 | 1 | 6 | 2 | 3 |
| Low Diversification Firms | 8 | 5 | 5 | 7 | 3 | 5.6 |
| Period Averages | 6 | 3.5 | 3 | 6.5 | 2.5 | |
| Four Quarter Ahead Forecasts: | | | | | | |
| High Diversification Firms | 7 | 3 | 3 | 1 | 1 | 3 |
| Low Diversification Firms | 8 | 5 | 1 | 5 | 4 | 4.6 |
| Period Averages | 7.5 | 4 | 2 | 3 | 2.5 | |
| Eight Quarter Ahead Forecasts: | | | | | | |
| High Diversification Firms | 8 | 7 | 2 | 4 | 2 | 4.6 |
| Low Diversification Firms | 8 | 10 | 2 | 4 | 7 | 6.2 |
| Period Averages | 8 | 8.5 | 2 | 4 | 4.5 | |

Table 5-4
Number of Truncated Errors
Brown and Rozeff Model

| Periods | 1 | 2 | 3 | 4 | 5 | Div. Avgs. |
|---|---|---|---|---|---|---|
| One Quarter Ahead Forecasts: | | | | | | |
| High Diversification Firms | 3 | 1 | 2 | 4 | 1 | 2.2 |
| Low Diversification Firms | 9 | 4 | 4 | 6 | 4 | 5.4 |
| Period Averages | 6 | 2.5 | 3 | 5 | 2.5 | |
| Four Quarter Ahead Forecasts: | | | | | | |
| High Diversification Firms | 1 | 2 | 5 | 2 | 4 | 2.8 |
| Low Diversification Firms | 5 | 3 | 3 | 2 | 5 | 3.6 |
| Period Averages | 3 | 2.5 | 4 | 2 | 4.5 | |
| Eight Quarter Ahead Forecasts: | | | | | | |
| High Diversification Firms | 2 | 6 | 1* | 2 | 2 | 2.6 |
| Low Diversification Firms | 4 | 6 | 1 | 3 | 7 | 4.2 |
| Period Averages | 3 | 6 | 1 | 2.5 | 4.5 | |

* signifies a non-normal sample

Table 5-5
Number of Truncated Errors
Griffin-Watts Model

| Periods | 1 | 2 | 3 | 4 | 5 | Product Type Avgs. |
|---|---|---|---|---|---|---|
| One Quarter Ahead Forecasts: | | | | | | |
| Non-Durable Firms | 8 | 2 | 0* | 4 | 5 | 3.8 |
| Durable Firms | 7 | 4 | 6 | 7 | 3 | 5.4 |
| Period Averages | 7.5 | 3 | 3 | 5.5 | 4 | |
| Four Quarter Ahead Forecasts: | | | | | | |
| Non-Durable Firms | 4 | 5 | 3 | 7 | 6 | 5 |
| Durable Firms | 9 | 5 | 4 | 2 | 5 | 5 |
| Period Averages | 6.5 | 5 | 3.5 | 4.5 | 5.5 | |
| Eight Quarter Ahead Forecasts: | | | | | | |
| Non-Durable Firms | 9 | 5 | 6 | 2 | 6 | 5.6 |
| Durable Firms | 13 | 7 | 2 | 5 | 5 | 6.4 |
| Period Averages | 11 | 6 | 4 | 3.5 | 5.5 | |

Table 5-6
Number of Truncated Errors
Brown and Rozeff Model

| Periods | 1 | 2 | 3 | 4 | 5 | Product Type Avgs. |
|---|---|---|---|---|---|---|
| One Quarter Ahead Forecasts: | | | | | | |
| Non-Durable Firms | 10 | 1 | 0 | 3 | 4 | 3.6 |
| Durable Firms | 7 | 2 | 7 | 7 | 3 | 5.2 |
| Period Averages | 8.5 | 1.5 | 3.5 | 5 | 3.5 | |
| Four Quarter Ahead Forecasts: | | | | | | |
| Non-Durable Firms | 3 | 5 | 4 | 5 | 5 | 4.4 |
| Durable Firms | 4 | 2 | 4 | 0 | 4 | 2.8 |
| Period Averages | 3.5 | 3.5 | 4 | 2.5 | 4.5 | |
| Eight Quarter Ahead Forecasts: | | | | | | |
| Non-Durable Firms | 5 | 3 | 6 | 2 | 4 | 4 |
| Durable Firms | 6 | 4 | 1 | 3 | 3 | 3.4 |
| Period Averages | 5.5 | 3.5 | 3.5 | 2.5 | 3.5 | |

* signifies a non-normal sample

With 120 different samples tested for normality using a 5% level of significance, the four samples which did not meet the necessary test statistic to be classified as normal are not much different from the six expected to be rejected by chance. The number of truncated errors for each of the samples generally is very random. The exception to this statement is period one for the concentration factor. This one period appears to contain a few more truncated errors than the remaining four periods. This behavior, the randomness of the truncated errors, as well as the relative percentages found are similar to those encountered by Brown and Rozeff (1979). The remaining analysis is carried out with the truncated values.

## Concentration

The hypothesized relationship between concentration level and univariate time-series earnings forecast accuracy, as stated previously, is that as the level of industry concentration increases so should forecast accuracy. Tables 5-7 through 5-12 report the mean APEs for the two groups, high and low concentration for the different time periods, models, and forecast horizons studied.

Table 5-7
Mean Absolute Percentage Errors
Griffin-Watts Model
One Quarter Ahead

| Periods | 1 | 2[b] | 3 | 4[c] | 5 |
|---|---|---|---|---|---|
| High Concentration Firms | .4598 | .2844 | .2552 | .2784 | .2277 |
| Low Concentration Firms | .4017 | .1930 | .1975 | .1909 | .2277 |

b - significant at 5% level
c - significant at 10% level

Table 5-8
Mean Absolute Percentage Errors
Griffin-Watts Model
Four Quarter Ahead

| Periods | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| High Concentration Firms | .4175 | .3857 | .3051 | .3233 | .3200 |
| Low Concentration Firms | .4062 | .4080 | .2476 | .2969 | .2778 |

Table 5-9
Mean Absolute Percentage Errors
Griffin-Watts Model
Eight Quarter Ahead

| Periods | 1 | 2 | 3[b] | 4 | 5 |
|---|---|---|---|---|---|
| High Concentration Firms | .5195 | .3999 | .4285 | .3634 | .3868 |
| Low Concentration Firms | .5062 | .3891 | .3192 | .3247 | .2954 |

b - significant at 5% level

Table 5-10
Mean Absolute percentage Errors
Brown and Rozeff Model
One Quarter Ahead

| Periods | 1 | 2[a] | 3 | 4[c] | 5 |
|---|---|---|---|---|---|
| High Concentration Firms | .4116 | .3120 | .2222 | .2714 | .2409 |
| Low Concentration Firms | .3580 | .1941 | .2077 | .1820 | .2250 |

a - significant at 1% level
c - significant at 10% level

Table 5-11
Mean Absolute Percentage Errors
Brown and Rozeff Model
Four Quarter Ahead

| Periods | 1 | 2 | 3 | 4[c] | 5 |
|---|---|---|---|---|---|
| High Concentration Firms | .3891 | .3718 | .3100 | .3595 | .3501 |
| Low Concentration Firms | .3267 | .3746 | .3264 | .2896 | .2980 |

c - significant at 10% level

Table 5-12
Mean Absolute Percentage Errors
Brown and Rozeff Model
Eight Quarter Ahead

| Periods | 1 | 2 | 3[c] | 4 | 5 |
|---|---|---|---|---|---|
| High Concentration Firms | .4267 | .3975 | .4532 | .4122 | .4026 |
| Low Concentration Firms | .4697 | .4020 | .3659 | .3618 | .3321 |

c - significant at 10% level

The obvious result is that for both univariate time-series models, the direction of an affect by concentration appears to be the opposite of the hypothesized affect. This is evident by the fact that in 25 out of 30 cases the low concentration firms have lower mean APEs than the high concentration firms. All of the significant differences are found when low concentration firms exhibit lower mean APEs than do their high concentration counterparts. The number of significant differences (3 out of 30 at the 1% or 5% level of significance) would lead to a conclusion that there is no real difference in forecast accuracy due to an industry concentration effect.

Diversification

With the diversification factor, firms which are more diversified are hypothesized to produce more accurate earnings forecasts. Tables 5-13 through 5-18 report the mean APEs for the high and low diversification groups.

Table 5-13
Mean Absolute Percentage Errors
Griffin-Watts Model
One Quarter Ahead

| Periods | 1 | 2[c] | 3 | 4 | 5 |
|---|---|---|---|---|---|
| High Diversification Firms | .3383 | .2119 | .2502 | .2620 | .1952 |
| Low Diversification Firms | .3589 | .2960 | .2919 | .3007 | .2250 |

c - significant at 10% level

Table 5-14
Mean Absolute Percentage Errors
Griffin-Watts Model
Four Quarter Ahead

| Periods | 1 | 2 | 3 | 4[c] | 5 |
|---|---|---|---|---|---|
| High Diversification Firms | .3424 | .3346 | .2739 | .2246 | .2482 |
| Low Diversification Firms | .3631 | .4176 | .2377 | .2986 | .2985 |

c - significant at 10% level

Table 5-15
Mean Absolute Percentage Errors
Griffin-Watts Model
Eight Quarter Ahead

| Periods | 1 | 2[c] | 3[b] | 4 | 5 |
|---|---|---|---|---|---|
| High Diversification Firms | .4682 | .3434 | .3645 | .3247 | .3081 |
| Low Diversification Firms | .4406 | .4426 | .2590 | .3666 | .3694 |

b - significant at 5% level
c - significant at 10% level

Table 5-16
Mean Absolute Percentage Errors
Brown and Rozeff Model
One Quarter Ahead

| Periods | 1 | 2[b] | 3 | 4 | 5 |
|---|---|---|---|---|---|
| High Diversification Firms | .3164 | .2162 | .2210 | .2376 | .1939 |
| Low Diversification Firms | .3624 | .3310 | .2878 | .3088 | .2572 |

b - significant at 5% level

Table 5-17
Mean Absolute Percentage Errors
Brown and Rozeff Model
Four Quarter Ahead

| Periods | 1 | 2[c] | 3 | 4 | 5[c] |
|---|---|---|---|---|---|
| High Diversification Firms | .2999 | .2908 | .3169 | .2796 | .2554 |
| Low Diversification Firms | .3552 | .3738 | .2716 | .3016 | .3358 |

c - significant at 10% level

Table 5-18
Mean Absolute Percentage Errors
Brown and Rozeff Model
Eight Quarter Ahead

| Periods | 1 | 2 | 3 | 4[c] | 5 |
|---|---|---|---|---|---|
| High Diversification Firms | .4171 | .3721 | .3909 | .3281 | .3025 |
| Low Diversification Firms | .3572 | .4350 | .3464 | .4119 | .3621 |

c - significant at 10% level

With the diversification factor, the direction of the affect on forecast accuracy is generally as hypothesized. The highly diversified firms produce more accurate forecasts than do the less diversified firms. As the forecast horizon increases, this relationship weakens. With both time-series models, the number of periods which produce significantly lower mean APEs for high diversification firms starts at five for one quarter ahead forecasts, reduces to four for forecasts four quarter ahead, and finally down to three for eight quarter ahead forecasts. With only one exception, the significant differences appear for the mean APEs where the high diversification firms produce more accurate forecasts. Of the two differences that are significant at the 5% level, one appears when the high diversification firms have lower mean APEs and one when the low diversification firms have lower mean APEs. Again, the overall lack of significant differences hinders a conclusion that the diversification factor affects the forecastability of earnings.

Product Type

The product type factor was hypothesized to produce more accurate forecasts when examining firms in non-durable product markets versus forecasts generated for firms in durable product markets. Tables 5-19 through 5-24 report the mean APEs for the durable versus non-durable comparisons.

Table 5-19
Mean Absolute Percentage Errors
Griffin-Watts Model
One Quarter Ahead

| Periods | 1 | 2[b] | 3[a] | 4 | 5 |
|---|---|---|---|---|---|
| Non-Durable Firms | .4225 | .1936 | .1771 | .2760 | .2959 |
| Durable Firms | .4341 | .3273 | .3246 | .3175 | .2851 |

a - significant at 1% level
b - significant at 5% level

Table 5-20
Mean Absolute Percentage Errors
Griffin-Watts Model
Four Quarter Ahead

| Periods | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Non-Durable Firms | .3776 | .3570 | .2579 | .3339 | .3036 |
| Durable Firms | .4745 | .3920 | .2917 | .2874 | .3240 |

Table 5-21
Mean Absolute Percentage Errors
Griffin-Watts Model
Eight Quarter Ahead

| Periods | 1[c] | 2 | 3 | 4 | 5[b] |
|---|---|---|---|---|---|
| Non-Durable Firms | .4800 | .3555 | .3882 | .2995 | .2865 |
| Durable Firms | .5834 | .4007 | .3405 | .3537 | .4218 |

b - significant at 5% level
c - significant at 10% level

Table 5-22
Mean Absolute Percentage Errors
Brown and Rozeff Model
One Quarter Ahead

| Periods | 1 | 2[a] | 3[a] | 4 | 5 |
|---|---|---|---|---|---|
| Non-Durable Firms | .3906 | .1972 | .1664 | .2487 | .2947 |
| Durable Firms | .4132 | .3362 | .3592 | .3023 | .2578 |

a - significant at 1% level

Table 5-23
Mean Absolute Percentage Errors
Brown and Rozeff Model
Four Quarter Ahead

| Periods | 1 | 2 | 3[b] | 4 | 5 |
|---|---|---|---|---|---|
| Non-Durable Firms | .3750 | .3815 | .2702 | .3309 | .3058 |
| Durable Firms | .3855 | .3908 | .3699 | .2707 | .3268 |

b - significant at 5% level

Table 5-24
Mean Absolute Percentage Errors
Brown and Rozeff Model
Eight Quarter Ahead

| Periods | 1 | 2[b] | 3 | 4[c] | 5 |
|---|---|---|---|---|---|
| Non-Durable Firms | .5198 | .3797 | .4073 | .3123 | .3106 |
| Durable Firms | .5003 | .4781 | .4086 | .4078 | .3605 |

b - significant at 5% level
c - significant at 10% level

The product type factor produces differences in forecast accuracy which are generally in the desired direction. The non-durable firms in 24 out of 30 cases have lower APEs than do their durable firm counterparts. Also of interest is that this proportion is consistent across time-series model used, as well as across the forecast horizon used. The significant differences all occur when the non-durable firms mean APEs are lower than the durable firms mean APEs. However, of the 24 cases when the product type affect is in the desired direction only one-third (7) of these cases are significant at a 1% or 5% level.

Overall Test Results

The following table reports the results of the z-tests for differences in mean accuracy. These tests are conducted by combining all five test periods together into one z-test of mean differences.

Table 5-25
Overall Test Results
Mean Absolute Percentage Errors

Concentration

| | Model (0,1,1)X(0,1,1) | Model (1,0,0)X(0,1,1) |
|---|---|---|
| One Quarter Ahead: | | |
| High Firms | .30109[b] | .29160[b] |
| Low Firms | .24217 | .23334 |
| Four Quarter Ahead: | | |
| High Firms | .35031 | .35601 |
| Low Firms | .31275 | .32306 |
| Eight Quarter Ahead: | | |
| High Firms | .41961[c] | .41843 |
| Low Firms | .36689 | .38632 |

Diversification

| | Model (0,1,1)X(0,1,1) | Model (1,0,0)X(0,1,1) |
|---|---|---|
| One Quarter Ahead: | | |
| High Firms | .25089[b] | .23672[a] |
| Low Firms | .29508 | .30990 |
| Four Quarter Ahead: | | |
| High Firms | .28537[c] | .28831[c] |
| Low Firms | .32344 | .32370 |
| Eight Quarter Ahead: | | |
| High Firms | .36153 | .36197 |
| Low Firms | .37620 | .38229 |

Product Type

| | Model (0,1,1)X(0,1,1) | Model (1,0,0)X(0,1,1) |
|---|---|---|
| One Quarter Ahead: | | |
| Non-Durable | .27224[b] | .23165[a] |
| Durable | .33808 | .33375 |
| Four Quarter Ahead: | | |
| Non-Durable | .32570 | .33168 |
| Durable | .35391 | .34873 |
| Eight Quarter Ahead: | | |
| Non-Durable | .36135[b] | .38593[c] |
| Durable | .42002 | .43104 |

a - significant at 1% level
b - significant at 5% level
c - significant at 10% level

The overall results produce similar results to the period by period tests. The concentration factor effect is opposite to the hypothesized direction. The product type and diversification factors produce results consistent with their hypotheses. With the diversification factor, the one period ahead forecasts produce significant results and the significance diminishes as the forecast horizon increases. The product type factor also produces significant differences at the one quarter ahead horizon. However, the significance vanishes at the four quarter ahead horizon and then returns at the eight quarter ahead.

## Summary

The analysis performed revealed several important trends. The hypothesized relationships appear valid for the product type and diversification factors. But a lack of overall significance leads to a conclusion of little affect on forecast accuracy by these factors. The concentration hypothesis does not appear valid in any form. A further discussion of these results, including limitations and extentions, is contained in chapter six.

# Chapter Six

## Summary and Conclusions

This research examines the affect of three factors on quarterly earnings forecasts. The factors examined; industry concentration, diversification, and product type, are hypothesized to affect quarterly earnings forecast accuracy as follows:

1) Quarterly earnings of firms in highly concentrated industries are more accurately forecasted than quarterly earnings of firms in less concentrated industries.

2) Firms with diversified earnings streams have quarterly earnings that are more accurately forecasted than firms with undiversified earnings streams.

3) Forecasts of quarterly earnings for firms in durable product markets are less accurate than for firms in non-durable product markets.

The z-test for differences in means is used to analyze forecast accuracy measures for the two groups of firms used to examine each hypothesis. The z-test analysis is carried out for each hypothesis using five test periods (1975 through 1979), three forecast horizons (one, four, and eight quarters ahead), and two univariate time-series models (Griffin-Watts and Brown and Rozeff). The results of these tests are reported in chapter five. This chapter examines the results and discusses the limitations and possible extentions of this research.

## Discussion of Results

Four major conclusions are indicated by the results of the tests of significance:

1) The industry concentration factor produced more accurate forecasts for firms in low concentration industries when examining each period's forecasts. This result is contrary to the hypothesized relationship. When the periods are combined into one test this difference disappears.

2) The results were as expected for both product type and diversification. However, a general lack of significance (particularly evident in the case of diversification) would indicate that any relationship that is present is weak at best.

3) There appears to be an interesting pattern in the cases of both diversification and product type. With diversification, the apparent relationship weakens as the forecast horizon is increased. In the case of product type, the apparent relationship is consistent across all forecast horizons.

4) The choice of the univariate time-series models does not affect any of the the previous findings. The previous findings are consistent across the two models.

The first finding of this research, the complete reversal of the concentration hypothesis, may be partially explained by considering management's motives. The hypothesis assumes that managers of firms in highly concentrated industries use their power over prices and costs to maximize each period's income, or at least to provide an earnings stream that can be perceived as valuable by the investor. This may not be a valid assumption. Managers of firms in highly concentrated industries may use their power to mislead governmental units or others investigating the possibility that they are an unregulated monopoly.

The managers of firms in less concentrated industries, on the other hand, have less incentive to have high variability in their earnings streams. Since micro-economic theory states that these firms would enjoy only normal profits, the less variable these earnings can appear, the better the firm appears. These managers have little power to influence their earnings stream properties, and other factors, such as those examined in this research, enable their earnings streams to test as more accurately forecasted than firms in high concentration industries.

In relation to the second finding of this research, a general lack of significance of diversification and product type is the most important result. The direction of the impact by both of these factors appears to be as hypothesized. However, certain periods where no significant difference could be found between the two groups have as large a difference between the groups as other periods where significance is found. This is due primarily to the variabilty of the accuracy of these univariate time-series forecasts.

The third finding gives some insight into the overall use of diversification and product type as predictors of forecast accuracy. The fact that the affect by the product type factor is consistent across forecast horizons would indicate that it is a more powerful factor than is diversification. This is also verified by the number of significant differences found for the product type factor versus the number found for diversification. The diversification factor with its weakening relationship as the forecast horizon is lengthened, is a better discriminator when overall forecast accuracy is better. As the overall accuracy declines, the variabilty of the forecasts increases and the z-test is unable to diferentiate between the two group means.

The last finding is consistent with previous research examining the Griffin-Watts and Brown and Rozeff models. Previous research has found little evidence indicating when one of these models would be preferred. The findings of this study would also lead to a conclusion that either model produces reasonably accurate forecasts, and there is little indication that one is superior.

## Limitations

Three limitations of the current study are worth noting. Two of these are expected when employing the univariate time-series modeling process. The familiar size and survivorship bias that are inherent in similar research of this nature are encountered in this study as well. This can impact the generalizability of the findings of this study, however, this is not considered a major drawback of this line of research.

The other limitation is invoked by the use of a univariate test of significance. There is no control over or measurement of the interactions between the tested factors. In an attempt to insure that the findings of one factor are not related to the findings of one of the other factors, an examination of the firms used for each factors tests of significance did not reveal a consistent duplication across the factors. While this relieves the concern that one subset of firms is consistently driving the results, the interactions of the factors are still unexamined.

## Possible Extensions

The following extensions of this research may warrant future examination.

1) Extending this analysis to other forms of quarterly earnings forecasting systems. These additional forecasting sytems would include financial analysts' forecasts as well as forecasts generated by econometric models.

2) Enlarging the sample size in an attempt to generate more significant differences across the groups examined.

3) An examination of other measurement methods for the factors examined in this study. This may include a "softening" of the measurement methods used in this research, in an attempt to identify the point at which the factors lose their discriminating power.

4) Identification of other factors which impact the earnings stream properties, so that they can then be used as discriminators of forecast accuracy.

5) Incorporation of multivariate testing procedures in anattempt to identify the interactive nature, if one exists, between the factors examined.

These extensions would all provide additional evidence on the question of identification of firms which are more easily forecasted.

## Final Statements

This research has attempted to identify factors which could be used to identify firms for which quarterly earnings forecasts may be more accurate. The overall tests of the hypotheses of this study were generally inconclusive. While some evidence was present supporting two of the hypotheses, an overall lack of significance hinders the general conclusions that can be drawn from this research.

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