AN EMPIRICAL INVESTIGATION OF THE CASH FLOW PREDICTABILITY
OF HISTORICAL
COST, GENERAL PRICE LEVEL, AND REPLACEMENT COST INCOME
MODELS

by

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Dissertation submitted to the Faculty of the

Virginia Polytechnic Institute and State University

in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

in

Business
with a major in Accounting

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September, 1983
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ACKNOWLEDGEMENTS

Finally, much gratitude is expressed to my parents,
, for their continued love, encourgement
about the value of education and financial support during my
long career as a student.

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Chapter I

OVERVIEW OF THE PROBLEM

1.1   INTRODUCTION

The accounting profession has often justified the issuance of its professional standards under the "usefulness of information" criterion. This has been given recent impetus by the Financial Accounting Standards Board (FASB) with its Statement of Financial Accounting Concepts No. 1-Objectives of Financial Reporting by Business Enterprises. Among the objectives specified is the following:

> Financial reporting should provide information to help present and potential investors and creditors and other users in assessing the amounts, timing, and uncertainty of prospective cash receipts from dividends or interest and the proceeds from the sale, redemption or maturity of securities or loans. Thus, financial reporting should provide information to help investors, creditors, and others assess the amounts, timing, and uncertainty of prospective net cash inflows to the related enterprise.[1]

This statement of objectives is part of an ongoing conceptual framework project within the accounting profession that has been conceived to provide guidance in the development and implementation of accounting principles.

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[1] Financial Accounting Standards Board, Statement of Financial Accounting Concepts No. 1-Objectives of Financial Reporting by Business Enterprises, 1978, pp. 17-18.

For example, the FASB made specific reference to these objectives when it issued Statement of Financial Accounting Standards No. 33-Financial Reporting and Changing Prices. The FASB used as partial justification for experimentation with alternative valuation methods(Statement No. 33) the objective of reporting information that helps investors, creditors, and others assess the amounts, timing, and uncertainty of prospective net cash inflows to the enterprise. 'That is, the FASB concluded that reporting measurements based on changing general and specific prices (in addition to the traditional historical prices) would be useful information for the assessment of future cash flows.

In addition, the FASB has addressed the income and cash flow reporting issues under the usefulness criterion with the issuance of an exposure draft of a potential accounting concept statement entitled Reporting Income, Cash Flows, and Financial Position of Business Enterprises. This proposed statement reaffirms that users of financial statements are looking primarily at information about the past. The FASB states, however, that current decision-making involves an assessment of what the future holds, and it concludes that a prime characteristic of useful financial information is its value in assisting users' predictions.

A major thrust of this proposed financial reporting concept statement is that information on income and cash flows should be segregated into homogeneous components for maximum predictive value. While the statement does not deal with concepts of recognition and measurement of the elements of financial statements, the FASB reiterates the cash flow objective by emphasizing that considerations which may have significant effects on the enterprise's cash flows are possibly not reflected in the financial statements. For example, it states that information based on historical prices may not be sufficient for all users of financial reports. An important conclusion of the proposed statement is that the income statement should contribute to the purposes of financial reporting by giving the results of particular activities or events that are significant for the prediction of future income and cash flows. That supposed relationship between the income statement and cash flow prediction has not been verified precisely, however.

These existing and proposed financial accounting standards and concepts have been promulgated and implemented in practice without substantial empirical evidence that the underlying concepts and required measurement techniques are consistent. While Statement No. 33 of the FASB requires measurement of general and specific price changes, as well

as historical prices, it is based on only an assumed correspondence to the cash flow prediction objective. Several research efforts have been directed at the perceived need to evaluate the financial accounting standard for income determination with respect to the objective of predicting cash flows. The results of this research to date are inconclusive as to the accounting income measurement that better predicts firm cash flows.

Prediction of important accounting variables (income, earnings per share, dividends, etc.) has received considerable attention in the accounting literature. Alternative accounting methods are evaluated in terms of relative abilities to predict variables of interest. Under this approach, the alternative that is associated with the better prediction of an important accounting variable is preferred over the others. The development of this research technique is presented in Chapter 2.

A brief review of the research that applies the predictive ability methodology to the income measurement issue in accounting provides the motivation for the current research. The current research has been designed to establish empirical evidence with firm cash flows as the object of prediction and alternative income measurement techniques as the predictors.

The initial research in this area (Bravo,1977) tested the abilities of historical cost, general purchasing power, and current operating profit income measures to predict income and cash flows. Cash flows were defined as historical cost income plus depreciation. Consistent with earlier income prediction studies, historical cost income was found to be a better predictor of itself than the other two income concepts. The extension of the predictive ability methodology to firm cash flows failed to show any statistically significant difference in the size of the cash flow forecast errors of the three income measures.

A simulation study (Swanson, 1977) revealed that replacement cost operating income predicted subsequent periods' distributable operating flows better than did historical cost income. Under certain simulated conditions, however, historical cost was found to be the superior predictor.

Fry (1978) investigated five income models, including general price-level-adjusted historical cost, replacement cost operating income, replacement cost total income, general price-level-adjusted replacement cost operating income, and general price-level-adjusted replacement cost total income. The variable of prediction in this research was replacement cost operating income. The results were

similar to those reported by Swanson, in that replacement cost operating income produced the smallest forecast errors.

A study in which the prediction of working capital from operations by historical cost and replacement cost incomes was reported by Means (1979). The conclusion was that historical cost is the better predictor of cash flow under this particular definition.

1.2 RESEARCH OJECTIVES

As reviewed above, under different circumstances of cash flow definition and data sources, both historical cost and replacement cost have been found to be better predictors. One problem in the interpretation of the existing cash flow prediction research is a lack of consistency in the income models evaluated and in the alternative definitions of cash flow used. The conflicting research findings must be partially attributed to this divergence. These inconsistent conclusions found in the existing research and the ongoing debate about competing income measurement models, as well as the current interest in cash flow prediction, provided the motivation for the current research. There are also some natural extensions of the existing body of research that are incorporated in the specification of the research questions listed below.

√ The primary research question of interest, based upon the evolution of accounting theory toward alternative income measurements and cash flow reporting, is:

> Are there differences in the abilities of
> alternative income models to predict firm
> cash flows?

This question was addressed using historical cost income; general price-level-adjusted historical cost income, with and without monetary gains and losses; and replacement cost income, with and without holding gains and losses. Each of these models has been used in previous research. In addition, both previously used definitions of cash flow (net income plus depreciation and working capital from operations) were tested in the present research. This permitted an assessment of the possibility that the previous research findings are data and/or definition dependent.

Previous research has employed a variety of predictor models to generate cash flow predictions from the alternative income measurements. The current research incorporates a sample of linear and nonlinear models from the predictive ability literature and tests for significant differences among them. This addresses the second research question about the possible dependency of research findings on the predictor models chosen:

Is there a difference in predictor-model
abilities to predict enterprise cash flows?

A natural extension of the primary research question
(about cash flow predictability) is to investigate variables
other than alternative income numbers that may influence
relative cash flow prediction. For example, varying
conditions among industries may be a confounding factor in
attempting to identify the income model that better predicts
firm cash flows. This possibility is specified by the third
research question:

Is there an industry effect on income models'
abilities to predict enterprise cash flows?

Other confounding factors may also exist. For
instance, differences among firms, even within the same
industry, may confuse any attempt to identify a cause and
effect relationship between income models and cash flow
predictions. To investigate the possible effect of firm
size on this research, one last research question was
addressed:

Is there a firm size effect on income models'
abilities to predict enterprise cash flows?

The last two objectives of this research are new areas in the application of the predictive ability methodology to the cash flow/income measurement issue in accounting.

1.3   IMPORTANCE OF THE STUDY

Accounting research has a role in the evolution of accounting theory. Historically, accounting theory has developed as the result of a political process among the official rule-making bodies of the accounting profession and other users of financial information. Considerable attention within the accounting profession has been devoted recently to the objective of codifying a body of accounting theory (i.e., the conceptual framework project). Both theoretical and empirical research can make contributions to the goal of specifying accounting theory by proposing certain normative relationships and then testing for their existence. Much theoretical research has been produced in the area of income measurement. The case for the current value and general price-level alternatives to historical cost income numbers· is well documemted (Edwards and Bell, 1961; Chambers, 1966; Sterling, 1967 and 1970; Burton, 1974).

More recently, empirical research has attempted to link the generally accepted accounting objectives and the debate

about alternative income measurement theories. These research efforts are referred to in section 1.1 above, and as indicated, are inconclusive relative to the objective of predicting enterprise cash flows. Because of the inability to draw consistent conclusions from previous research findings, there is a need to generate more empirical evidence to evaluate the relationship between accounting objectives and accounting practices. It has also been suggested (American Accounting Association, 1977) that material differences in risks, measured by standard deviations of income, could have redistributional effects in resource allocations as investors and management react to differences among valuation methods.

In addition, an extension of the existing research to investigate the possible confounding effects of other variables such as industry classification and firm size can contribute to our understanding of the cash flow prediction/income measurement issue. This research project should contribute additional evidence to help resolve the prior research conflicts and expose other variables that must be considered in any attempt to apply in practice the cash flow prediction objective.

Chapter II

REVIEW OF THE RELEVANT LITERATURE

The purpose of this chapter is to examine the
underlying foundation of earlier research that serves as the
justification for the research questions posed in Chapter 1.
It is divided into four parts that deal separately with the
evolution of predictive ability research in accounting,
theoretical development of alternative income models,
empirical research on alternative income models, and
empirical research on cash flow prediction.

2.1 <u>PREDICTIVE ABILITY LITERATURE</u>

Predictive ability is not a new criterion for the
evaluation of accounting data.[2] Empirical research has
employed this criterion for many years because the
evaluation of alternative accounting measurements has been a
major concern of the accounting profession. According to
the predictive ability criterion, alternative accounting
measurements are evaluated in terms of their relative
abilities to predict events of interest to decision makers.
The criterion is generally applied by identifying that
measure among competing measures that best predicts an event

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[2] See, for example, Beaver, Kennelly, and Voss (1968).

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or variable of interest.

The research reviewed in this section traces the development of the use of accounting data to predict variables or events of interest to decision makers. Green and Segall (1966) studied the predictive power of first-quarter earnings reports. They proposed that the variable of central interest to investors is earnings per share. The study was concerned with the use of interim reports to forecast annual earnings per share (EPS). Three predictive models were used: (1) simple extrapolation, where first-quarter earnings were multiplied by four to forecast annual EPS; (2) forecasting that next year's EPS will differ from this year's by the same percentage that next year's first-quarter EPS differs from this year's first-quarter; and (3) linear regression of annual EPS on first-quarter EPS for the five years preceding the year for which the forecast is desired, and applying the regression estimates to first-quarter earnings of that year. Green and Segall assert that, while these extrapolations are naive, they are at least starting points for many investors and ending points for a few.[3]

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[3] David Green and Joel Segall, "The Predictive Power of First-Quarter Earnings Reports," Journal of Business, January 1967, p. 45.

Business failure was also a topic of the early predictive ability studies. Horrigan (1965) considered the use of financial ratios although earlier researchers had found such ratios to be somewhat inefficient predictors of financial difficulties.[4] After considering the statistical properties of ratios, Horrigan reviewed the literature on financial ratio use in the prediction of business failure as one aspect of the history of financial-ratio applications. He concluded that there was a consistent association between three financial ratios (net working capital to total assets, net worth to total debt, and the current ratio) and subsequent firm failures when ratios were calculated as early as four to five years prior to such failure.[5]

Other studies considered the same object of prediction used by Horrigan. Beaver (1968) investigated the predictive ability of financial ratios in terms of bankruptcy. His approach was to investigate the financial statement data of seventy-nine failed and seventy-nine nonfailed firms in a univariate study in which he found a single ratio (cash flow/total debt) to discriminate best. Beaver concluded that his empirical results support what we would expect for the failed firms; that is, smaller revenues, poorer net

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[4] James O. Horrigan, "Some Empirical Bases of Financial Ratio Analysis," The Accounting Review, July 1965, p. 558.

[5] Horrigan, "Some Empirical Bases," p. 568.

income and cash flow positions, etc. While the explanatory power of such results is limited, Beaver stated that it is feasible to evaluate alternative accounting measures in terms of their predictive abilities.[6]

In the period following these studies on business failure, income prediction dominated the predictive ability literature. Frank (1969) compared the accuracy of predictions of future values of accounting (historical cost) income based on past values of accounting income with forecasts of those same values that were based on past values of current cost income.[7] In addition, the accuracy of predictions of future values of current cost income was compared with that of predictions of future values of accounting income. Current cost operating income was computed by restating each firm's cost of goods sold and depreciation expense in terms of current year dollars

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[6] William H. Beaver, "Alternative Accounting Measures as Predictors of Failure," The Accounting Review, January 1968, p. 122.

[7] Frank obtained estimates of current cost income by restating each firm's cost of goods sold and depreciation expense in terms of current year dollars through the use of price level indices. To restate cost of goods sold, the price indices used for the firms in a given industry were the values of the monthly series of the specific components of the wholesale price index considered most appropriate for that industry. A single index was used for all firms to restate the gross fixed asset balance to current year dollars. This index was the implicit price deflator for the nonresidential business investment component of gross national product.

through the use of price-level indices. These price indices for the firms in a given industry were obtained from the monthly series of the specific components of the wholesale price index considered most appropriate for that industry. Neither income measure was adjusted for changes in general purchasing power.

The results of the analysis indicated that, for the the industries studied, current cost income has no clear advantage over historical cost income in predicting future values of either income measure. In the oil and chemical industries, however, there was evidence that current cost income resulted in better predictions of future accounting earnings than did current accounting income.[8]

A different approach to prediction of various income measures was taken by Simmons and Gray (1969). Because of the practical problems of restating actual data for general and specific price-level changes, simulation was used to compare the alternative income measures.[9] General and specific price-level adjusted income and operating income were included in the research. Also, Simmons and Gray

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[8] Werner Frank, "A Study of the Predictive Significance of Two Income Measures," <u>Journal of Accounting Research</u>, Spring 1969, pp. 132-133.

[9] Simmons and Gray applied simulation using ·a linear extrapolation of past net income to predict future net income for selected combinations of changes of specific and general price-level indexes.

included holding gains and losses in operating income; straight-line extrapolation was used as the prediction technique. Models used for statement conversion were: (1) replacement cost according to the AAA Committee on Realization Guidelines and (2) general price-level historical cost according to the AICPA Accounting Research Study No. 6. Results indicated that net income was generally a better predictor of its future values than was operating income for the majority of the simulated conditions.[10] Because of varying results in prediction under differing assumptions, the authors could not claim that the evidence suggested that one definition of income is superior to other definitions of income for prediction purposes.

As indicated in the above review, the first predictive ability studies investigated the prediction of business failure or firm income. Revsine (1971) discussed the appropriateness of these accounting applications of prediction research. He reviewed the predictive ability literature and reported that, because knowledge of users' decision models is limited, the basic issue of precisely what the appropriate object of prediction should be has received little explicit attention. He concluded that the

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[10] John K. Simmons and Jack Gray, "An Investigation of the Effect of Differing Accounting Frameworks on the Prediction of Net Income," The Accounting Review, October 1969, p. 776.

theoretical basis for suggesting that income forecasts are useful in their own right is unspecified. Since income by any definition is an artificial construct, Revsine questioned the relevance of enhancing a users' ability to predict future income levels. He suggested that what is important is an understanding that income prediction is relevant--not for its own sake--but because of the correspondence between future income and some other events that constitute the real object of prediction.[11]

Next, Revsine considered the criterion employed to assess predictive ability. He reviewed the Simmons and Gray approach that recommended straight-line extrapolation as a prediction method. Revsine proposed that any income measure selected as a forecasting basis should minimize the deviation between the anticipated and realized object of prediction. According to Revsine, if the object of prediction is volatile then the predictor should provide evidence of those movements at the earliest possible moment.[12]

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[11] Lawrence Revsine, "Predictive Ability, Market Prices, and Operating Flows," The Accounting Review, July 1971, p. 487.

[12] Revsine, "Predictive Ability," p. 488.

Following Revsine's exploration of the theoretical questions surrounding predictive ability research, evidence about the object of prediction appeared in the October 1973 Report of the Study Group on the Objectives of Financial Statements of the American Institute of Certified Public Accountants (AICPA). This report states that the specific role that financial statements play in the economic decision-making process has not been identified. Accordingly, this group based its study on the assumption that users' information needs and their decision processes are consistent with economic and behavioral theory, which states that:

1. Users of financial statements seek to predict, compare, and evaluate the cash consequences of their economic decisions.

2. Information about the cash consequences of decisions made by the enterprise is useful for predicting, comparing, and evaluating cash flows to users. If the value of the unit of measure is unstable, that is, if inflation or deflation is so great that direct cash consequences are no longer comparable, such circumstances should be recognized in the financial statements.[13]

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[13] AICPA, Report of the Study Group on the Objectives of Financial Statements, New York: AICPA, 1973, p. 14.

The above statements reinforce the user-orientation of financial reporting. Accordingly, the Study Group went on to state that:

1. An objective of financial statements is to provide information useful to investors and creditors for predicting, comparing, and evaluating potential cash flows to them in terms of amount, timing, and related uncertainty.

2. An objective is to provide a statement of financial activities useful for predicting, comparing, and evaluating enterprise earning power. This statement should report mainly on factual aspects of enterprise transactions having or expected to have significant cash consequences. This statement should report data that require minimal judgment and interpretation by the preparer.[14]

Many of these ideas were later included in the _Statement of Financial Accounting Concepts No. 1 -- Objectives of Financial Reporting by Business Enterprises_ issued by the FASB in 1979. The objectives state that:

1. Financial reporting should provide information to help present and potential investors and creditors and other users in assessing the amounts, timing, and uncertainty of prospective cash receipts from dividends or interest and the proceeds from the sale, redemption or maturity of securities or loans.

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[14] AICPA, _Report of the Study Group_, pp. 20-38.

2. Since investors' and creditors' cash flows are
    related to enterprise cash flows, financial reporting
    should provide information to help investors,
    creditors, and others assess the amounts, timing, and
    uncertainty of prospective net cash inflows to the
    related enterprise.

3. Financial reporting should provide information about
    the economic resources of an enterprise, the claims
    to those resources (obligations of the enterprise to
    transfer resources to other entities and owners'
    equity), and the effects of transactions, events, and
    circumstances that change its resources and claims to
    those resources.[15]

The above discussion appears to establish a need to

evaluate the cash flows of the firm and the precedent for

evaluating predictive ability of accounting measurements.

Beaver, Kennelly, and Voss (1968) caution, however, that one

difficulty in the implementation of predictive ability

studies is the specification of what events constitute

parameters of decision models and the specification of a

theory that will link those events to the accounting

measures in some sort of predictive relationship.

The Committee on Accounting Theory Construction and

Verification of the American Accounting Association (1971)

stated that all decision models require predictions of the

independent variables (parameters); therefore, prediction

models of some type are required. The Committee also

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[15] FASB, Statement of Financial Accounting Concepts No. 1,
    pp. 17-20.

concluded that the selection of both the decision model and the prediction model(s) is limited by the available data. Accounting theory construction and verification depends upon specifying the final operation of the decision model(s); this requires goal specification, decision model specification, predictions from the operation of the prediction model, and information from the data bank.[16]

Based upon the above statements, the findings of a predictive ability study are conditional on how well the predictive model is specified. This involves a specification of the functional form of the relationships (e.g., linearity) and how the variables are operationally defined. An observed association between accounting measures and the event being predicted does not necessarily represent a causal relationship between the measures and the event because other explanatory factors may have been ignored. In addition, Beaver, Kennelly, and Voss point out that the evaluation of relative predictive power may require an assumption about the cost associated with the prediction errors which involves additional knowledge of other variables in the decision model. Otherwise, it may be impossible to conclude which measure is the better

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[16] "Report of the Committee on Accounting Theory Construction and Verification," The Accounting Review, Supplement 1971, p. 64.

predictor.

Because of these potential difficulties, the ability to generalize the results across purposes may be restricted. Beaver, Kennelly, and Voss conclude that neither the potential inability to generalize nor the tentative nature of the conclusions should be regarded as a deterrent to conducting the predictive ability studies. They note that research efforts into the predictive ability of accounting data are necessary for the fulfillment of accounting's decision-making orientation and for meaningful evaluation of alternative accounting measures.[17]

With this defense of predictive ability research by Beaver, Kennelly, and Voss and general acceptance of this type research in the literature, predictive ability research continued during the 1970's as theoretical and empirical research efforts turned to the area of changing price levels. This literature included proposals for general price-level adjustments and some form of current value adjustment to either replace or supplement the historical cost financial statements. This predictive ability literatue helped form the FASB's support for the continued use of historical cost financial statements:

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[17] William H. Beaver, John W. Kennelly, and William M. Voss, "Predictive Ability as a Criterion for the Evaluation of Accounting Data," The Accounting Review, October 1968, p. 683.

1. These statements based on actual transactions determine changes in owner's equity in the long run;

2. Historical prices are the result of arms-length bargaining and they provide reliable measures of transactions;

3. Historical statements provide a basis with which to compare measurements of the effects of changing prices;

4. Users are accustomed to historical cost statements.[18]

The FASB also cited the predictive ability criterion when it summarized its reasons for deciding to experiment with price-level adjustments as supplementary information:

1. Measurements in conventional statements are in nominal dollars with no direct allowance for variability in purchasing power;

2. Many people think users need information about measurements in units having the same general purchasing power;

3. Many people think users need information about changes in the prices of assets while they are held by an enterprise;

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[18] Financial Accounting Standards Board, Statement of Financial Accounting Standards No. 33--Financial Reporting and Changing Prices, Stamford, Conn.: FASB, 1979, pp. 3-4.

4. The FASB believes that users' understanding of past performance and ability to assess future cash flows is severely limited without information on the effects of general inflation and other price changes.[19]

The FASB expressed its intention to study the extent of use, the types of users, and the purposes of the use of constant dollar and current cost information. This implies, of course, that the FASB desires additional research that attempts to link alternative income measurements to the objectives of financial reporting. The current research has been designed to provide additional empirical evidence about the cash flow predictive abilities of these alternative accounting measurements.

2.2   THEORETICAL SUPPORT FOR ALTERNATIVE INCOME MODELS

The purpose of this section is to present theoretical arguments for alternative income measurement models and to review the empirical research that investigated these models. Revsine (1970) presents theoretical support for the replacement cost income alternative. He develops an a priori model that assesses the theoretical validity of the assumption that replacement cost income is a surrogate for "ideal" economic income. According to Revsine, economic income is concerned with changes in the service potential of

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[19] FASB, SFAS No. 33, pp. 4-5.

assets and replacement cost income is an indirect approximation of that ideal.[20] He identifies two distinct correspondences underlying the supposed relationship between total replacement cost income and total economic income:

1. The current operating profit component of replacement cost income is an indirect measure of the expected income component of economic income;

2. The realizable cost savings component of replacement cost income is an indirect measure of the unexpected income component of economic income.[21]

Revsine later proposed a normative model of investors' information needs that is based on a model of investor behavior from the economics and finance literature.[22] This normative model suggests that investors are primarily concerned with the level and timing of their future cash inflows.

Accounting recognition of Revsine's model is reflected in A Statement of Basic Accounting Theory (AAA, 1966), which states in part:

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[20] Lawrence Revsine, "On the Correspondence Between Replacement Cost Income and Economic Income," The Accounting Review, July 1970, p. 513.

[21] Revsine, "On the Correspondence," pp. 517-518.

[22] Lawrence Revsine, Replacement Cost Accounting, Englewood Cliffs, N.J.: Prentice Hall, Inc., 1973.

> We should point out that, so far as is known today, if investors (both potential and actual and both owners and creditors) could predict the amount and timing of future cash receipts from their investments then according to many theorists they should need little else in the way of information.[23]

Revsine's normative model of investors' needs extends this view by including not only expected future dividend flows but also the risk inherent in those flows. From this model, it appears that accounting measurements should facilitate estimates of such flows and their associated risk to be relevant for the information needs of financial statement users. Revsine concludes that these flow estimates and risks constitute the primary criteria by which the relevance of replacement costing to investors is to be judged.[24]

Specifically, Revsine evaluates the predictive ability of replacement cost by examining its utility as a predictor of the distributable operating flows[25] of the enterprise. His analysis presents a case for replacement cost income

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[23] American Accounting Association, A Statement of Basic Accounting Theory, AAA, 1966, p. 23.

[24] Revsine, Replacement Cost Accounting, p. 33.

[25] Operating flows represent the amounts of cash and other liquid resources generated by operating activities. Distributable operating flow is used by Revsine in the Hicksian sense as that amount of resources that can be distributed to owners without constricting the level of future operating activity.

that includes realizable cost savings because such savings represent changes in market values. Revsine asserts that these market values are a reflection of enhanced future earning power. Thus, replacement cost income (including realizable cost savings) makes the income measurement a better lead indicator of future distributable operating flows if future flows and asset prices change in the same direction. Nevertheless, empirical research is needed to determine the correspondence between price changes and operating flows.[26]

As theoretical support for alternative income measurements (such as Revsine's arguments above) continued to accumulate, other researchers attempted empirical verification of the various income theories. Buckmaster and Brooks (1974) compare historical cost income, general price-level operating income, and current value income for forty-two companies in four industries over a nineteen year period. This study follows the methodology illustrated in the Accounting Principles Board Statement No. 3, Financial Statements Restated for General Price-Level Changes, in determining general price-level adjusted operating income numbers. For current value income the specific wholesale price index appropriate for the particular industry is

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[26] Revsine, Replacement Cost Accounting, p. 169.

applied to the historical cost. They conclude:

1. All three income models tend to yield materially
    different numbers at the level of the individual
    firm;

2. With few exceptions, historical cost income is
    greater than current value income and general price-
    level income;

3. The pattern of differences between current value
    income and general price-level income varies by
    industry.[27]

Sterling (1975) attempted to justify the existence of

alternative income models by relying upon assumptions about

the use of accounting information. He wrote that a

measurement requires one to consciously decide which

attribute is to be measured. To aid in specifying those

attributes, he proposed that decision models be examined for

the criteria of interpretability and relevance. After

evaluating historical cost, price-level adjusted historical

cost, current value, and price-level adjusted current value

financial statement measurements, Sterling concluded that

both current values and general price-level adjustments are

required to meet both criteria.[28] In fact, he emphasizes

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[27] Dale Buckmaster and LeRoy D. Brooks, "The Effects of
     Price-Level Changes on Operating Income," CPA Journal,
     March 1974, p. 53.

that both adjustments are necessary and that neither is a substitute for the other.

2.3   CASH FLOW LITERATURE

Because of the debate about alternative income measurements and proposed objectives of financial reporting which permeated the literature during the 1970's, some empirical researchers began to investigate a possible linkage using the predictive ability approach. Early attempts to evaluate the abilities of the alternative income models to predict enterprise cash flows are reviewed in this section.

Bravo (1977) tested the comparative ability of historical cost, general purchasing power, and current operating profit income measures to predict income and cash flows. Actual published data for the twenty-eight largest 1975 Fortune 500 companies were adjusted by general price indexes[29] and specific price indexes. Various prediction models from the literature were then tested for predictive ability. When Bravo compared percentage errors between

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[28] Robert R. Sterling, "Relevant Financial Reporting in an Age of Price Changes," The Journal of Accountancy, February 1975, p. 50.

[29] R. J. Petersen, "Interindustry Estimation of General Price Level Impact on Financial Information," The Accounting Review, January 1973, pp. 34-43.

projected and actual income values, he found historical cost income to be a better predictor of itself than were the other two income concepts. The second most accurate income concept was replacement cost operating income and third general price-level-adjusted historical cost income.

In the second test, Bravo compared the ability of the three income concepts to predict firm cash flows (defined as historical cost income plus depreciation). Historical cost income consistently gave the best predictions of cash flows, but no statistically significant difference in the size of the cash flow forecast errors of the three income measures could be found.[30]

These results might be interpreted as an indication of the superiority of historical cost income for the purposes of predicting future historical cost income and firm cash flows. As will be discussed below, however, other empirical studies reported evidence that conflicts with this conclusion. The currently proposed research will contribute to the available evidence to help resolve this issue.

Data availability was recognized as a major limitation in applying predictive ability research to evaluate income models. While other cash flow research employed actual

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[30] Herrera Fernando Bravo, "An Empirical Analysis of the Predictive Ability of Alternative Income Measures," Ph.D. dissertation, University of California, Los Angeles, 1977, pp. 98-99.

reported data, Swanson (1977) used a simulation methodology to compare the relative abilities of historical cost income and replacement cost operating income from one period to predict subsequent period's distributable operating flow. The results showed that replacement cost operating income better predicted the subsequent period's distributable operating flows under certain circumstances. Swanson urged caution in claiming a superior association of replacement cost with future distributable operating flows because historical cost can be superior in some cases. The results showed that other factors such as pricing policy, markup, holding period, and pattern of input price change can affect which income concept better predicts future distributable operating cash flows.[31]

Two additional studies used actual data to test income models' predictions of cash flow and income. Fry (1978) examined five income models as alternatives to the historical cost income model with respect to their abilities to predict replacement cost operating income. This object of prediction was used to approximate distributable operating flow, since Revsine had argued earlier[32] that

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[31] Edward P. Swanson, "The Ability of Replacement Cost to Predict the Subsequent Period's Cash Flow: A Simulation," Collected Papers of the American Accounting Associations' Annual Meeting, 1977, pp.83-84.

[32] Revsine, "On the Correspondence," p. 513.

distributable operating cash flow was a surrogate for economic income, the "ideal" income measure. Fry included general price-level-adjusted historical cost income, replacement cost operating income, replacement cost total income, general price-level-adjusted replacement cost operating income, and general price-level-adjusted replacement cost total income models.

Financial statements of thirty companies were restated by using the GNP implicit price deflator for general price-level adjustments. Wholesale price indexes for the various industries or construction cost indexes were used to get the replacement cost adjustments. Linear and nonlinear trend models were applied to predict replacement cost operating income for the period 1970-1973. Results of statistical tests on percentage deviations (predicted value minus actual value, divided by actual value) indicated that replacement cost operating income had smaller deviations than historical cost. General price-level-adjusted historical cost income and general price-level-adjusted replacement cost total income had deviations not statistically different from historical cost. Replacement cost total income had deviations larger than historical cost.[33]

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[33] Nicholas Eugene Fry, "An Empirical Evaluation of Five Price Level Adjusted Income Concepts as Alternatives to Historical Cost," Ph.D. dissertation, Mississippi State University, 1978, pp. 216-218.

One empirical study that used only reported income data (no restatement procedures applied) and an alternative cash flow definition has been published. Means (1979) analyzed data for one hundred randomly selected corporations that included in their form 10-k reports replacement cost information as required by Accounting Series Release No. 190 of the Securities and Exchange Commission (SEC). The objective was to determine which measurement method, historical cost or replacement cost, provides relatively greater aid to users in predicting cash flows to the enterprise. Cash flow was defined to be the amount of working capital generated from operations, as shown on the statement of changes in financial position, adjusted for current items other than cash. Predictive ability was assessed by forecast error.

Actual filings with the SEC for 1976-1978 and five predictor models from the literature provided the data to be analyzed. The predictor models included two naive models, one accounting ratio model, and two regression models, and utilized income and prior-period actual sales figures. Based upon statistical tests of the forecast errors, Means concluded that historical cost data was a better predictor of cash flow from operations than was replacement cost data provided by firms under Accounting Series Release No. 190.

Additionally, she compared the predictive ability of the combination of replacement cost data and historical cost data with historical cost data alone. Test results led her to conclude that the predictive ability of the combination data was statistically equal to that of historical cost data alone.[34]

✓SEC commissioner, Barbara Thomas, in a 1982 address to the National Association of Accountants, expressed the view that not only is cash flow information itself vital to the analysis of investment risk but cash flow considerations also are important in evaluating other key accounting issues.[35] In explaining the current interest in cash flow information, Thomas described an environment during the 1940's to early 1970's of relatively stable prices and high liquidity in which accrual historical cost earnings tended to track cash flows for most industries. But, under conditions of rapid inflation and recession the gap between accrual historical cost income and cash inevitably widens. Recent business failures and dangerously low liquidity of other United States companies have motivated a broad-based

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[34] Kathryn Marotte Means, "An Empirical Investigation Into the Predictability of Cash Flows From Operations Using Replacement Data," Ph.D. dissertation, Georgia State University, 1979, pp. 135-137.

✓ [35] Barbara S. Thomas, "Statements in Quotes: Reporting Cash Flow Information," Journal of Accountancy, November 1982, p. 99.

and long overdue interest in the importance of cash flow.[36]

This interest was evidenced by accounting practitioners through the issuance of the FASB's exposure draft on reporting income and cash flows (November 1981), referred to in Chapter 1 above and Accounting Series Release Nos. 142 and 299 of the SEC. Also, substantial academic research, both theoretical and empirical, and dealing with related income measurement and cash flow issues is reviewed elsewhere in this chapter.

Thomas also identified some critical questions that remain to be solved. Among these are the specific definition of the term "cash" to be used in cash flow reporting and possible formatting standards relative to presentation of cash flow information. The present research has been designed in part with the objective of investigating the former issue. Specifically, alternative measures of cash flow are tested for their relative associations with alternative income measurements as explained in Chapter 4.

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[36] Thomas, "Statements in Quotes," p. 99.

2.4 EMPIRICAL RESEARCH ON ALTERNATIVE INCOME MODELS

Empirical research on alternative income models precedes the more recent research interest in cash flow prediction and reporting issues. Some of this research has been cited in an earlier section of this chapter. The purpose of this section is to review the findings of additional research and to thereby establish a conceptual framework vis-a-vis the questions that have been specified for this current research.

Samuelson (1972) conducted one of the first empirical studies concerning the predictive ability of general price-level adjusted and unadjusted historical cost earnings streams for twenty firms in the electric utility industry during the period 1935-1940. Predictive ability was assessed by comparing ex ante and ex post valuations of each firm based on homogeneous risk class models defined by Modigliani and Miller. Numerical differences between these two valuations for each firm were analyzed (1) to assess the accuracy of earnings numbers in general for predicting asset returns, and (2) to compare the relative predictive abilities of unadjusted and price-level adjusted earnings numbers.

Samuelson concluded that the effect of general price-level adjustment on predictive ability was small relative to

the overall accuracy of the predictions.[37] The error rate in predicting firm valuations ranged from 25 to 29 percent of the ex post valuations. The effect of using price-level-adjusted earnings to predict ex post valuation resulted in only a two to three percent change in the prediction errors.[38] Samuelson, however, made no inferences about the true direction of the price-level bias. Moreover, these results are affected by the fact that the Consumer Price Index used to adjust historical cost data was relatively constant over the time period of the study, such that any generalization of these results to other price-level conditions would be unwarranted.

More recently, several research studies have been reported that provide evidence that replacement cost disclosures required by the SEC's Accounting Series Release No. 190 produced no security price reactions at the time of disclosure in the 10-k reports. Some of these findings (Beaver, Clark, and Wright, 1979; Beaver, Lambert, and Morse, 1980) suggested a significant relationship between security returns and percentage changes in historical cost earnings. Easman, Falkenstein, and Weil (1979) reported

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[37] Richard A. Samuelson, "Prediction and Price-Level Adjustment," _Journal of Accounting Research_, Autumn 1972, p. 343.

[38] Samuelson, "Prediction and Price-Level Adjustment," p. 337.

research findings that demonstrated a stronger association between replacement cost income and security returns than between historical cost income and security returns.

Beaver, Griffin, and Landsman (1982) investigated the association of security prices with historical cost income and pre-holding gain net income computed from Accounting Series Release No. 190 replacement cost data. The methodology involved two-stage cross-sectional regressions of security returns on one or more of the earnings variables. Then the researchers varied the original research design by altering the holding period over which the returns were computed, by using residual returns, and by pooling single regression. In the second case, consistent with previous findings, results indicated that the pre-holding gain replacement cost income provided no incremental explanatory power, given knowledge of historical cost earnings. They concluded that the replacement cost income is a garbled version of historicl cost earnings, at least for explaining security returns. One objective of the current research is to investigate the possibility that previous cash flow prediction research was dependent on definitions and prediction modelschosen.

Of additional interest to the present research project is an extension by Beaver, Griffin, and Landsman. They

applied their original research design to the Easman Inflation Consultants, Inc., data base of replacement cost data. (This data base is a primary data source in the study of the cash flow predictability of alternative income models in the current project.) Beaver, et al., conclude that the explanatory power of historical cost net income is significant at conventional levels regardless of whether or not pre-holding gain net income from the Easman data base is also included. Furthermore, the explanatory power of pre-holding gain net income is not significant at conventional levels, regardless of whether or not historical cost net income is incorporated in the explanatory model.[39] The authors explain this discrepancy with the Easman, et al., findings as attributable to definitions of variables and cross-sectional versus time-series modes of analysis.

Other empirical evidence about the association between general price-level restated data and securities price behavior has been reported by Baran, Lakonishok, and Ofer (1980). The Parker model[40] was used to estimate the general price-level restatement, and the authors reported that the

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[39] William H. Beaver, Paul A. Griffin and Wayne R. Landsman, "The Incremental Information Content of Replacement Cost Earnings," Journal of Accounting and Economics, July 1982, p. 36.

[40] James E. Parker, "Impact of Price-Level Accounting," The Accounting Review, January 1977, pp. 69-96.

average absolute value of the estimation error was approximately five percent when compared with numbers produced internally by companies.[41] (The present research also employs the Parker model to generate the general price-level adjustments, as explained in Chapter 4.)

Baran, et al., concluded that the associations between market betas and general price-level adjusted betas were significantly higher than those obseved between market and historical cost betas. The general price-level adjusted betas outperformed the historical cost betas in every comparison made for the eighteen-year period examined and across three earnings definitions, two beta specifications, and three portfolio sizes.[42] This result can be interpreted as evidence that different information is included in the two accounting risk measures, and is at least one justification for the presentation of the general price-level alternative income number. They did not address the cash flow prediction criterion as a possible justification for the alternative general price-level adjusted income model.

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[41] Arie Baran, Josef Lakonishok and Aharon R. Ofer, "The Information Content of General Price-Level Adjusted Earnings: Some Empirical Evidence," The Accounting Review, January 1980, p. 25.

[42] Baran, et al., "The Information Content," p. 34.

Other empirical research on the general price-level adjusted income model considered further ramifications of the alternative income measurement issue. Sepe (1982) investigated the impact of accounting policy change deliberations concerning general price-level data on securities-price structure. The Parker general price-level restatement procedures were applied to COMPUSTAT data for 195 firms and correlations between security returns and restated accounting variables were examined for two time segments. One corresponded to the period of initial consideration of the FASB 1974 discussion memorandum on providing supplemental general price-level data and the other to the withdrawal of the proposal by the FASB. Test results showed positive correlations during the period when the FASB proposal was being considered and negative correlations during the withdrawal period of that proposal.

The fact that the initial market reaction was later reversed, corresponding to the relevant FASB proposal dates, was interpreted by Sepe as evidence that the securities price reactions were not caused by another correlated event.[43] The possible effects of other correlated events on studies of correlations between stock prices and alternative

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[43] James Sepe, "The Impact of the FASB's 1974 GPL Proposal on the Security Price Structure," The Accounting Review, July 1982, p. 482.

income measures have been a major criticism of earlier research in this area. Additionally, the results may indicate that the disclosure of general price-level adjusted information provides relevant information not previously used by security market participants.[44] No attempt was made by Sepe, however, to relate the cash flow prediction objective to the general price-level adjusted data.

2.5 SUMMARY

This chapter presents a chronological review of the relevant literature that has impacted on the content and structure of the research project being presented here. It seems clear from the significant volume of preceding research that theoretical support is widespread for the continuing interest by the accounting profession in the cash flow and income measurement questions. From an analysis of the current state of the empirical research on these issues it can also be suggested that this body of literature remains inconclusive because of the varying conditions and circumstances under which the research has been conducted.

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[44] Sepe, "The Impact of the FASB's," p. 483.

All of this comes together to provide support for the research questions presented earlier and the predictive ability methodology that has been chosen and that is presented as the research design in Chapter 3.

Chapter III

RESEARCH DESIGN AND METHODOLOGY

The purpose of this chapter is to explain how the predictive ability methodology has been applied in the current design to investigate the research questions presented in Chapter 1. It includes definitions of terms relevant to those questions, descriptions of the four prediction models employed, formal statements of the research hypotheses, and descriptions of the statistical analysis to be applied.

3.1 DEFINITION OF TERMS

3.1.1 CASH FLOW

Cash flow is the object of prediction (dependent variable) with the various income numbers alternating as the independent varible using each of the prediction models explained below. To accomplish the research objectives specified in Chapter 1, each of the previously used definitions of cash flow from earlier research was tested. For example, some prior research has approximated cash flow as net income plus depreciation and amortization.[45] Other research has defined cash flow as working capital from

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[45] See Bravo, p. 18.

operations as shown on the statement of changes in financial position.[46]

3.1.2   INCOME MEASUREMENT MODELS

Both of the above measurements of cash flow were predicted using various income numbers as the independent variable.   Various combinations of these income models have been used in earlier research, and an objective of the present research is to include all of the previous income and cash flow measurements in a single research design in an attempt to eliminate inconsistencies in the reported results. √The income models are:

1. Historical cost as currently reported in the traditional financial statements.

2. General price-level adjustd historical cost including monetary gains/losses.

3. General price-level adjusted historical cost excluding monetary gains/losses.

4. Replacement cost operating income excluding holding gains/losses.

5. Replacement cost total income that includes holding gains/losses.

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[46] See Means, p. 4.

Cash flow predictions from each of these models were compared with predictions of future cash flows from prior cash flows as a control for relevant quality assessment.

General price-level adjusted income was computed by applying the gross national product (GNP) implicit price deflator for each year to financial statement items as indicated by the Parker model (to be explained in Chapter 4). The use of this GNP price index attempts to measure the change in general prices for the economy as a whole. Any associated monetary gain/loss is a measure of the increase or decrease in purchasing power from the level of monetary assets and monetary liabilities maintained during each period. Under the Parker model, monetary assets are the current assets excluding inventory, marketable securities, and prepaid expenses while monetary liabilities are current and noncurrent liabilities excluding deferred taxes, unearned income, and advances from customers. When prices are rising, a monetary gain results from an excess of monetary liabilities over monetary assets, and a monetary loss results from an excess of monetary assets over monetary liabilities. The numerical monetary gain/loss for a period is computed by multiplying the ratio of ending general price-level index divided by beginning general price-level index times the average net monetary asset/liability

position for that period. Two different income models used in this research (models 2 and 3 above) were derived by first including and then excluding this monetary gain/loss in computing the net income.

The remaining two income models were designed to reflect the effects of specific price-level changes on certain elements of the financial statements according to the model proposed by Falkenstein and Weil (also explained in Chapter 4). Replacement cost operating income is computed by restating cost of goods sold, inventory, and property, plant, and equipment for specific price changes affecting each of these elements each period for each firm in the total sample. The amount of the holding gain/loss associated with each period's specific price changes is an estimate of the change in the specific prices for inventory and property, plant, and equipment assets for that period as measured by changes in specific indexes. "Replacement cost operating income" does not normally include this holding gain/loss. When the holding gain/loss for each period is included in replacement cost operating income, the resulting income measurement is titled "replacement cost total income."

3.1.3 FORECAST ERROR

Each of the net income values is used as the independent variable in four prediction models (explained below) to predict both of the cash flow measures (the dependent variable). To compare the relative abilities of each income measurement model to predict cash flows, however, some measure of prediction error must be defined.

The present research assessed predictive ability of the income models by a percentage deviation measure that has been used in previous research.[47] First, an absolute forecast error was defined as the difference between the actual and forecasted cash flow for each forecast year. This error was then converted to a percentage to control for variations in the magnitude of the cash flow numbers as follows:

$$E_t = \left| \frac{\hat{c}_t - c_t}{c_t} \right| \times 100\%,$$

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[47] Bravo, "An Empirical Analysis," pp. 30-31.

where,

E_t = percentage forecast error in period t,

$\hat{C}_t$ = predicted cash flow in period t,

C_t = actual cash flow in period t.

This error term was calculated for each firm in the sample for 1976 and 1977. The average forecst error for each firm over these two periods was then used in the statistical analysis that is discussed in a subsequent section.

3.1.4   SAMPLE STRATIFICATION

Recall that other objectives of this research include testing for possible conditions under which the relative cash flow predictabilities of the alternative income models vary. Specifically, tests for industry and firm-size effects were conducted. Industry effects were analyzed using the average percentage deviations of the individual firms in each industry classification. Two-digit SIC codes[48] were used to divide the sample data into twelve industry groupings of four or more firms. These twelve groupings were used to test for industry effects by a

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[48] William Beaver and James Manegold, "The Association Between Market Determined Measures of Systematic Risk: Some Further Evidence," <u>Journal of Financial and Quantitative Analysis</u>, June 1975, p. 244.

statistical methodology discussed below. The four-firm minimum results in the omission of nineteen firms from the industry effects test because most of these belonged to one-firm industries in the data base.

Firm-size effects were tested by dividing the total sample of firms into two subsamples according to the size requirements for reporting under Statement No. 33 of the FASB.[49] Additionally, firm-size effects were tested by further dividing the sample by total assets as follows:

1. less than $1.0 billion

2. $1.0 to $1.9 billion

3. $2.0 to $2.9 billion

4. $3.0 billion and over.

The average percentage deviations of the individual firms in each size classification were used to test for firm-size effects according to the statistical analysis design.

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[49] These firm size requirements are: (1) inventory, property, plant, and equipment (before depreciation) of more than $125 million, or (2) total assets (net of depreciation) of more than $1 billion.

3.2   THE FOUR PREDICTOR MODELS

The predictive ability literature contains several models for assessing the relationship between independent and dependent accounting variables. Four separate models (including the control) were selected for this research because there is no accepted method to determine the most suitable forecasting model for time-series data.[50] First, simple linear regression was used in the following form:

$$E(C_t) = a + bI_{t-1} , \qquad (1)$$

where,

t   = forecast year, 1976 or 1977,

$E(C_t)$ = expected cash flow in period t,

I_{t-1} = income in period t-1.

The prediction equation for 1976 was estimated using the cash flow and income data for the periods 1972-1975. Cash flow for 1976 was predicted by using the 1975 income numbers as the independent variable in the specified prediction equation. The predicted value was compared with the actual cash flow for 1976 and the percentage deviation

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[50] See Ball and Watts, Journal of Finance, June 1972.

forecast error computed as previously defined. Actual income and cash flow data for 1972-1976 were used to specify the prediction equation for 1977. This equation was used to generate the predicted cash flow for 1977 using 1976 income, and the forecast error was then computed.

The second model is a multiple linear regression model that has been used in two previous cash flow prediction studies.[51] This model is expressed as follows:

$$E(C_t) = a + b_1 I_{t-1} + b_2 S_{t-1}, \qquad (2)$$

where,

$E(C_t)$ = forecast of cash flows at time t,

I_{t-1} = income for period t-1,

S_{t-1} = sales for period t-1.

The prediction equation and forecast error was computed as previously described. For the first forecast year (1976), the prediction equation was specified from the cash flow and income data for 1972-1975. To forecast 1976 cash flows, income and sales values from 1975 were substituted

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[51] George M. Scott, <u>Research Study on Current Value Accounting Measurements and Utility</u>, Touche Ross Foundation, 1979, p. 165. See also, Means, p. 86.

into the prediction equation as the two independent variables. The forecast error was computed by comparing the actual and forecasted cash flow amounts. Similarly, data for 1972-1976 were used to specify the 1977 prediction equation.

The above regression models incorporate a linear relationship. To allow for the possibility that some income and/or cash flow patterns may not be linear, a nonlinear first-degree exponential prediction model was employed.[52] This model can be expressed as:[53]

$$E(C_t) = aI_{t-1}^b \ , \tag{3}$$

where,

$E(C_t)=$ forecast of cash flows at time t,

I_{t-1} = income for period t-1.

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[52] Prior research has employed first-degree and higher order exponential models. Because the behavior pattern of the variables used in this research was not known in advance, however, it is believed that the model selected is a practical solution to the objective of representing the class of nonlinear prediction models in this design.

[53] R. J. Wonnacott and T. H. Wonnacott, _Econometrics_, New York: John Wiley & Sons, 1979, pp. 120-122.

For computational convenience, this model was transformed[54] with natural logarithms when deriving the prediction equations for 1976 and 1977. After the prediction equation was specified (1972-1975 income and cash flow data to specify the 1976 equation), the prediction of cash flow and forecast error was computed in the same manner described for the two previous regression models.

Several prediction studies in accounting have used what has been termed "naive" models. These have been based primarily on conclusions by Ball and Watts that the earnings variable is highly unstable, and that the most recent observations are the best measures from which to predict the next value of the variable. In order to provide a control forecast for comparison with the income models' cash flow forecasts, a model was tested that states that forecasted cash flow will change by the same amount that the previous years' cash flow changed from the year before that:[55]

$$E(C_t) = 2C_{t-1} - C_{t-2}, \tag{4}$$

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[54] This model uses a natural log transformation. The log transformation permits the specification and later prediction as if it were a linear model.

[55] Charles H. Brandon and Jeffrey E. Jarrett, "Revising Earnings Per Share Forecasts: An Empirical Test," Management Science, March 1979, p. 214.

where,

$E(C_t)$ = forecasted cash flow for period t,

C_{t-1} = cash flow in period t-1,

C_{t-2} = cash flow in period t-2.

The relationships among cash flow prediction, income models, and prediction models can now be expressed in the following testable hypothesis form. This set of hypotheses addresses the specific research questions posed in Chapter 1.

3.3 HYPOTHESES TO BE TESTED

The average percentage deviation (over the two forecast years) under each income model and predictor model for each firm was calculated as already described and used to test the following null hypotheses that are based on the research objectives:

H_0^1 : There is no difference among the five income models in predicting cash flows over all firms in the sample.

H_0^2: There is no difference among the three predictor models in predicting cash flows over all firms in the sample.

H_0^3: There is no interaction between the income models and the predictor models in predicting cash flows over all firms in the sample.

H_0^4: There is no interaction between the income models and the industry classifications in predicting cash flows.

H_0^5: There is no interaction between the predictor models and industry classifications in predicting cash flows.

H_0^6: There is no three-way interaction among income models, predictor models, and industry classifications in predicting cash flows.

H_0^7: There is no difference among the twelve industry classifications in predicting cash flows.

Each hypothesis was tested using both definitions of cash flow explained earlier. In addition, hypotheses four

through seven were retested after substituting firm-size classifications for industry classifications. Also, each of the income models was compared individually with the "control" cash flow model.

The alternative hypothesis related to each of the above null hypotheses is that there is a significant difference in the percentage deviations of the cash flow predictions for each of the specified comparisons. The multivariate statistical testing of these hypotheses is explained in the next section of this chapter.

3.4 STATISTICAL ANALYSIS

The analysis was carried out as a three-way repeated measurements design. This multivariate approach was required because, for each firm in the sample, there is a lack of independence across observations for the five income models and four prediction models.[56] The three factors are: (1) income model (five levels), (2) predictor model (three levels), and (3) industry effects (thirteen levels). The entire design was reanalyzed with the industry factor replaced by a firm-size factor with two levels, and again with four levels, as described in the definition of terms

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[56] Clyde Y. Kramer and Donald R. Jensen, "Fundamentals of Multivariate Analysis Part I: Inference About Means," Journal of Quality Technology, April 1969, pp. 120-123.

section of this chapter.

After cash flows were estimated and the percentage forecast errors computed, the first three hypotheses were tested by a one-group Hotelling's T-squared procedure. This test is a generalization of Students t-statistic from univariate statistical analysis and involves the testing of hypotheses for the vector of means, the vector of hypothetical means, and the matrix of variances and covariances for a multivariate normal population.[57] These first three hypotheses were tested for income model effects, predictor model effects, and possible interaction effects between the income model and predictor model.

If any null hypothesis of no significant difference was rejected, the associated pairs of income models and predictor models were tested for significance using simultaneous confidence intervals. This procedure permitted the determination of those specific components of the vector of means that differ from their hypothetical values.[58] If the simultaneous confidence interval for each comparison contains ·the hypothetical value (zero-point in this

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[57] Clyde Y. Kramer and Donald R. Jensen, "Fundamentals of Multivariate Analysis Part II: Inference About Two Treatments," Journal of Quality Technology, July 1969, p. 189.

[58] Kramer and Jensen, "Fundamentals of Multivariate," pp. 195-199.

application), those two models are considered not significantly different. Similarly, if the confidence interval does not contain the hypothetical value that pair is considered significantly different.

Hypotheses four through six were tested by a one-way multivariate analysis of variance. This procedure permitted the third level (industry and firm-size classifications) of the repeated measurements design to be analyzed simultaneously with the income models and predictor models. The multivariate test was required because of the lack of independence across the various models for each firm (as previously explained). If the null hypotheses for interaction effects are rejected, the means of each possible interaction combination were visually inspected in order to assess the nature of the interaction.

Hypothesis seven for the industry effect/firm-size effect was tested by one-way analysis of variance. There was no independence problem associated with testing for these effects because the percentage deviation forecast errors werre averaged over all the predictor models. Therefore, a univariate analysis was appropriate. When this null hypothesis was rejected, pairwise comparisons of all industry classifications and pairwise comparisons of all firm-size classifications were made using Duncan's Multiple

Range Test because it is the more powerful of the pairwise tests.

McCall and Appelbaum (1973) caution that the use of repeated measurements research designs requires adherence to strict assumptions regarding the variance-covariance (i.e. correlations among repeated measures) structure of the data. They point out that violation of the assumption of homogeneity of covariances in a repeated measures analysis of variance application results in too many rejections of the null hypothesis for the stated significance level.[59]

In discussing alternatives to traditional analysis of variance in repeated measures designs, McCall and Appelbaum suggest possible use of a set of independent contrasts for the repeated factors as the dependent variables in a multivariate analysis of variance.[60] They conclude that given multivariate normality but no assumptions about the variance-covariance structure, such a procedure is somewhat less powerful than conventional techniques when the assumptions on the covariance structure are met. Additionally, they state that when the homogeneity of covariance is ambiguous, the multivariate test is probably

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[59] Robert B. McCall and Mark I. Applebaum, "Bias in the Analysis of Repeated Measures Designs: Some Alternative Approaches," Child Development, 1973, p.401.

[60] McCall and Applebaum, "Bias in the Analysis," p. 414.

the single most exact, powerful, and versatile analysis of repeated measurement data. Based on these and other similar findings in the literature, independent contrasts were used in the multivariate analysis of variance applications in this research.

3.5 SUMMARY

The research questions specified in Chapter 1 and the precedent for predictive ability research on income measurement and cash flow issues in accounting from Chapter 2 provide the background and justification for the specific research design presented in this chapter. This design was developed through definitions of the dependent and independent variables in the prediction process, a discussion of the particular prediction models selected, and a presentation of the formal hypotheses to be tested. Finally, support for the statistical methodology that relies on a multivariate repeated measurements design to investigate the specified relationships was presented. The following chapter presents the data sources and further develops the actual models that were used to carry out the proposed research design.

Chapter IV

DATA SOURCES AND RESTATEMENT PROCEDURES

This chapter includes a discussion of the primary data sources that contain the financial variables that were analyzed in accordance with the research design and methodology presented in the previous chapter. Also, given is a detailed description of the replacement cost data estimation process using the Falkenstein and Weil (F-W) model, and the general price-level (GPL) adjustment procedures as specified in the Parker model. After the restatement models are developed in the chapter, examples of the validation steps applied to the sample historical cost, replacement cost, and GPL adjusted data are described.

4.1 DATA SOURCES

The primary data source was a Statistical Analysis System computer tape that included historical cost data from the Standard and Poor's COMPUSTAT tapes, replacement cost numbers generated by Easman Inflation Consultants, Inc.[61] (hereafter, Easman), and GPL restated data computed using the Parker model. This tape contains a total of 88

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[61] Angela Falkenstein and William S. Easman, Jr. Inflation Accounting Research Service, Easman Inflation Consultants, Inc. Greenwich, Connecticut (1981).

historical cost, replacement cost, and GPL adjusted historical cost financial variables for 153 companies for the periods 1971-1977. Historical cost variables were converted to replacement cost and GPL price-level adjusted variables by the application of general and specific price indexes as explained later in the chapter.

Upon review of this data base it was discovered that the replacement cost variables for a majority of the companies were not available for 1971, so that year was dropped from the data base. Also, data for 64 variables for FMC Corporation were missing for all years, so this data was excluded from the final sample of companies. Therefore, the final data base used in this research included 152 companies from 72 industries (based on a four-digit SIC code) for 6 years.

The unadjusted historical cost variables included in the data base were drawn from the COMPUSTAT tapes. The validation procedures for this historical cost data, the replacement cost data, and the GPL adjusted data are presented in the final section of this chapter. The next section describes the specific steps that Easman employed to generate the replacement cost approximations and the detailed application of the Parker model to derive the GPL adjusted variables.

4.2   RESTATEMENT PROCEDURES

4.2.1   REPLACEMENT COST DATA

The replacement cost data supplied by Easman is intended to represent specific price-level adjustments on each firm's inventory and fixed asset holdings for each of the periods included on the tape. As already mentioned, these specific price-level changes are computed according to the restatement procedures developed by Falkenstein and Weil.[62] A description of these restatement procedures follows.

The F-W model for specific price-level adjustments results in computations for "sustainable" income and "economic" income. This "sustainable" income (referred to elsewhere as distributable income) is computed by adjusting the conventionally reported net income for (1) the difference between replacement cost of goods sold and historical cost of goods sold and (2) the difference between replacement cost depreciation and historical cost depreciation. These differences between the replacement cost and historical cost numbers for both cost of goods sold and depreciation are referred to as realized holding

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[62] Angela Falkenstein and Roman L. Weil, "Replacement Cost Accounting--What Will Income Statements Based On the SEC Disclosures Show?" Financial Analysts Journal, Part I, January-February 1977, pp. 46-57, and Part II, March-April 1977, pp. 48-57.

gains/losses. F-W state that they consider this sustainable income the single most useful number for analysts and investors interested in the ability of a firm to pay cash dividends in the future.[63]

After sustainable income has been computed, a further modification to include the unrealized holding gains/losses produces "economic" income. According to the F-W model, the unrealized holding gain/loss on inventory is the difference between the replacement cost value of inventories at the end of the year and the replacement cost value of inventories at the beginning of the year. Similarly, the unrealized gain/loss on plant and equipment is the difference between the replacement cost value of plant and equipment at the end of the year and the replacement cost value of plant and equipment at the beginning of the year. The specific procedures used to estimate the replacement cost numbers referred to above will now be explained.

First, replacement cost of goods sold and replacement cost depreciation expense are computed for use in calculating "sustainable" income. F-W procedures involve the use of the Bureau of Labor Statistics' Wholesale Price Index (WPI) by stage of processing for the specific price-level adjustment. To estimate replacement cost of goods

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[63] Falkenstein and Weil, "Replacement Cost Accounting--Part I", p. 48.

sold, the following steps are taken:[64]

1. LIFO and FIFO components of cost of goods sold are separated. This requires that firms have disclosured LIFO and FIFO percentages of beginning and ending inventories.

2. For cost of LIFO goods sold, no adjustment is made unless there is a dip into old LIFO layers. This approach is justified because it has been shown that if purchases are spread evenly throughout the year, and a periodic inventory system is used, then the LIFO cost of goods sold is approximately equal to (actually, slightly larger than) the replacement cost of goods sold.[65] If there is a dip into old LIFO layers, (a) it is identified as the excess of beginning LIFO inventory over ending LIFO inventory, and (b) the amount of the dip into old layers is adjusted by two or fewer years of specific price change.

3. For FIFO cost of goods sold an adjustment is always made. F-W show that their relatively simpler estimate of FIFO replacement cost of goods sold

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[64] Falkenstein and Weil, "Replacement Cost Accounting--Part II," p. 52.

[65] Sidney Davidson and Roman L. Weil, "Inflation Accounting: The SEC Proposal for Replacement Cost Disclosures," Financial Analysts Journal, March-April 1975, pp. 61-62.

always approximates the estimates from more tedious methods.[66] This easier approximation involves the identification of the portion of the current year's purchases that entered cost of goods sold as "cost of goods sold" minus "beginning inventory." No adjustment is made to this quantity. The beginning FIFO inventory, however, is adjusted for one full year of specific price change.

4. All specific price changes are taken either from specific components of the WPI or from the stage of processing series of the WPI. The specific components of the WPI for finished goods include:

a) total finished goods

b) consumer foods

c) finished goods excluding consumer foods--total

d) finished consumer goods excluding consumer foods--total

e) finished consumer goods excluding consumer foods--durable

f) finished consumer goods excluding consumer foods--nondurable

g) capital equipment

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[66] Falkenstein and Weil, "Replacement Cost Accounting--Part II," p. 51.

h) total finished consumer goods.

5. The specific components of the WPI for intermediate materials include:

a) total

b) foods and materials for food manufacturing and feeds

c) other.

6. The specific components of the WPI for crude materials include:

a) total

b) food stuffs and feed stuffs

c) other.

7. The stage of processing series of the WPI includes:

a) crude materials for further processing

b) intermediate materials, supplies, etc.

c) consumer finished goods

d) producer finished goods.

An estimate of replacement cost depreciation expense with the F-W model involves three separate steps.[67] The first of these steps is to determine the age of the fixed assets. Since the acquisition date of a firm's fixed assets is not always readily available, the F-W procedures use the average age of depreciable assets as an approximation of the

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[67] Falkenstein and Weil, "Replacement Cost Accounting--Part II," pp. 52-54.

base year from which to measure the holding period of these assets. The holding period determines the time span over which the specific price-level adjustments apply in computing the replacement cost of gross fixed assets. This average age is calculated by dividing the accumulated depreciation balance by current year depreciation charges. If a company uses the straight-line method for computing depreciation, the base period is found by subtracting the average age of depreciable assets from the year that the replacement cost figures are being generated.

The above base period calculations would overstate the average age of a firm's depreciable assets if it used an accelerated method for computing depreciation charges. This results, of course, from the fact that higher depreciation charges are recorded under the accelerated methods in earlier years of an asset's life than with the straight-line method.

Davidson, Stickney and Weil have shown that, when a company uses some form of accelerated depreciation, the procedure described above overstates the average age of depreciable assets by 15 to 20 per cent, depending on the rate of increase in acquisitions of depreciable assets.[68]

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[68] Sidney Davidson, Clyde P. Stickney and Roman L. Weil, Inflation Accounting: A Guide for the the Accountant and Financial Analyst (New York: McGraw-Hill Book Co., 1976), pp. 126-127.

Therefore, the average age using straight-line depreciation computations has to be reduced for those firms in the sample that applied accelerated depreciation methods. This reduction is accomplished by multiplying separate age-reducing factors (for the double declining balance and sum-of-the-year's-digits methods) by the straight-line average age. These factors were developed for multiple levels of unadjusted averae life (in years) and various annual growth rates of the depreciable assets.[69]

The second stage in the computation of replacement cost of depreciable assets using the F-W model requires the development of conversion factors for restating plant and depreciation amounts. F-W point out that detailed information about asset types for different industries is not readily available. Their approach is to construct the required industry asset profiles from the Department of Commerce interindustry transaction studies (input-output matrix) that trace the buyers and sellers of producer structures and equipment.

The concept of this input-output analysis is that every purchaser of products and services is also a supplier, both within the same industry and to other industries. The

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[69] Sidney Davidson and Roman L. Weil, "Inflation Accounting," _Financial Analysts Journal_, January-February 1975, pp. 70-71.

matrix discloses the level of purchases (columns) and sales (rows) for each industry. Analyses of broad purchasing patterns of structures and equipment over a period of years show consistency in the proportions of goods purchased by a given industry from the selling industries.[70] As a result, F-W construct an asset profile for a purchasing industry by examining its purchases, assuming that the proportions of purchases from the various supplying industries remains relatively constant.

Asset profiles could be constructed for a large number of industries from the economy-wide input-output matrix; however, F-W narrowed these to 33 purchasing industries--2 extractive industries, 25 manufacturing industries, and 6 service industries. Then, those supplier industries selling amounts of assets large enough to affect the composite price index of the purchasing industries (at a cutoff of five percent) were identified. Supplier industries where products were similar, or where price changes were essentially identical over a period of years, were consolidated to a·level of from four to eight supplier industries for each purchasing industry.

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[70] Falkenstein and Weil, "Replacement Cost Accounting--Part II," p. 55.

Conversion factors for the various industry groups were developed from WPI data for capital goods costs on machinery and equipment and the construction cost index on new construction. These indexes usually yield reasonable replacement cost estimates when there has been little technological change in the production process, or when related productivity gains can be factored into the indexes. They will overstate replacement cost for industries where technological improvements are important, but the amount is not yet measurable.[71] For each company that a replacement cost estimate is required, the lines of business being analyzed must be matched with one or more of the 33 industry groups described above.

Next, the percentage of each firm's capital assets that is committed to each of these industries is determined. In most cases, the firms operating in more than one industry do not categorize their fixed assets by industry. The F-W methodology approximates the industry weightings from the breakdown of each firm's sales by major lines of business in the form 10-k. This approach assumes that percentages for sales can be meaningfully used to assign plant and equipment assets to lines of business. For each firm, the weighted conversion factor for year-end replacement cost estimation

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[71] Falkenstein and Weil, "Replacement Cost Accounting--Part II," p. 56.

is obtained by multiplying each industry group weight (a percentage) by the specific price change factor for each industry group (derived from the input-output analysis) and then summing the products.

The third step in the F-W methodology for developing the replacement cost estimate for depreciation and fixed assets is to multiply the weighted conversion factors by the year-end historical cost values for depreciation and fixed assets. The resulting replacement costs of gross fixed assets at the beginning and end of the year are used to calculate an average straight-line replacement cost depreciation expense for each year. This depreciation expense is calculated by averaging the two year-end replacement costs and dividing by the average age of the historical gross plant and equipment (historical value of gross depreciable property at each year end divided by each year's depreciation charge, then averaged).

4.2.2   GENERAL PRICE-LEVEL-ADJUSTED DATA

The estimates of GPL adjusted net income are based on the Parker methodology.[72] Other models, such as Petersen and Davidson and Weil, are available to restate financial statement data for GPL changes. The data base for the

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[72] Parker, "Impact of Price-Level Accounting," pp. 69-96.

current research utilized the Parker model because Ketz reports that, except for owners' equity, the three models mentioned perform about equally well.[73] In addition, Ketz points out that the Parker model permits one to use the COMPUSTAT tapes to obtain original historical cost data and is much easier to apply than the alternatives. Disadvantages of the Parker model that have been disclosed in the literature are that it tends to overestimate owners' equity more than the other models and it does not cope with accelerated depreciation.[74]

Because this research does not use owners' equity in the computation of GPL adjusted net income, that particular disadvantage of the Parker model is inconsequential here. Because COMPUSTAT does not disclose the depreciation method that is used by each firm for financial reporting, the straight-line method is assumed under the Parker model. It is believed that this will not have a significant impact on the current research because the 1981 issue of Accounting Trends and Techniques (AICPA) reports that approximately 73% of the 600 companies surveyed use straight-line depreciation

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[73] John Edward Ketz, "A Comparison of the Predictability of Business Failure by the Financial Ratios of General Price Level Statements With Those of Historical Cost Statements," (Ph.D. dissertation, Virginia Polytechnic Institute and State University, 1977), p. 111.

[74] Ketz, "A Comparison of the Predictability," p. 119.

for financial reporting purposes.

The adjustment process requires the calculation of the average GPL change for the year. Sales, operating expenses, dividends, and other items that are assumed to occur evenly throughout the year should be adjusted at this average rate. Because Parker does not specify how to compute this average price change, the GPL data used in this research was compiled using the geometric mean.

If FIFO is the inventory valuation method, the purchases are determined and the average daily purchases are calculated. After the number of days' purchases in the ending inventory is determined, the ending inventory layers by date of acquisition can be identified. The FIFO inventory GPL adjustment is made from this dating procedure.

The LIFO ending inventories are adjusted by picking an arbitrary starting point for the initial layer and then identifying each layer added after that. (Data for the first year, 1971, were used to establish the initial layer for the current research.) The amount of each inventory layer is adjusted to the price-level of the year under consideration.

For a weighted average ending inventory, the first year's restatement is accomplished in the same manner as described above for FIFO inventory. In following years, the

ratio of ending inventory to cost of goods available for sale is determined. The cost of goods available for sale is adjusted for each period's GPL change. This adjusted cost of goods available for sale is multiplied by the ending inventory ratio previously computed to yield the estimated GPL adjusted ending inventory. Under all three inventory methods, price level-adjusted cost of goods sold is computed by subtracting the adjusted ending inventory from the adjusted cost of goods available for sale.

The restatement procedures for depreciation expense and net plant are the same for the Parker and Davidson and Weil models, except that Parker assumes the straight-line method is used. First, the average age of the depreciable assets is computed as the accumulated depreciation divided by the depreciation expense. The GPL adjustment is then made using these adjusted age estimates of the depreciable assets.

The monetary gain or loss is computed from the average monetary assets and average monetary liabilities for each year. These are simple averages of beginning and ending balances of the monetray items, and the average GPL change is multiplied by the excess monetary assets (monetary loss) or excess monetary liabilities (monetary gain).

4.3   VALIDATION PROCEDURES

4.3.1   HISTORICAL COST

Since the data base to be used in the analysis of cash flow predictability of alternative income models was not compiled by the author, extensive validation of all categories of data was undertaken. As already indicated, the historical cost financial variables in the data base originated from the COMPUSTAT tapes. It was decided that these variables could be traced to the annual reports and/or forms 10-k of the annual SEC filings for each firm in the data base. A total of twenty firms from eighteen separate four-digit industry code classifications was selected for verification of the historical cost data. There are twenty-eight historical cost variables for each firm included in the data base. For each of the twenty firms, historical cost variables that are important in this analysis--net sales, working capital from operations, income before extraordinary items, and depreciation expense--were compared with data from both annual financial statements and forms 10-k for the years 1972, 1975, and 1977. The comparison disclosed no material discrepancies for any of the twenty companies for any of the three years verified. An example of this part of the validation process is included in Figure 1.

VARIABLE & SOURCE	1972	1975	1977
Net sales:			
10-k	$1753.02	$2305.90	$3416.50
Data base	1753.00	2305.88	3416.44
Working capital from operations:			
10-k	$ 238.25	$ 214.90	$ 390.90
Data base	238.25	214.89	390.87
Income before extraordinary items:			
10-k	$ 102.84	$ 64.80	$ 195.20
Data base	102.84	64.79	195.19
Depreciation:			
10-k	$ 150.86	$ 170.80	$ 203.90
Data base	150.86	170.79	203.89

Figure 1: Historical Cost Validation Example
Aluminum Company of America
(in millions)

4.3.2   REPLACEMENT COST

There were two reasons for the validation of the replacement cost numbers in the sample data. First, it was essential to ascertain that the numbers are internally consistent. For example, when reported net income based on historical cost is adjusted for the realized holding gains/losses on inventory and depreciable assets, the result should be replacement cost operating income according to the F-W model. Similarly, replacement cost total income is derived by adjusting the reported historical cost income for the unrealized holding gains/losses on inventory and depreciable assets according to the same model. Therefore, it was necessary that the data be tested for the existence of these specified relationships. The second reason is that it was necessary to test for computational accuracy the actual restatement procedures that have been applied by Easman to calculate the replacement cost numbers.

As already indicated, the test for internal consistency involved testing that the theoretical relationships specified by the restatement models among historical cost, replacement cost operating income, and replacement cost total income exist in the data. A sample of ten firms was selected from the total and internal consistency verified for all the specified relationships (including general

price-level adjusted as explained later in this chapter) for
one year, chosen randomly, for each firm.

4.3.2.1   REPLACEMENT COST OPERATING INCOME

An example of the internal consistency verification for
replacement cost operating income for Philip Morris for 1972
follows in Figure 2.   This figure is comprised of values
from the data base variables that enter into the computation
of replacement cost (RC) operating income.   The value of the
replacement cost operating income variable in the data base
was $66.6 million for Philip Morris for 1972.   Because the
data base value for RC-operating income of $66.6 million is
approximately equal to the $66.8 million from the detailed
computation contained in Figure 2, internal consistency was
considered to be established in this case.   Indeed, in each
of the ten cases examined in detail these relationships were
found to exist consistently in the data.   Next, the
restatement procedures that are required to produce this
replacement cost operating income are examined.

For Philip Morris, the excess of replacement cost cost
of goods sold (COGS) used in the previous example was
determined as shown in Figure 3 using variables taken from
the data base.   While the historical COGS was easily
verified from annual reports or form 10-k, the various

Historical cost income   - $124.5

Less: Excess of replacement cost:

     Cost of goods sold (COGS)   (51.7)

     Depreciation expense   (6.0)

Replacement cost operating income (computed) $ 66.8

Note: All dollar values in all tables and figures are in millions.

Figure 2:   RC-Operating Income Computation for Philip Morris--1972

Historical COGS $807.6

Less: Replacement COGS   859.3

Excess of replacement COGS $ 51.7

Figure 3:   Computation of Excess RC-COGS for Philip
            Morris-1972

restatement steps of the F-W model were applied in an attempt to recompute the replacement COGS for each of the test firms.[75]

Because Philip Morris values finished goods inventories by FIFO and raw materials/work-in-process inventories by average cost, two separate adjustments were made to convert historical COGS to replacement COGS. According to the model, no adjustment is made to the portion of current year purchases that entered COGS (i.e., COGS minus beginning inventory) but a one-year specific price adjustment is made to the beginning inventory. Figure 4 gives the computations to restate beginning FIFO and average cost inventories to a replacement cost basis.

The conversion of the FIFO component of beginning inventory in Figure 4 follows the one-year restatement guideline of the F-W model. Because the finished goods inventories are valued by FIFO the replacement cost conversion factor used in that example is the 1972 WPI for total consumer finished goods in the numerator (116.6) and

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[75] Easman Inflation Consultants, Inc. declined to make the computer program steps for the replacement cost restatement procedures available to the author. In an effort to recompute the replacement cost values several subjective, even trial and error, interpretations of the F-W model had to be made. That is, the choice from among numerous wholesale price indexes and industry classifications of asset profiles derived from the input-out matrices was not specified on a firm by firm basis by Falkenstein and Weil.

1/1/72 historical cost inventory:

    83% average cost and 17% FIFO   = $670.244

One-year specific price adjustment to this inventory:

    Raw materials/work-in-process (83%):

    .83 x $670.244 x (118.9/109.9)   = $600.3

    Finished goods (17%):

    .17 x $670.244 x (116.6/112.9)   =   119.2

1/1/72 inventory restated to replacement cost $719.5

Figure 4: RC-Beginning Inventory--FIFO & AC--for Philip
          Morris

the same index for 1971 (112.9) in the denominator. Because the F-W model does not explicitly deal with average cost inventory valuation it was decided to restate the raw material/work-in-process inventories for two years of specific price change. This was an arbitrary choice based on the observation that there were significant increases in these inventories over the immediately preceding two-year period. The numerator of the conversion factor for raw material/work-in-process (118.9) is the 1972 WPI-Total Intermediate Materials and the denominator the same index for 1970 (109.9).

In order to validate the replacement COGS value taken from the data base and identified in Figure 2, a recomputed replacement COGS value for 1972 (Philip Morris) is illustrated in Figure 5. It can be seen from the analysis in Figure 5 that the recomputed replacement cost COGS for Philip Morris (1972) is $856.89 million and the replacement cost COGS variable in the data base is $859.36 million. This difference of $2.47 million can be partially attributed to the fact that F-W did not specify the choice among alternative indexes applicable to the various components of total inventory for individual firms. Also, as explained earlier, an arbitrary choice that seemed reasonable in this case was made to restate the average cost component of

Current year purchases that entered COGS
(no price adjustment):

   Historical COGS $807.63

   Less: Historical cost beginning inventory   670.24

   Current year purchases in COGS $137.39

   Add: Replacement cost beginning
            inventory from Figure 3   719.50

Replacement COGS--computed $856.89

Figure 5: Replacement COGS Computed for Philip Morris--1972

inventory for purposes of the validation procedure. Based on these results, it does seem justified to conclude that the replacement COGS restatement procedures of the F-W model have been reasonably applied in the Philip Morris case. Similar conclusions were drawn for the other sample firms selected for validation.

Now attention will be directed to the validation of the replacement cost depreciation expense that enters into the computation of the replacement cost operating income. For the purpose of illustrating the restatement procedures involved for depreciation, the Philip Morris example will be continued here. The excess of replacement cost depreciation expense that was first identified in Figure 2 is calculated from the data base variables shown in Figure 6.

Again, historical cost depreciation can be easily verified from the annual reports and/or forms 10-k. This was performed as explained in the first section of this chapter. Next, the methodology of the F-W model was applied in an attempt to validate the replacement cost depreciation expense of $32.8 million reported in Figure 6. That methodology involves the computation of the average age of fixed assets by dividing accumulated depreciation for each year by the annual depreciation/amortization for that year. From the data base for this research the computation for Philip Morris for 1972 is presented in Figure 7.

Historical cost depreciation expense for 1972 $26.8

Less: Replacement cost depreciation
       expense for 1972   32.8

Excess of replacement cost depreciation $ 6.0

Figure 6:   Excess of Replacement Cost Depreciation for
             Philip Morris

$$\frac{\text{gross plant - net plant}}{\text{depreciation expense}} = \frac{\$597.13 - \$399.31}{\$26.82} = 7.4 \text{ years}$$

Figure 7: Computing Average Age of Fixed Assets for Philip
            Morris--1972

Next, this average age is used to compute the base period where the restatement for specific price-level changes begins:

1972 (year of restatement) - 7.4 (average age) = 1964.6

To get the fixed asset conversion factor for replacement cost restatement at the end of 1972 the appropriate WPI's for capital equipment (formerly, WPI for producer finished goods) were selected for 1972 and the base period, 1964.6. The index for 1972 becomes the numerator and the approximate 1964.6 index the denominator in computing the conversion factor:

$$\text{Fixed asset RC-conversion factor for 1972} = \frac{119.5}{94.4} = 1.2659$$

Using this factor, the replacement cost depreciation can be computed from the historical cost depreciation. This computation and a comparison with the data base variable for replacement cost depreciation for Philip Morris in 1972 is

Replacement cost depreciation computed:
$26.82 x 1.2659 = $33.95

Less: Replacement cost depreciation,
        Easman data   32.79

Difference $ 1.16

Figure 8:   RC-Depreciation Comparison for Philip

            Morris--1972

presented in Figure 8. The difference computed in Table 8 can be partially attributed to the fact that the specific assignment of each firm's plant asset components to the broad spectrum of asset profiles from the input-output matrix relationships is not specified by the F-W model or in the Easman data. It is believed, however, that the above computation procedures establish the reasonableness of the replacement cost restated depreciation in the Philip Morris case and for the remaining validation sample of firms.

4.3.2.2   REPLACEMENT COST TOTAL INCOME

The next phase of the replacement cost data validation process was concerned with the internal consistency and verifiability of replacement cost total income. The computation of replacement cost total income for Sears, Roebuck and Co. for 1974 from data base variables is included in Figure 9.

The replacement cost total income variable in the data base has a value of $820.5 million for 1974 and the internal consistency among the replacement cost variables is demonstrated for this case. Other similar comparisons were made for the sample of ten firms selected for validation and internal consistency was satisfactorily confirmed in all cases.

Reported net income $511.25

Less: Unrealized holding loss on inventory   (26.70)

Add: Unrealized holding gain on property,
        plant, and equipment   336.00

Replacement cost total income--computed $820.55

Figure 9:   Computing RC-Total Income for Sears--1974

INVENTORY (FIFO)

   2/1/75 inventory:

      Replacement cost estimate:

$$\$1879.06 \times \frac{137.7}{122.6} = \$2111.4$$

      Less: Historical cost   1879.1

      Holding gain on inventory 2/1/75 $232.3

   2/1/74 inventory:

      Replacement cost estimate:

$$\$1979.25 \times \frac{155.5}{137.7} = \$2234.4$$

      Less: Historical cost   1979.3

      Holding gain on inventory 2/1/74   255.1

   Unrealized holding loss on inventory
   for 1974-computed as holding gain 2/1/75
   minus holding gain 2/1/74   ($ 22.8)

Figure 10: Computing Unrealized Holding Loss on Inventory-
            Sears

Next, an attempt was made to validate the unrealized holding gain/loss values for inventory and property, plant, and equipment that are included in replacement cost total income. Under F-W procedures for the computation of unrealized holding gains/losses on these items, the unrealized holding gain/loss at the end of each period minus the unrealized holding gain/loss at the beginning of that period is the amount of the unrealized gain/loss to be recognized in replacement cost total income. The recomputed 1974 unrealized holding gain/loss on inventory and plant for Sears are presented in Figures 10 and &k, respectively.

The Easman data contains a value for unrealized holding loss on inventory for Sears (1974) of $26.7 million. The estimated replacement costs of inventory computed in Figure 10 are computed according to the F-W procedures requiring that FIFO inventories be restated for one year of specific price change. The schedule for Sears is based on a replacement cost conversion index of the approximate year-end WPI for total finished goods. As previously explained, the F-W model does not give specific guidance on the choice of indexes for the different inventory categories for specific firms. As a result, the attempt at validating the replacement cost values required choices among indexes that seemed reasonable for the specific firms, but also resulted

in a variation from the Easman values of $3.9 million for Sears.

The Easman data estimates the unrealized holding gain on plant for Sears (1974) as $336.0 million. The validation computations in Figure 11 for unrealized holding gains/losses on plant are based on conversion factors derived from the WPI-Capital Equipment and the predecessor WPI-Producer Finished Goods indexes.

This portion of the recomputation procedures resulted in replacement cost values that were not as close to the Easman approximations as others reported previously in this chapter. This can be partially explained by the fact that no attempt was made to separate the plant asset groups of each firm into the appropriate asset profiles of the F-W model that were derived from the national input-output matrices (33 possible choices for each firm). This decision was made because no specific criteria are given by F-W on the assignment of a firm's asset groups to the economy-wide asset profiles, nor on the specific price indexes to be used for those asset profiles. In addition, Easman would not disclose the specific assumptions and interpretations made on a firm-by-firm basis in generating their replacement cost data. Therefore, the decision was made to attempt replacement cost computations for the overall group of plant

PROPERTY, PLANT, AND EQUIPMENT

2/1/75 Plant-unrealized holding gain:

(a) average age of assets = $\dfrac{\$1191.56}{\$\ 148.95}$ = 8.0 years

(b) base period = 1974 - 8 = 1966

(c) specific price-level conversion factor
    for 1966-1974:   141/96.8 = 1.4566

(d) 12/31/74 plant replacement cost estimate:
        $3415.44 x 1.4566   = $4974.9
    12/31/74 plant historical cost   3415.4

Unrealized holding gain on plant at 12/31/74: $1559.5

2/1/74 Plant-unrealized holding gain:

(a) average age of assets = $\dfrac{\$1099.12}{\$\ 127.33}$ = 8.6

(b) base period = 1973 - 8.6 = 1964.4

(c) specific price-level conversion factor
    for 1964.4-1973:   132.25/94.4 = 1.401

(d) 12/31/73 plant replacement cost estimate:
        $3077.31 x 1.401 = $4311.31
    12/31/73 plant historical cost   3077.31

Unrealized holding gain on plant at 12/31/73: $1234.0

Unrealized holding gain on plant for 1974
    (computed as $1559.5 - $1234.0): $325.5

Figure 11: Computing Unrealized Holding Gain on Plant for
            Sears

assets for each firm using the more general capital equipment and producer finished goods components of the WPI series. This proved to be a reasonable approach for the Sears example presented, but reasonable approximations did not result for some of the validation firms.

4.3.3   GENERAL PRICE-LEVEL ADJUSTED HISTORICAL COST

The Parker model procedures were applied to the historical cost data to compute the effect of GPL changes. Two variations of GPL adjusted income are included in the data base for the current research--one with and the other without monetary gains/losses.

4.3.3.1   GPL-NET INCOME WITHOUT MONETARY GAINS/LOSSES

To compute GPL adjusted net income without the monetary gain/loss, the GNP-Implicit Price Deflator was applied to the components of the income statement as shown in Figure 12 for U. S. Steel for 1975. The 1975 U. S. Steel GPL-net income without holding gains/losses variable on the experimental data base was $224.38 million. The sales, cost of goods sold, operating expenses, and tax expense components of net income were all restated at the average general price-level change for 1975. This conversion factor

GPL-Sales:

      $8167.0 x 1.0356 = $8457.75

Less: GPL-Cost of Goods Sold:

      $6855.0 x 1.0356 =   (7099.04)

    GPL-Operating Expenses:

      $191.25 x 1.0356 =   (198.06)

    GPL-Tax Expense:

      $264.0 x 1.0356 =   (273.40)

    GPL-Depreciation Expense:

      $297.19 x 2.2125 =   (657.53)

Computed GPL-net income
without holding gains/losses $ 229.72

Figure 12: GPL-Net Income, No Holding Gains/Losses, for
            U.S. Steel--1975

was computed as the geometic mean[76] of year-end 1975 and year-end 1974 GNP-Implicit Price Deflators:

$$\sqrt{\frac{130.27}{121.45}} = \sqrt{1.0726} = 1.0356$$

The GPL-conversion factor for depreciation covers the period from acquisition date of depreciable assets through the period being restated. The computation of this conversion for U. S. Steel is presented in Figure 13. This computed GPL-conversion factor to restate depreciation expense (2.2125) differs from the factor used in the data base construction (2.2386) and explains the GPL-net income without monetary gains/losses difference identified by Figure 12 as due primarily to restating depreciation expense. Restating the depreciation expense requires a subjective choice of indexes when the average age of the fixed assets is an uneven number of years, as was the case in this example. The recomputation process demonstrates the

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[76] See Davidson, Stickney, and Weil, _Inflation Accounting_, pp. 94-99. These authors define "geometric mean" as it is used in this research to calculate one-half year of price change. The numerator is the fourth-quarter average index for this year and the denominator is the fourth-quarter average index for last year.

(a) Average age of assets (as before):

$$\frac{\$6397.0}{\$\ 297.2} \ = \ 21.5 \text{ years}$$

(b) Base time = 1975 - 21.5 = 1953.5

(c) GPL-conversion factor for period 1953.5-1975:

$$\frac{130.27}{58.88} \ = \ 2.2125$$

Figure 13: GPL-Conversion Factor for Depreciation, U.S. Steel--1975

internal consistency of the GPL-income statement components and reasonable assurance that the GPL-conversions have been carried out as specified in the Parker model for the U. S. Steel example. Similar results were obtained for the other validation firms.

4.3.3.2   GPL-Net Income With Monetary Gains/Losses

Next, the computation of U. S. Steel's 1975 GPL-net income that includes monetary gains/losses is presented in Figure 14. This is the same value as the data base variable "GPL-net income including monetary gains/losses" and demonstrates internal consistency among these additional variables.

The final step in the validation of the data used in this research is to test for computational accuracy of the monetary gains/losses for the validation sample of firms. An example of this analysis for U. S. Steel for 1975 is included in Figure 15. The price index used in this example is the average price-level change for 1975 as previously computed and this procedure results in a reasonable approximation of the monetary gain variable included in the experimental data base. Indeed, for each of the ten firms in the validation sample, the monetary gain/loss was verified to be the same in each case.

GPL-net income excluding monetary gains $224.38

Add: Net monetary gain for 1975   42.09

GPL-net income with monetary gain $266.47

Figure 14:   GPL-Net Income With Monetary Gain, U. S.
             Steel--1975

Average monetary assets, year-end 1975 and 1974:

 Cash, marketable securities, and receivables $1841.29

Less: Average monetary liabilities, same
      period: current liabilities and long-
      term debt   3021.55

Excess monetary liabilities $1180.26

Monetary gain = ($1180.26 x 1.0356) - $1180.26 = $42.02

Figure 15: Computing Monetary Gain/Loss, U. S. Steel--1975

4.4   <u>SUMMARY</u>

In conclusion, the validation procedures described in this chapter were designed to test the internal consistency and computational accuracy of the historical cost, GPL restated historical cost, and replacement cost variables included in the experimental data base. The internal consistency was verified for each of the three measurement models by testing that the components of each net income figure were those that produced the value of the corresponding data base variable. This was accomplished satisfactorily for all three income models (and their variations) and a specific example for each is discussed in this chapter.

The computational accuracy of the alternative income restatement procedures applied in the sample data is more difficult to verify. Because the Easman data, employing the F-W methodology, does not give specific guidelines on the selection of price indexes, nor on how the various categories of inventory and plant assets are restated for specific firms, subjective choices were made by the author in order to carry out the computational tests. These choices resulted in at least close approximations of the realized holding gains/losses of the replacement cost operating income model and both GPL restated income models.

The unrealized holding gain/loss component of the replacement cost total income model, however, was not as susceptible to recomputation for the reasons already identified. Nonetheless, taken together, the entire validation process appears to establish the overall reasonableness of the historical cost, GPL, and replacement cost variables of the experimental data base for this research.

Chapter V

ANALYSIS OF THE DATA

The purpose of this chapter is to present an analysis
of the cash flow forecast errors that have been produced by
the income measurement methods and prediction models chosen
for this study. The tests of the hypotheses are discussed
and the results of the statistical tests are presented.

Statistical analysis was conducted on the average
forecast errors that were defined in Chapter 3.[77] First,
computer programs were written to produce prediction
equations under the four prediction models selected.[78]
Second, these results were employed to forecast cash flows
for two prediction years. For each firm and forecast year a
forecast error was computed by subtracting actual cash flows
from forecasted cash flows and dividing the resultant sum by
actual cash flows. Then, for each firm an average of the
two forecast errors was computed. The internal validity of
each step in these programs was extensively tested on each
forecast model and income method for several test firms.
Examples of this series of program validation procedures are
presented in Appendix A.

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[77] See pages 48 and 49.

[78] See pages 51-55 of Chapter 3.

5.1   TESTS OF HYPOTHESES--WORKING CAPITAL FROM OPERATIONS

The seven hypotheses presented in Chapter 3 are based
on the possible effects that can be identified in a three-
factor repeated measurements research design.   This design
is specified in Table 1 and incorporates five levels of the
income factor and three levels of the prediction model
factor.   The third factor of this design groups sample firms
according to three separate criteria: (1) industry
classification (12 groups), (2) firm size classification I
(two groups), and (3) firm size classification II (four
groups).   The results of the statistical tests for the
interaction and main effects presented in the research
hypotheses are discussed in the following sections.   The
interaction effects are presented first because significant
results were obtained for these effects and the
interpretations of the main effects should be made only
after consideration of the fact that each particular
combination of income measurement, regression model, and
industry/firm size classification gives different cash flow
forecast errors.

TABLE 1

Outline of Research Design

FIRMS	HC			GPLWO			GPLW			RCWO			RCW		
	SLR	MLR	EXP	SLR	MLR	EXP	SLR	MLR	EXP	SLR	MLR	EXP	SLR	MLR	EXP

BY INDUSTRY
    1
    .
    .
    .
   12

BY FIRM SIZE I
(TOTAL ASSETS)
< $1 billion
$1 billion & over

BY FIRM SIZE II
(TOTAL ASSETS)
< $1 billion
$1.0-$1.99 billion
$2.0-$2.99 billion
$3.0 billion & over

KEY TO ABBREVIATIONS:

HC   = HISTORICAL COST INCOME

GPLWO = GENERAL PRICE LEVEL ADJUSTED NET INCOME EXCLUDING
        MONETARY GAINS/LOSSES

GPLW = GENERAL PRICE LEVEL ADJUSTED NET INCOME INCLUDING
        MONETARY GAINS/LOSSES

RCWO = REPLACEMENT COST NET INCOME EXCLUDING HOLDING GAINS/LOSSES

RCW   = REPLACEMENT COST NET INCOME INCLUDING HOLDING GAINS/LOSSES

SLR   = SIMPLE LINEAR REGRESSION

MLR   = MULTIPLE LINEAR REGRESSION

EXP   = EXPONENTIAL REGRESSION

5.1.1   Three-Way Interactions

The research hypothesis related to the investigation of three-factor interactions in the analysis of working capital from operations prediction is restated below:

H_0 :   There is no three-way interaction among income methods, predictor models, and industry or firm size classifications.

To test for interaction effects among all three factors of the research design, the multivariate analysis of variance (MANOVA) statistical procedure[79] produced the p-values reported in Table 2. P-values represent the significance levels at which the null hypothesis of no difference (H) would be rejected. A significance level of 10 percent was selected for the rejection of the null hypotheses for all interaction and main effects to provide reasonable opportunity for the important effects to be identified. Therefore, any p-value of 10 percent or less was considered a rejection of the related null hypothesis, in which case further analysis was conducted in an attempt to explain the

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[79] The MANOVA procedure in SAS reports four significance tests: (1) the Hotelling-Lawley trace, (2) Pillai's trace, (3) Wilk's criterion, and (4) Roy's Maximum Root criterion. All MANOVA p-values reported in this chapter were the result of the Wilk's criterion significance test.

reason for the rejection. Accordingly, these results shown in Table 2 were interpreted as indicating the presence of significant three-way interaction when the third factor of the design was industry and again when this third factor was firm size classification II.

In order to interpret this three-way interaction, the means of the three factors were analyzed[80] separately for each income measurement and again for each prediction model. Table 3 presents the means of the the average forecast errors for each industry classification, each prediction model, and each income model. These two sets of analyses showed fairly consistent patterns of industry forecast error means for each prediction model and each income model except industry 5 (steel). For the SLR and MLR prediction models, the means for the steel industry were approximately three times higher than the other eleven industry groups over all five income models. However, with the EXP prediction model, the mean forecast errors for the steel industry were lower than the other eleven industry groups for both GPL income models and both RC income models. This difference in the

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[80] Because of the practical limitations of plotting three factors each with multiple levels in this research, and the numerous definitions applied to the third factor of the research design the three-way interaction plots are not presented in this discussion. Because of primary interest in the main effects, however, plots of these results are presented later in this chapter.

TABLE 2

MANOVA Analysis for Three-Way Interactions

Income Method, Prediction Model, & Industry	Income Method, Prediction Model, & Firm Size Classification I	Income Method, Prediction Model, & Firm Size Classification II
.0016*	.2004	.0814*

* significant difference at .10 level

Note: The p-values reported in all tables are the levels at which the test results would be considered significant.

patterns of forecast errors for the three factors of the research design apparently results in rejection of the null hypothesis of no three-way interaction with factor three as industry group.

Substituting the firm size II grouping into factor three (note from Table 2 that the firm size I grouping of firms was not significant at the .01 level) yielded means of the three factors that are given in Table 4. When the means of each firm size group and all three prediction models were analyzed separately for each income measurement method, it was clear whether, for both GPL income methods and both RC income methods, the EXP prediction model did a significantly better job than the SLR and MLR prediction models for the fourth group of firm size II. This was not the case for the HC income method, however, where all three prediction models perform about equally well for all four groups of firm size II. This variation in error means for the largest firms is the apparent cause for the rejection of the null hypothesis of no three-way interaction when factor three is the firm size II classification scheme.[81]

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[81] The fourth group of the firm size II classification was statistically larger than the other three groups (see main effects section of this chapter). Three of the five steel industry firms belong to this group of largest firms; however, when the MANOVA analysis was conducted without the steel industry, the null hypothesis of no three-way interaction was again rejected.

TABLE 3

Means of Forecast Errors (Working Capital From Operations)
For Income Models, Prediction Models, and Industries

INDUSTRY	HC			GPLWO			GPLW			RCWO			RCW		
	SLR	MLR	EXP	SLR	MLR	EXP	SLR	MLR	EXP	SLR	MLR	EXP	SLR	MLR	EXP
1	15.71	14.86	14.72	16.94	13.91	17.31	16.06	14.28	15.44	17.91	14.98	18.72	21.1	14.8	20.78
2	17.68	17.45	17.75	20.38	18.08	20.88	21.38	18.13	22.3	26.65	17.73	28.65	24.13	17.9	24.03
3	14.63	12.87	14.29	17.03	12.28	16.26	16.8	12.35	15.98	18.14	12.3	19.58	18.54	11.91	18.53
4	18.31	16.19	18.39	21.57	16.23	21.96	22.34	16.24	23.8	24.61	15.93	21.46	23.74	16.44	23.91
5	65.48	74.7	65.7	62.38	74.92	14.7	62.0	75.54	18.18	63.62	76.26	16.5	72.54	79.22	26.64
6	18.06	15.8	17.87	21.29	15.38	22.04	21.21	15.55	21.27	20.68	15.1	20.51	23.55	16.59	22.83
7	25.58	23.11	25.01	27.95	22.78	30.59	27.79	22.88	30.02	27.63	22.69	27.66	30.83	25.43	30.95
8	23.51	22.59	24.01	26.37	23.24	24.77	27.8	23.56	27.61	26.95	22.02	21.05	26.59	22.85	28.48
9	20.53	17.74	18.7	24.29	17.18	25.39	24.43	17.14	24.47	26.21	16.93	26.07	29.72	18.17	29.72
10	13.88	11.66	14.14	17.03	11.31	16.04	16.41	11.61	15.24	16.47	11.21	18.34	20.29	13.44	21.83
11	15.72	13.16	14.18	19.4	12.18	17.76	19.8	11.94	22.94	17.94	12.22	14.28	24.0	12.72	24.72
12	28.35	23.73	25.18	27.03	22.08	22.7	27.48	22.3	23.8	30.05	22.48	28.83	28.9	23.75	23.0
All Other Firms	16.96	16.38	17.79	19.19	16.43	19.03	19.81	16.42	21.02	20.13	16.9	19.65	20.9	16.79	21.92

NOTE: See Appendix B for the specific firms within each industry.

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TABLE 4

Means of Forecast Errors (Working Capital From Operations)
For Firm Size II Classifications

FIRM SIZE II (total assets)	HC			GPLWO			GPLW			RCWO			RCW		
	SLR	MLR	EXP	SLR	MLR	EXP	SLR	MLR	EXP	SLR	MLR	EXP	SLR	MLR	EXP
< $1 billion	20.64	18.99	20.04	22.92	18.34	22.95	23.21	18.39	23.96	24.91	19.12	22.86	24.73	18.91	24.62
$1-$1.99 billion	17.67	15.45	17.32	20.35	14.84	21.06	19.85	14.99	20.37	21.35	15.31	21.86	22.76	15.46	22.81
$2-$2.99 billion	14.88	14.17	14.94	17.63	14.53	17.25	18.15	14.72	18.08	18.12	13.6	19.2	22.85	15.06	22.65
$3 billion & over	28.49	28.59	28.39	29.76	28.71	19.89	30.17	28.98	21.05	28.7	27.63	19.06	32.46	30.62	25.2

5.1.2   Two-Way Interactions

The research hypotheses relating to the investigation of possible two factor interactions in the analysis of working capital from operations prediction are restated below:

H_0 :   There is no interaction between the income methods and the predictor models in predicting cash flows over all firms in the sample.

H_0 :   There is no interaction between the income methods and the industry/firm size classifications in predicting cash flows.

H_0 :   There is no interaction between the predictor models and industry/firm size classifications in predicting cash flows.

The results of the MANOVA analysis to test for all possible two-way interactions are presented in Table 5. Note that significant two-way interactions (to a significance level of .10) exist for income and prediction, income and industry, income and firm size II, and prediction and industry.   Means for these four two-way interactions were

inspected to investigate the nature of the interaction effects. The results of these analyses are described below.

Table 6 presents the means of forecast errors for each of the five income methods for each industry classification. When these means were analyzed, all industry groups except number 5 (steel) exhibited fairly consistent patterns across all five income methods within a forecast error range of about 14 to 27 percent. However, forecast errors for the steel industry were significantly higher for historical cost than the GPL and RC income methods, and this apparently causes the rejection of the null hypothesis of no interaction between income methods and industry classifications.

Table 7 presents means of forecast errors for each of the four firm size II classifications for each income method. An analysis of these means reveals that, for the first three firm size groups, the historical cost forecast error was the smallest, and the forecast errors were larger for the two GPL incomes and the two RC incomes. For the fourth firm size II classification (largest firms), however, the forecast errors for both GPL and RCWO incomes were smaller than historical cost. This may explain why the null hypothesis of no interaction between income methods and firm size II classifications of firms is rejected.

TABLE 5

MANOVA Analysis for Two-Way Interactions

INCOME & PREDICTION	INCOME & INDUSTRY	INCOME & FIRM SIZE I	INCOME & FIRM SIZE II
<.00001*	.0066*	.3208	.0389*

PREDICTION & INDUSTRY	PREDICTION & FIRM SIZE I	PREDICTION & FIRM SIZE II
.0034*	.7220	.1655

*   significant difference at .10 level

TABLE 6

Means of Forecast Errors For Income Methods & Industries

INDUSTRY	HC	GPLWO	GPLW	RCWO	RCW
1	15.09	16.05	15.26	17.20	18.89
2	17.63	19.78	20.60	24.34	22.02
3	13.93	15.19	15.04	16.67	16.33
4	17.63	19.92	20.80	20.67	21.37
5	68.63	50.67	51.91	52.13	59.47
6	17.24	19.57	19.34	18.76	20.99
7	24.56	27.10	26.90	25.99	29.07
8	23.37	24.80	26.32	23.34	25.97
9	18.99	22.30	22.01	23.07	25.87
10	13.22	14.80	14.42	15.34	18.52
11	14.35	16.45	18.23	14.81	20.48
12	25.75	23.93	24.53	27.12	25.22
all others	17.05	18.22	19.08	18.89	19.87

GRAPH 1: FORECAST ERRORS FOR INDUSTRY AND INCOME MEASUREMENT
(WC FROM OPERATIONS)
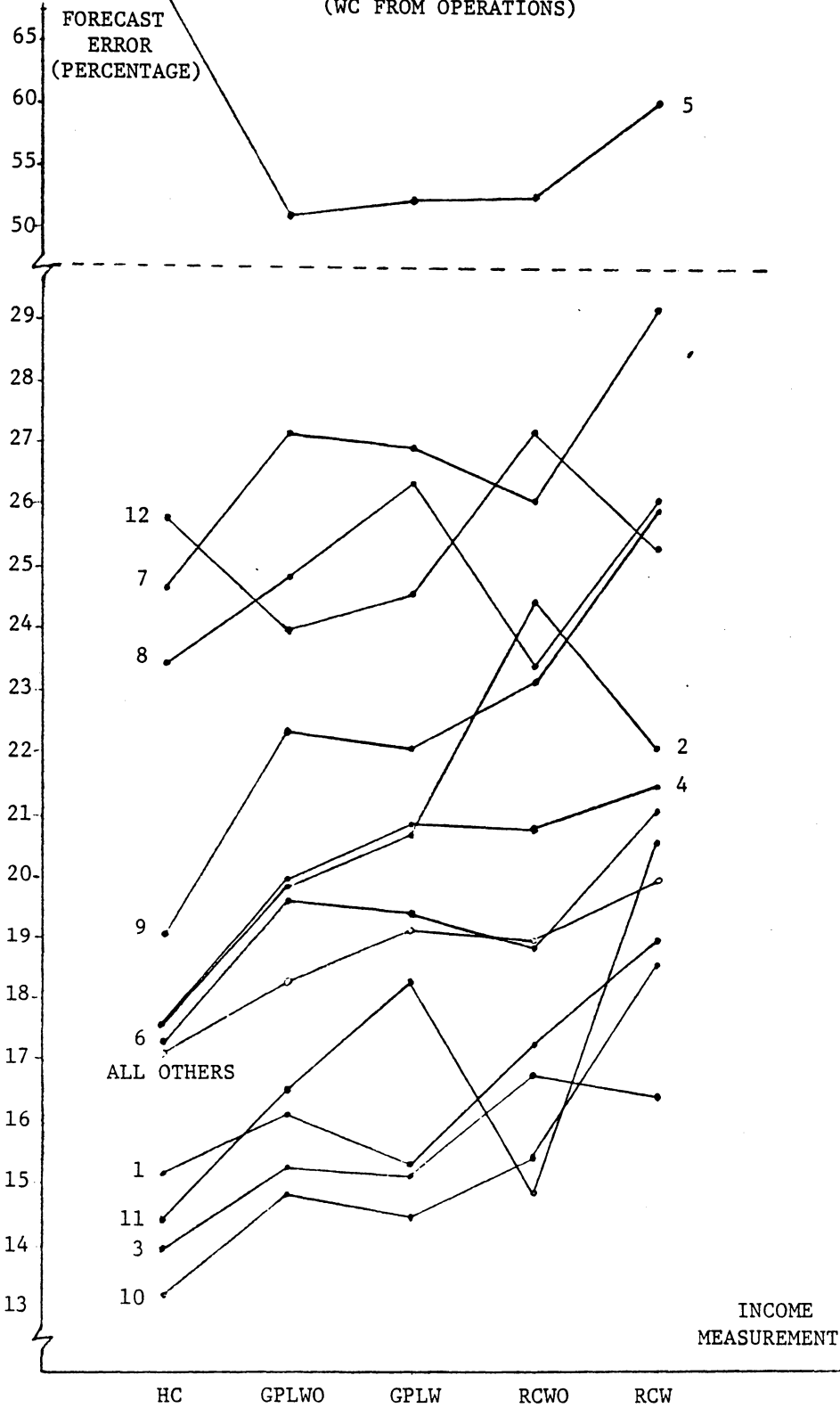
TABLE 7

Means of Forecast Errors for Firm Size II Classification

FIRM SIZE II	HC	GPLWO	GPLW	RCWO	RCW
<$1 billion	19.89	21.40	21.85	22.30	22.75
$1-$1.99 billion	16.81	18.75	18.40	19.50	20.34
$2-$2.99 billion	14.66	16.47	16.98	16.98	20.19
$3 billion & up	28.49	26.12	26.73	25.13	29.42

GRAPH 2:   FORECAST ERRORS FOR EACH FIRM SIZE II GROUP
AND INCOME MEASUREMENT
(WC FROM OPERATIONS)
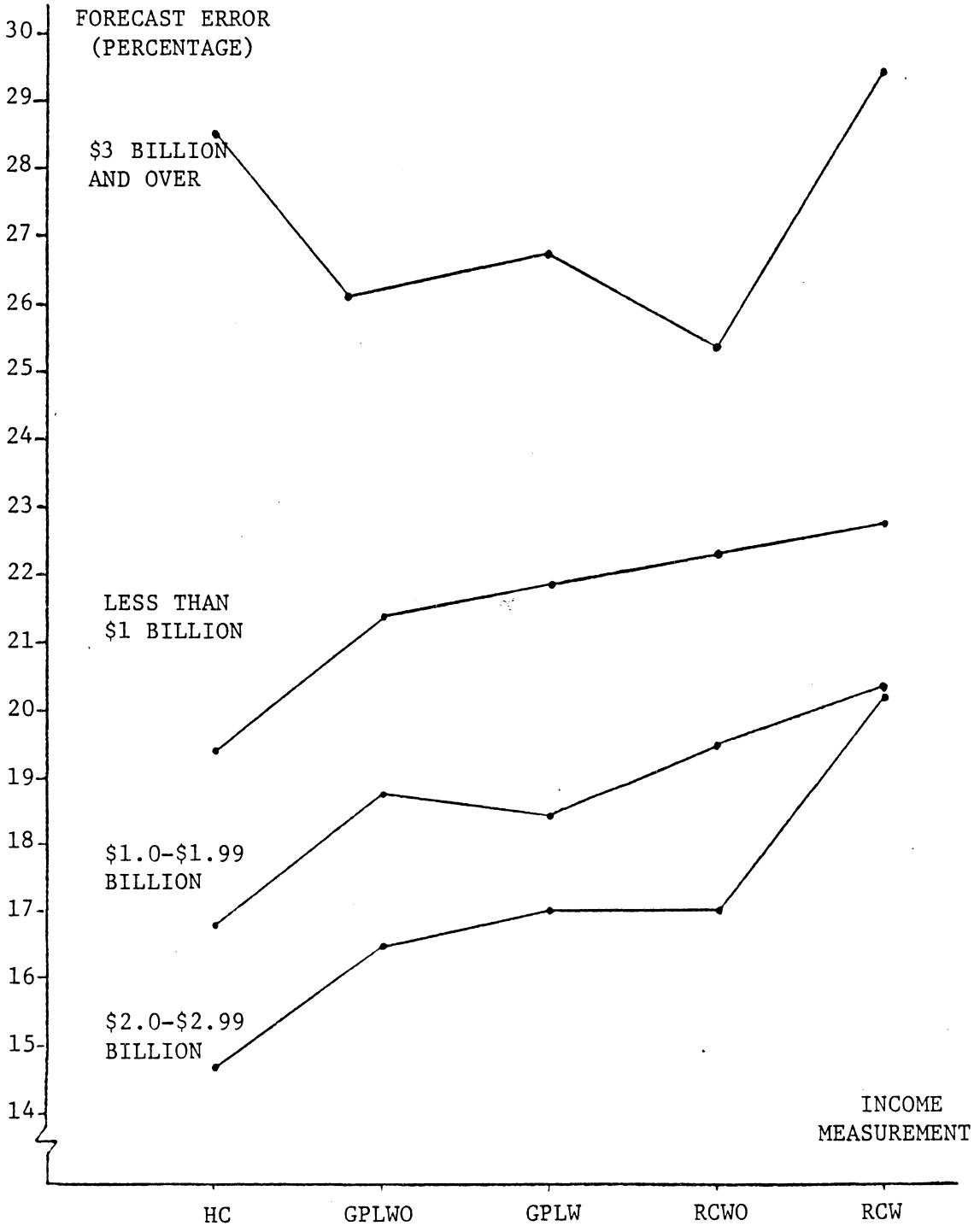
Another significant two-way interaction exists between the prediction model factor and the industry classification factor. Table 8 lists the forecast error means for each of the three prediction models and each industry classification. An inspection of these industry means for each prediction model reveals that for all industry groups except the steel industry there was a consistent pattern. This pattern included very similar errors for the SLR and EXP predictions and slightly lower errors for each industry with the MLR. For the steel industry, however, the error pattern was highest with MLR prediction and substantially lower (less than one-half of the SLR and MLR models) with the EXP model. This divergent error pattern for the steel industry appears to be largely responsible for rejecting the null hypothesis of no interaction between the prediction models and industry classifications.

The final significant two-way interaction was between the income methods and prediction models. Table 9 presents the means of the forecast errors for each income method and prediction model. When these means are reviewed, it can be seen that the SLR prediction model produced the smallest forecast errors for historical cost income and increasingly larger errors over the two GPL income and the two RC income methods. The same pattern held for the forecast errors

TABLE 8

Means of Forecast Errors for Prediction Model & Industry

INDUSTRY	SLR	MLR	EXP
1	17.54	14.57	17.39
2	22.04	17.86	22.72
3	17.03	12.34	16.93
4	22.12	16.21	21.90
5	65.20	76.13	28.34
6	20.96	15.68	20.91
7	27.96	23.38	28.84
8	26.24	22.85	25.19
9	25.04	17.43	24.87
10	16.81	11.85	17.12
11	19.37	12.44	18.78
12	28.36	22.87	24.70
all others	19.40	16.59	19.88

GRAPH 3: FORECAST ERRORS FOR INDUSTRIES AND PREDICTION MODELS
(WC FROM OPERATIONS)
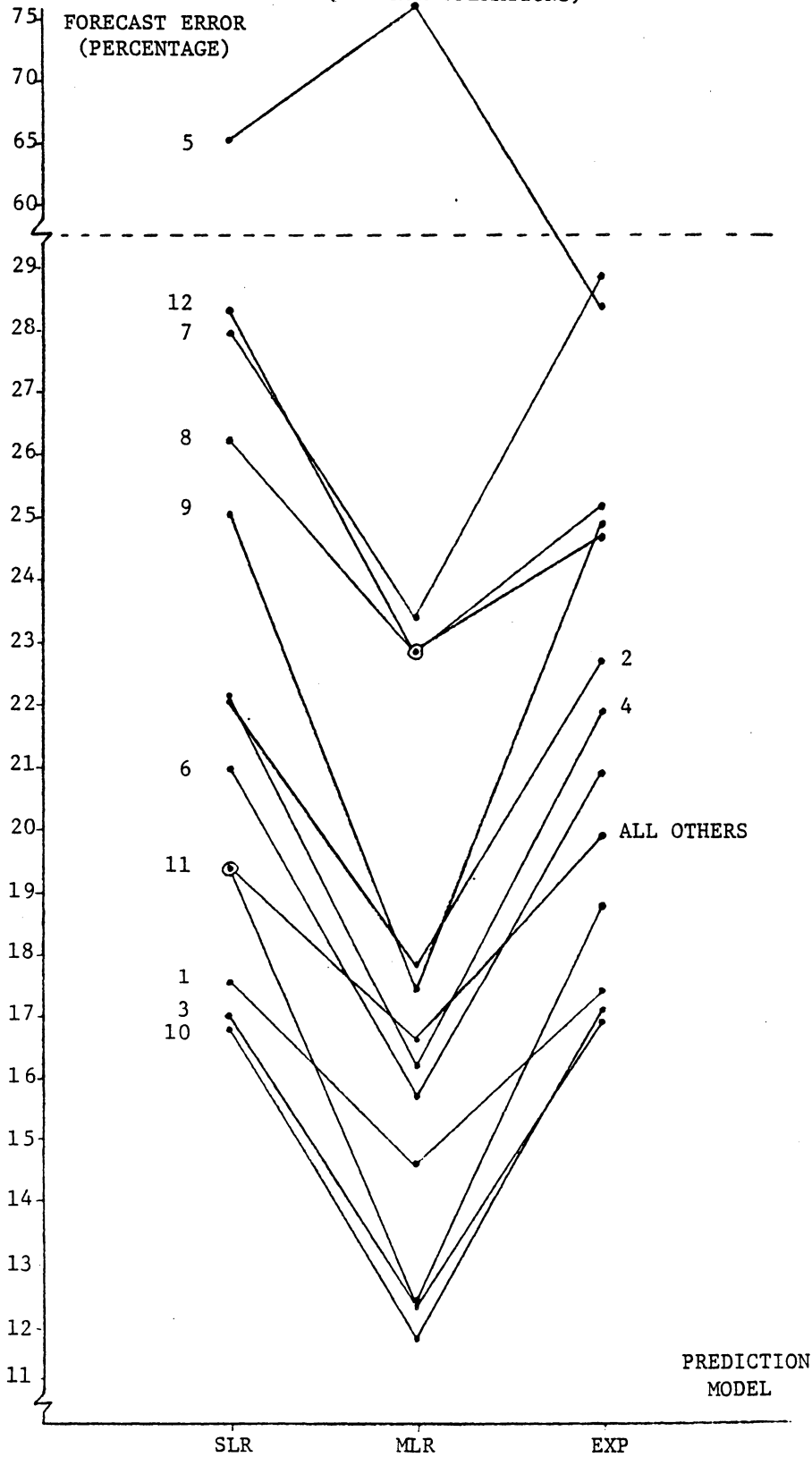
produced by the EXP prediction model. The MLR prediction model, however, exhibited lower forecast errors for the two GPL income methods and the RCWO income method than for the HC and RCW income methods. This divergent result within the MLR model apparently caused rejection of the null hypothesis of no interaction between the income methods and prediction models.

5.1.3   Main Effects

As pointed out above, caution must be exercised when interpreting the main effects tests because significant forecast error differences were obtained with the various combinations of income method, prediction model and industry/firm size factors (i.e., significant interactions). The main effects in this research design are associated with the income method factor (five levels), the prediction model factor (three levels), and a third factor defined three different ways (each of which is tested separately): 1) industry factor (twelve levels), 2) firm size I factor (two levels), and 3) firm size II factor (four levels). The research hypotheses related to the investigation of these main effects in the analysis of the prediction of working capital from operations are restated below:

TABLE 9

Means of Forecast Errors for Income & Prediction Models

MODEL	HC	GPLWO	GPLW	RCWO	RCW
SLR	20.19	22.49	22.61	23.35	25.25
MLR	18.86	18.55	18.69	18.59	19.37
EXP	19.88	20.81	21.32	21.21	23.84

(for 146 firms in the sample)

GRAPH 4: FORECAST ERRORS FOR INCOME AND PREDICTION MODELS
(WC FROM OPERATIONS)
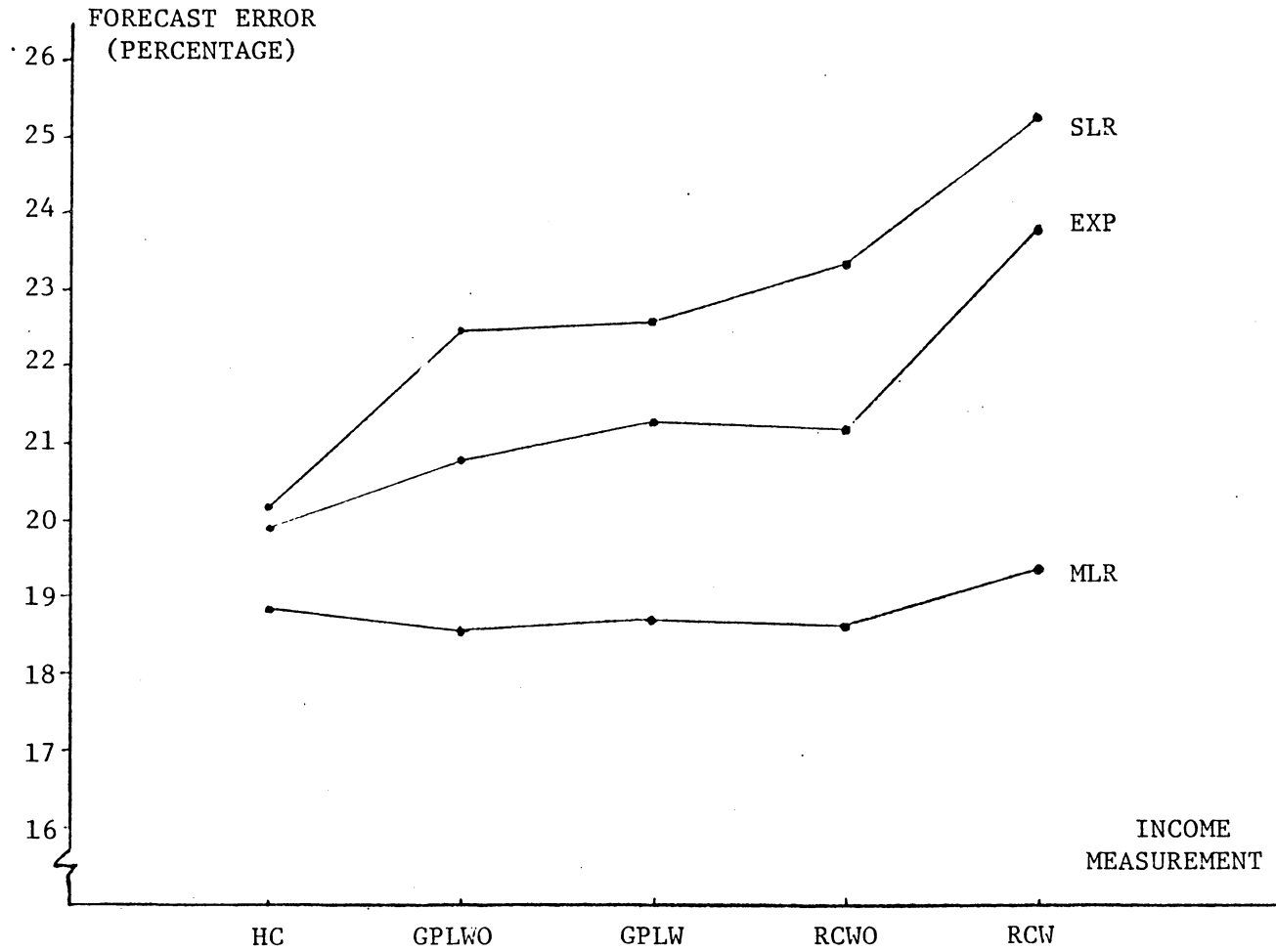
H$_0$: There is no difference among the five income methods in predicting cash flows over all firms in the sample.

H$_0$: There is no difference among the three predictor models in predicting cash flows over all firms in the sample.

H$_0$: There is no difference among the industry/firm size classifications in predicting cash flows.

The main effects for income method and prediction model were tested using one-group Hotelling's T-squared, while the industry and firm size effects were investigated using one-way analysis of variance.[82] Table 10 presents the p-values from these tests for the five main effects.

The means of the forecast errors for the five income methods (for 146 sample firms) were as follows:

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[82] As explained in Chapter 3, when income method and prediction model effects were investigated, the observations for each firm were not independent. This lack of independence across cells required use of the multivariate procedure. But when the industry and firm size effects were being investigated, forecast errors were averaged over the other two factors. This removed the independence problem and the univariate procedure was appropriate.

TABLE 10

Results of Statistical Tests for Main Effects

INCOME METHOD	PREDICTION MODEL	INDUSTRY	FIRM SIZE I	FIRM SIZE II
.00004*	<.00001*	.0021*	.7383	.1056**

* significant difference at .10 level

** This p-value is just above the cut-off level but judged close enough to warrant further investigation.

HC	19.64%
GPLWO	20.61%
GPLW	20.87%
RCWO	21.05%
RCW	22.82%

The one-group Hotelling's T-squared rejected the null hypothesis of no difference among these income methods' abilities to predict cash flows at the .10 level of significance. Simultaneous confidence intervals were then constructed for each possible pair of income methods to identify the significant differences. This required the construction of ten simultaneous confidence intervals.[83] The upper and lower limits of these intervals are reported in Table 11.

The interpretation of these confidence intervals depends upon whether or not zero is included in the interval. If the zero-point is included in included in the interval, then the two income methods being compared are not considered to be significantly different. Similarly, if the

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[83] The simultaneous confidence interval in multivariate analysis is similar to the univariate confidence interval derived from application of a multiple range test or other procedure designed to control experimentwise type I error rate. It uses the vector of means, the covariance matrix, and the appropriate positive square root of the Hotelling's T-squared table value for the treatments being compared to compute the confidence interval.

TABLE 11

Simultaneous Confidence Intervals for Income Methods

INCOME METHOD PAIRS	LOWER LIMIT	UPPER LIMIT
HC vs. GPLWO	-2.9391	0.9957
HC vs. GPLW	-3.2133	0.7544
HC vs. RCWO	-3.4255	0.6105
HC vs. RCW*	-5.3091	-1.0461
GPLWO vs. GPLW	-0.8050	0.2895
GPLWO vs. RCWO	-1.7426	0.8709
GPLWO vs. RCW*	-3.8352	-0.5767
GPLW vs. RCWO	-1.5966	1.2404
GPLW vs. RCW*	-3.5783	-0.3181
RCWO vs. RCW*	-3.4746	-0.0656

* significant difference at .05 level

GRAPH 5: FORECAST ERRORS FOR EACH INCOME MEASUREMENT
(WC FROM OPERATIONS)

FORECAST ERROR
(PERCENTAGE)
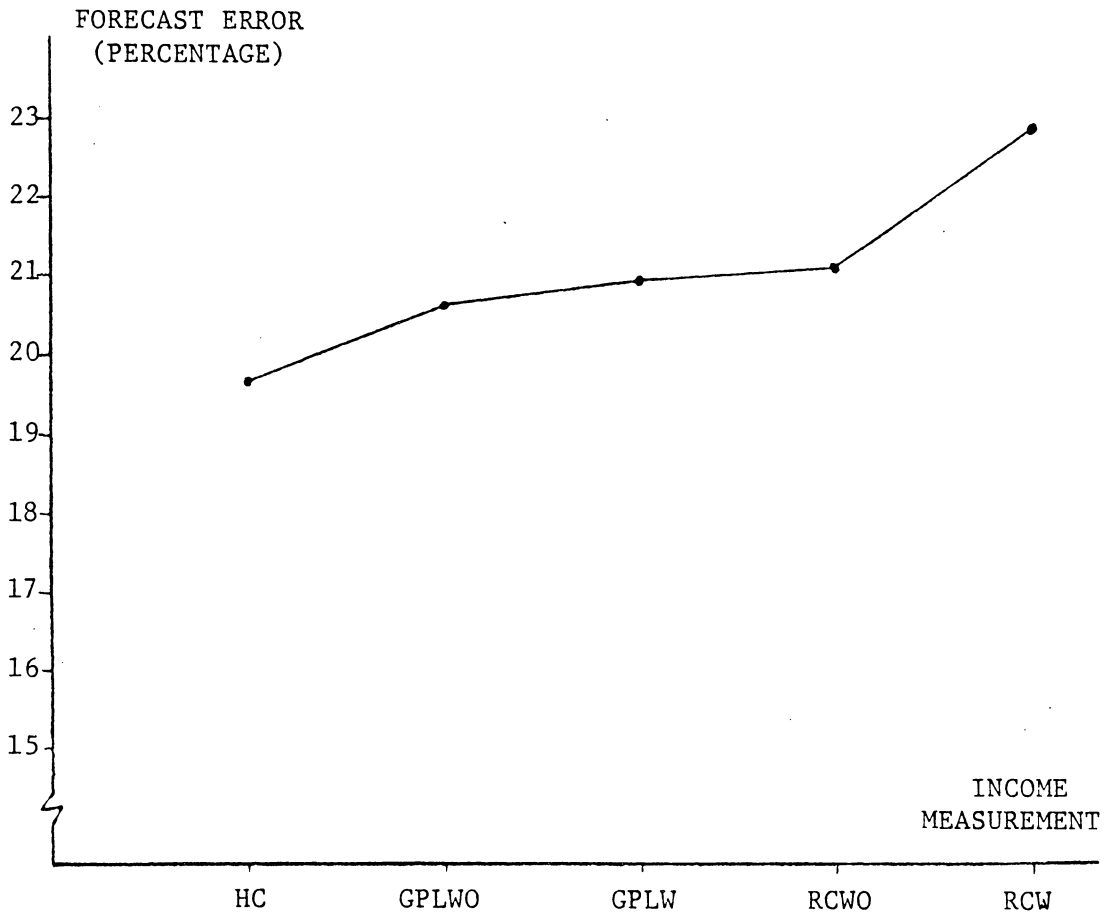
zero-point is not contained within the interval, the two income methods are considered significantly different.[84] Based on the results contained in Table 11, four of the possible ten pairwise comparisons of income models proved significantly different in this study:

1. HC average forecast error is significantly less than RCW average forecast error but does not differ from the other three income models.

2. GPLWO average forecast error is significantly less than RCW average forecast error but does not differ from the other three income models.

3. GPLW average forecast error is significantly less then RCW average forecast error but does not differ from the other three income models.

4. The average forecast error with RCWO is significantly less than the error produced by RCW but does not differ from the other three models.

5. In fact, the only significant error difference in all the pairwise comparisons occurred with RCW; it appears that RCW is the major reason for the significant income method differences that were disclosed by the simultaneous intervals.

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[84] Kramer and Jensen, "Fundamentals of Multivariate," pp. 195-199. Also, see pp. 58-59 of Chapter 3.

The means of the forecast errors for the three prediction models (for 146 sample firms) were as follows:

SLR   22.78%

MLR   18.81%

EXP   21.41%

The one-group Hotelling's T-squared procedure resulted in a rejection of the null hypothesis of no difference among the prediction models' abilities to predict cash flows at the .10 level of significance (see Table 10). Simultaneous confidence intervals were also constructed for each pairwise comparison of prediction models to identify pairs that were significantly different. Table 12 presents the upper and lower limits of these confidence intervals that can be interpreted as described above for income model effects.

These results indicated that the mean forecast error with MLR is significantly less than the mean error produced by SLR. The SLR and EXP prediction mean forecast errors were not significantly different. Similarly, even though MLR prediction produced mean forecast errors smaller than EXP, in this study the difference was not statistically different at the .05 level.

As reported in Table 10, the results of the analysis of variance procedure supported a rejection of the null

TABLE 12

Simultaneous Confidence Intervals for Prediction Models

PREDICTION MODELS	LOWER LIMIT	UPPER LIMIT
SLR vs. MLR*	2.7017	5.2236
SLR vs. EXP	-1.8311	4.5596
MLR vs. EXP	-6.6983	1.5016

* significant difference at .05 level

GRAPH 6: FORECAST ERRORS FOR THE THREE PREDICTION MODELS
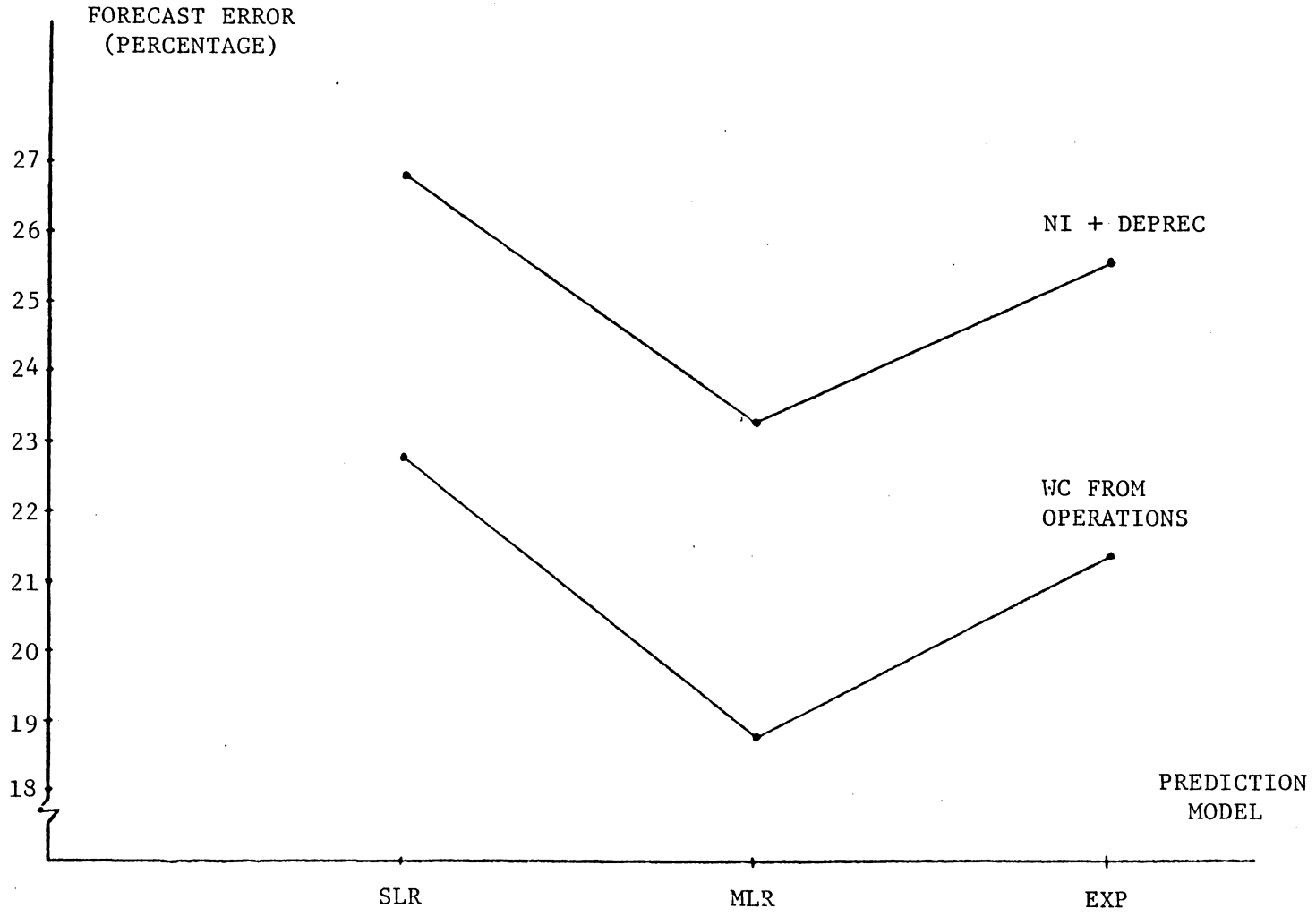
hypothesis of no industry difference in ability to predict cash flows at the .10 level of significance. Table 13 presents the mean forecast errors for each of the twelve industry classifications for the fifteen combinations of income model and prediction model, ordered from highest to lowest forecast error.

Duncan's Multiple Range Test[85] was applied to examine the pairwise comparisons of these industry means at a .05 level of significance.[86] This test showed that the mean forecast error for the steel industry was significantly higher than the errors for the other eleven industries. The test also indicated that forecast errors for the other eleven industries did not differ significantly from one another.

The results of the analysis of variance procedure also supported rejection of the null hypothesis of no difference among the four firm size II classifications at the .10 level of significance (see Table 10 comment). Again, Duncan's

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[85] Lyman Ott, _An Introduction to Statistical Methods and Data Analysis_, Belmont, Ca.: Wadsworth Publishing Company, Inc., 1977, pp. 392-395.

[86] The author felt that it was appropriate to use a more conservative level of significance (.05) in further investigating the effects that were judged to be significant (at the .10 level) in the preliminary analysis of the interaction and main effects tests. The .05 level has been used consistently in the accounting predictive ability literature.

TABLE 13

Ordered Means of Forecast Errors for Industries

INDUSTRY	ORDERED FORECAST ERROR MEANS (%)
5	56.56
7	26.73
12	25.31
8	24.76
9	22.45
2	20.87
4	20.08
6	19.18
11	16.86
1	16.50
3	15.43
10	15.26

test was applied to determine the firm size categories that differed significantly in terms of forecast error means. Table 14 reports these means for each firm size in order from highest to lowest forecast error.

The conclusion that can be made based on Duncan's test is that the mean forecast error for the largest firms was significantly different (higher) from the other three size groups., Additionally, the mean forecast errors for the three smaller firm size groups did not differ. These tests were conducted at a significance level of .05.

5.2 TESTS OF HYPOTHESES--NET INCOME PLUS DEPRECIATION

The same research design described in the previous section was applied to investigate cash flow prediction where cash flow was defined as net income plus depreciation.

5.2.1 Three-Way Interactions

The research hypothesis relating to the investigation of possible three factor interactions in the analysis of net income plus depreciation prediction is restated below:

H_0 : There is no three-way interaction among income
        methods, predictor models, and industry or
        firm size classifications in predicting
        cash flows.

TABLE 14

Ordered Means of Forecast Errors for Firm Size II Groups

FIRM SIZE II GROUPS	ORDERED FORECAST ERROR MEANS (%)
$3 billion & over	27.18
< $1 billion	21.64
$1-$1.99 billion	18.76
$2-$2.99 billion	17.06

The multivariate analysis of variance procedure produced the p-values for the three possible three-factor interactions that are given in Table 15. Note that the income method, prediction model, and industry interaction was significant at .10; also, the income method, prediction model, and firm size II interaction was significant at the same level. As before, the means of the three factors in the design were evaluated to assess the nature of the significant interactions. Table 16 presents the means of forecast errors for each income method, each prediction model, and each industry group. An inspection of these errors clearly indicates that forecast errors for industries 4 (containers), 5 (steel), 7 (electrical equipment and appliance manufacturers), and 8 (auto and aerospace manufacturers) were substantially higher than errors for the other eight industries. This was true, however, only for the forecast errors predicted by the SLR and MLR models for the two GPL income measurements. The EXP model forecasted with much lower error than the other two models for industry number 5; conversely, this model forecasted with much higher error for industries 4, 7, and 8 than for the remaining industries. The other eight industries had consistent forecast error patterns for the five income measurements and the three prediction models. From these analyses it

appeared that the primary forecast error variation among industry, income method, and prediction model was associated with the stel industry for both GPL net incomes and EXP prediction. This would be the most obvious cause of rejecting the null hypothesis of no interaction among the three factors at the .10 significance level, when net income plus depreciation is the object of prediction.

The other significant three-way interaction involved the income method, prediction model, and firm size II classification. Table 17 presents the means of forecast errors for these three factors. The patterns of forecast errors for all income measurement methods and the SLR- and MLR-model predictions were consistent. The fourth group for firm size II classification (largest firms) had the highest mean forecast error for all incomes as predicted by the SLR and MLR models. With EXP prediction, however, the smallest firms group had the highest mean forecast error for both GPL incomes and both RC incomes. This result is the apparent cause of rejecting the null hypothesis of no three-factor interaction at the .10 level when factor three is the firm size II classification scheme.

TABLE 15

MANOVA Analysis for Three-Way Interactions

INCOME METHOD, PREDICTION MODEL, & INDUSTRY	INCOME METHOD, PREDICTION MODEL, & FIRM SIZE I	INCOME METHOD, PREDICTION MODEL, & FIRM SIZE II
.0104*	.1580	.0888*

* significant difference at .10 level

TABLE 16

Means of Forecast Errors (NI + Deprec)
For Income Models, Prediction Models and Industries

INDUSTRY	HC			GPLWO			GPLW			RCWO			RCW		
	SLR	MLR	EXP	SLR	MLR	EXP	SLR	MLR	EXP	SLR	MLR	EXP	SLR	MLR	EXP
1	16.3	16.21	15.71	17.74	16.95	17.94	18.09	17.49	18.14	18.04	16.8	19.44	21.18	17.23	21.53
2	18.7	18.23	18.78	23.28	21.0	23.45	24.1	21.25	24.65	26.8	18.2	28.63	25.85	18.48	26.08
3	14.4	13.02	14.36	21.42	18.51	18.86	21.41	18.6	19.02	18.26	12.88	19.93	18.31	12.82	18.9
4	17.53	16.07	17.7	54.69	50.84	52.11	55.36	51.03	58.43	23.89	16.1	20.69	23.1	16.44	23.33
5	19.16	17.5	19.68	51.14	52.58	17.38	50.64	52.52	18.64	19.64	17.24	17.86	27.9	23.26	23.64
6	16.15	13.43	15.98	20.73	15.67	19.24	20.48	16.19	19.9	18.59	12.75	17.77	21.46	14.27	20.6
7	24.85	22.9	24.85	83.88	80.07	82.34	83.97	80.37	82.19	27.02	22.41	27.83	30.2	24.97	30.34
8	25.54	24.45	24.43	65.12	62.25	65.89	65.29	62.51	67.27	29.13	23.17	23.24	27.04	24.94	26.4
9	17.54	16.07	17.04	27.81	24.17	30.14	28.07	24.18	27.12	24.98	14.26	23.98	28.18	17.09	27.76
10	15.59	13.47	15.94	26.6	22.04	18.64	25.2	22.96	17.01	18.17	13.56	20.07	21.5	15.57	22.81
11	15.28	12.5	14.72	25.8	20.32	18.88	25.98	21.82	24.08	16.7	11.34	13.22	22.56	10.82	23.88
12	23.8	23.2	23.63	22.58	21.43	21.15	22.68	21.83	22.35	28.85	20.08	29.8	24.9	23.75	25.1
All Other Firms	17.5	16.41	17.03	22.89	20.59	19.32	23.25	20.82	20.95	19.05	16.04	17.58	21.89	17.34	22.64

TABLE 17

Means of Forecast Errors (NI + Deprec)
For Income Models, Prediction Models, and Firm Size II Classifications

FIRM SIZE II (total assets)	HC			GPLWO			GPLW			RCWO			RCW		
	SLR	MLR	EXP	SLR	MLR	EXP	SLR	MLR	EXP	SLR	MLR	EXP	SLR	MLR	EXP
< $1 billion	19.95	18.72	19.68	42.54	39.74	41.66	42.71	40.08	42.44	24.59	18.29	22.53	24.3	18.75	24.61
$1.0-$1.99 billion	17.46	15.66	17.43	27.6	23.83	24.66	27.34	24.33	25.89	20.88	15.62	21.31	22.44	16.55	22.71
$2.0-$2.99 billion	13.31	12.55	13.28	24.15	21.05	23.9	24.05	21.09	23.65	17.16	11.91	18.49	21.55	14.25	21.5
$3.0 billion and over	21.57	19.8	20.66	44.51	42.81	35.29	45.14	43.17	36.36	20.97	18.62	19.8	24.76	21.61	24.12

5.2.2   Two-Way Interactions

The research hypotheses relating to the investigation of possible two-factor interactions in the analysis of net income plus depreciation prediction are restated below:

H_0 :   There is no interaction between the income methods and the predictor models in predicting cash flows over all firms in the sample.

H_0 :   There is no interaction between the income methods and the industry/firm size classifications in predicting cash flows.

H_0 :   There is no interaction between the predictor models and industry/firm size classifications in predicting cash flows.

All possible interactions between two factors in this research design were analyzed by MANOVA (industry/firm size effects tested with income or prediction effects) and by one-group Hotelling's T-squared (only income and prediction model effects tested).   Table 18 gives the p-values for each of these two-factor analyses.   Separate analyses of the means of forecast errors for the two significant two-factor interactions were made as before.

TABLE 18

MANOVA Analysis for Two-Way Interactions

INCOME & PREDICTION	INCOME & INDUSTRY	PREDICTION & INDUSTRY	INCOME & FIRM SIZE I
<.00001*	.1319	.0257*	.4456

PREDICTION & FIRM SIZE I	INCOME & FIRM SIZE II	PREDICTION & FIRM SIZE II
.7548	.1486	.1566

* significant difference at .10 level

Table 19 gives the means of forecast errors for the income method and prediction model interactions. A review of these means reveals that SLR prediction yielded the largest forecast error for all income methods except RCW. The EXP prediction produced the largest forecast error for the RCW income method. The MLR prediction consistently gave the lowest forecast error for every income method. It appears that the variation in prediction model results for SLR and EXP with the RCW income measurement is the primary cause for rejecting the null hypothesis of no two-way interaction between income methods and prediction models at the .10 level of significance.

The only other significant two-factor interaction disclosed by the MANOVA procedure was that between the prediction method and industry classifiction. Table 20 presents the means of forecast errors for these factors. The analysis of these means disclosed the significantly higher forecast errors for containers, steel, electrical equipment, and auto/aerospace, as before. The significant interaction between industry and prediction model appears to be caused by the steel and container industries. The container industry had a larger forecast error with the SLR prediction, but steel had the larger error with the MLR prediction and a much lower forecast error than the other

TABLE 19

Means of Forecast Errors for Income & Prediction Models

MODEL	HC	GPLWO	GPLW	RCWO	RCW
SLR	18.36	35.33	35.41	21.55	23.36
MLR	16.94	32.39	32.73	16.45	17.84
EXP	18.08	32.44	33.22	20.97	23.42

GRAPH 7:   FORECAST ERRORS FOR INCOME AND PREDICTION MODELS
(NI + DEPREC)
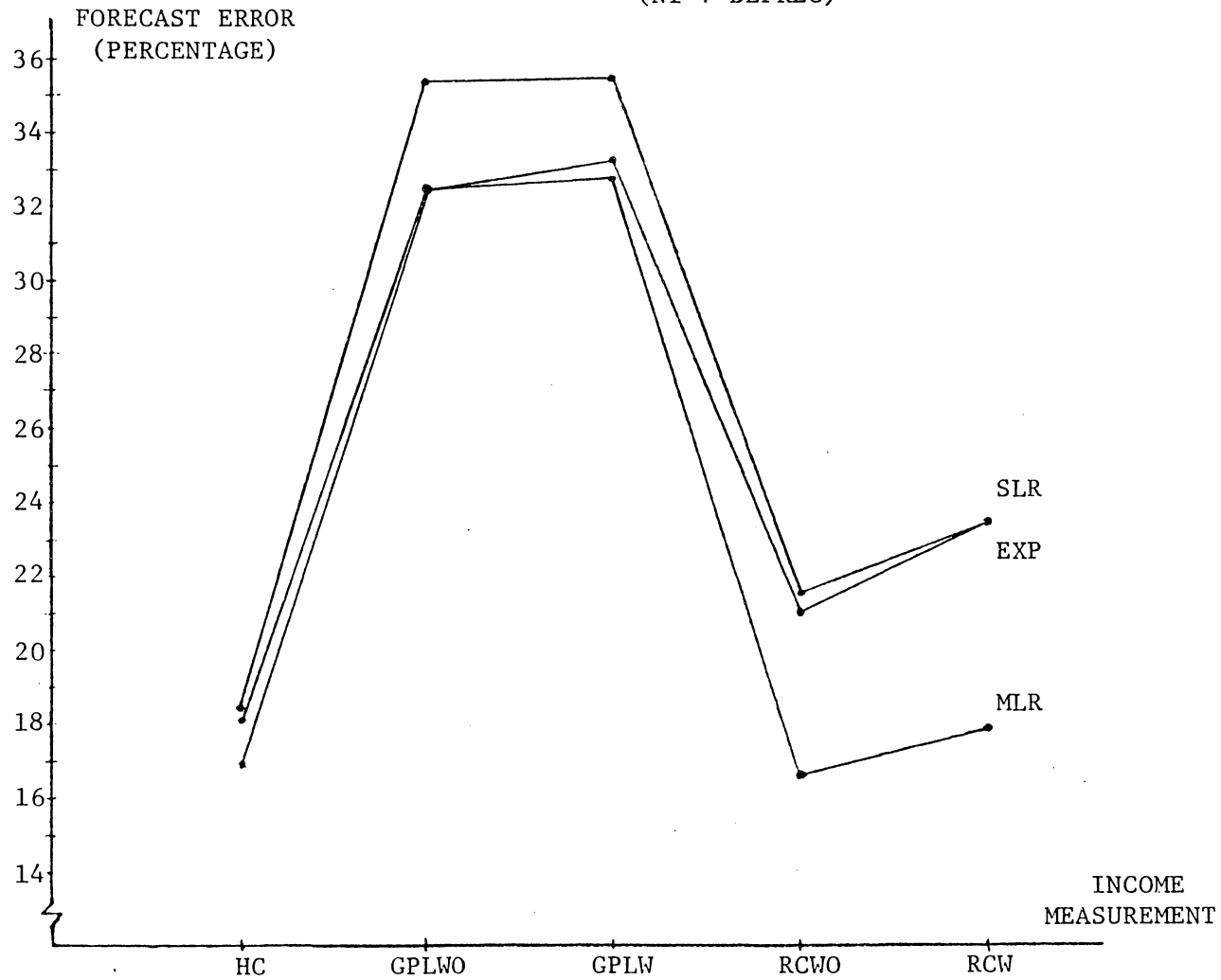
three with the EXP prediction. This variable pattern of forecast errors between the container industry (number 4) and the steel industry (number 5) may be the major influence in rejecting the null hypothesis of no interaction between prediction models and industries at the .10 significance level; with the other ten industries, however, only electrical equipment (number 7) and auto/aircraft manufacturing (number 8) displayed no interaction of forecast error across all three prediction models. This analysis indicates that there were multiple interactions that contributed to the rejection of the null hypothesis.

5.2.3   Main Effects

The research hypotheses relative to the investigation of possible main effects in the analysis of net income plus depreciation prediction are restated below:

H_0 :   There is no difference among the five income
          methods in predicting cash flows over all
          firms in the sample.

H_0 :   There is no difference among the three predictor
          models in predicting cash flows over all firms
          in the sample.

TABLE 20

Means of Forecast Errors for Prediction Model & Industry

INDUSTRY	SLR	MLR	EXP
1	18.27	16.94	18.55
2	23.75	19.43	24.32
3	18.76	15.17	18.21
4	34.91	30.10	34.45
5	33.70	32.62	19.44
6	19.48	14.46	18.70
7	49.98	46.15	49.51
8	42.42	39.46	41.45
9	25.32	19.15	25.21
10	21.41	17.52	18.90
11	21.26	15.36	18.96
12	24.56	22.06	24.41
all others	20.91	18.24	19.50

GRAPH 8:   FORECAST ERRORS FOR INDUSTRIES AND PREDICTION MODELS
(NI + DEPREC)
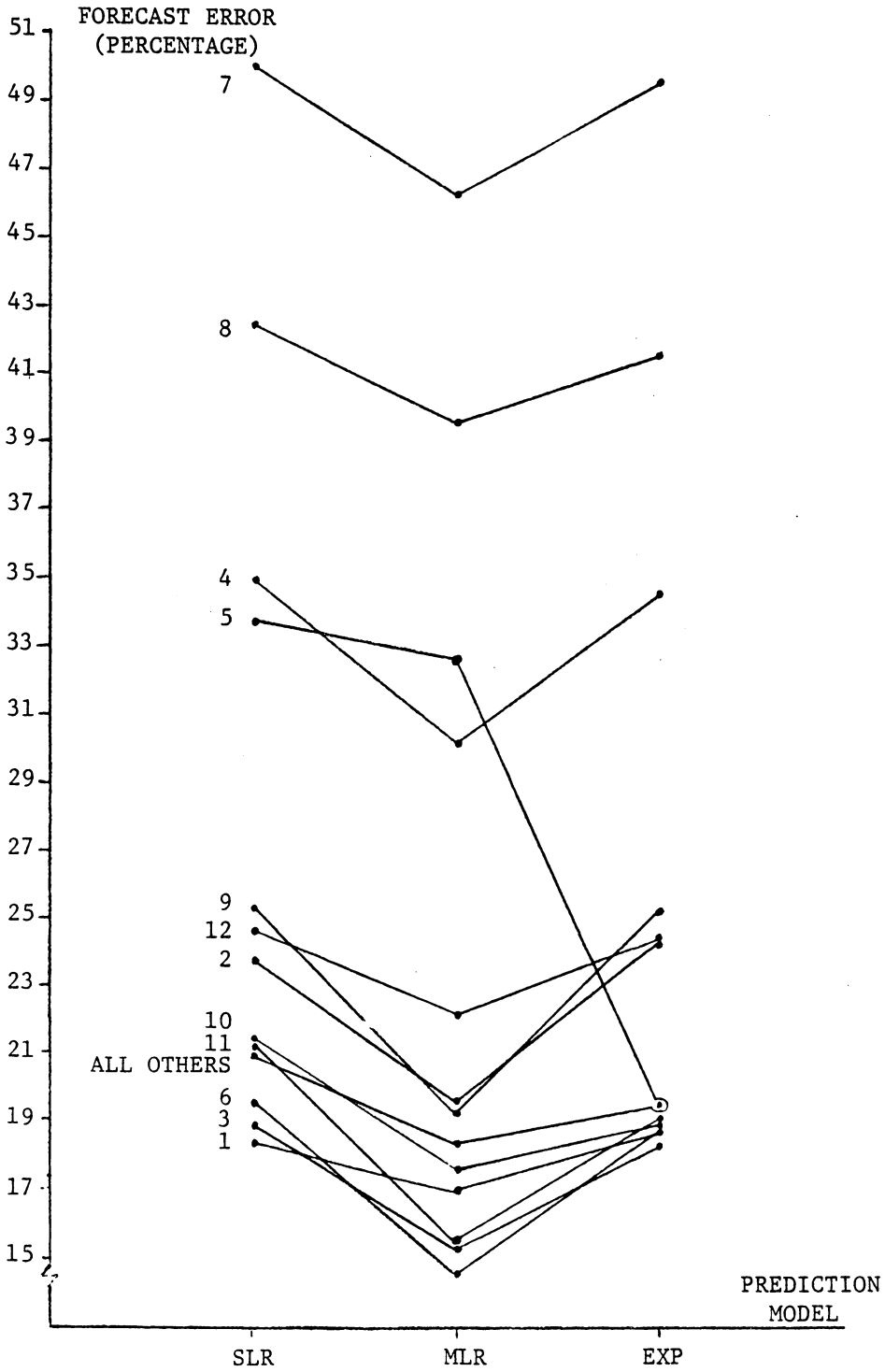
H_0 : There is no difference among the industry/firm size classifications in predicting cash flows.

The main effects were investigated by the one-way analysis of variance (for industry & firm size effects) and one-group Hotelling's T-squared test (for income and prediction model effects). Table 21 gives the p-values from these two sets of tests for main effects. The significant main effects of income method, prediction model, and industry classification were then examined through pairwise comparisons (simultaneous confidence intervals or Duncan's test) between all the levels within each of these three factors. These results are discussed below.

The means of the forecast errors for the five income models (for 148 sample firms) were as follows:

HC	17.79%
GPLWO	33.39%
GPLW	33.79%
RCWO	19.66%
RCW	21.54%

The Hotelling's T-squared test indicated rejection of the null hypothesis of no difference in income methods' abilities to predict cash flows (defined as net income plus

TABLE 21

Results of Statistical Tests for Main Effects

INCOME METHOD	PREDICTION MODEL	INDUSTRY	FIRM SIZE I	FIRM SIZE II
<.00001*	<.00001*	.0089*	.1301	.1709

* significant difference at .10 level

depreciation) at the .10 significance level. Simultaneous confidence intervals were constructed for each possible pair of income models to identify significant differences. The upper and lower limits of the ten possible confidence intervals are reported in Table 22.

From these intervals comparisons among the income methods can be made. The forecast errors produced by historical cost income were significantly less than those for the GPL and RC incomes. The two GPL income measurements resulted in the largest forecast errors among the five incomes, but neither was significantly larger than RCW. Both GPL methods were significantly larger than RCWO . There was no significant difference between the two GPL incomes; however, the forecast errors for RCWO were significantly less than those for RCW.

The means of the forecast errors for the three prediction models (for 148 sample firms) were as follows:

SLR	26.80%
MLR	23.27%
EXP	25.63%

The one-group Hotelling's T-squared test indicated a rejection of the null hypothesis of no difference in prediction models' abilities to predict cash flows at

TABLE 22

Simultaneous Confidence Intervals for Income Method Effects

INCOME METHODS	LOWER LIMIT	UPPER LIMIT
HC vs. GPLWO*	-27.7223	-3.4619
HC vs. GPLW*	-28.0615	-3.9250
HC vs. RCWO*	-3.1606	-0.5610
HC vs. RCW*	-5.2734	-2.2185
GPLWO vs. GPLW	-1.0993	0.2970
GPLWO vs. RCWO*	1.4072	26.0554
GPLWO vs. RCW	-0.7468	24.4391
GPLW vs. RCWO*	1.8468	26.4180
GPLW vs. RCW	-0.2930	24.7876
RCWO vs. RCW*	-3.5900	-0.1803

* significant difference at .05 level

GRAPH 9: FORECAST ERRORS FOR EACH INCOME MEASUREMENT
(NI + DEPREC)
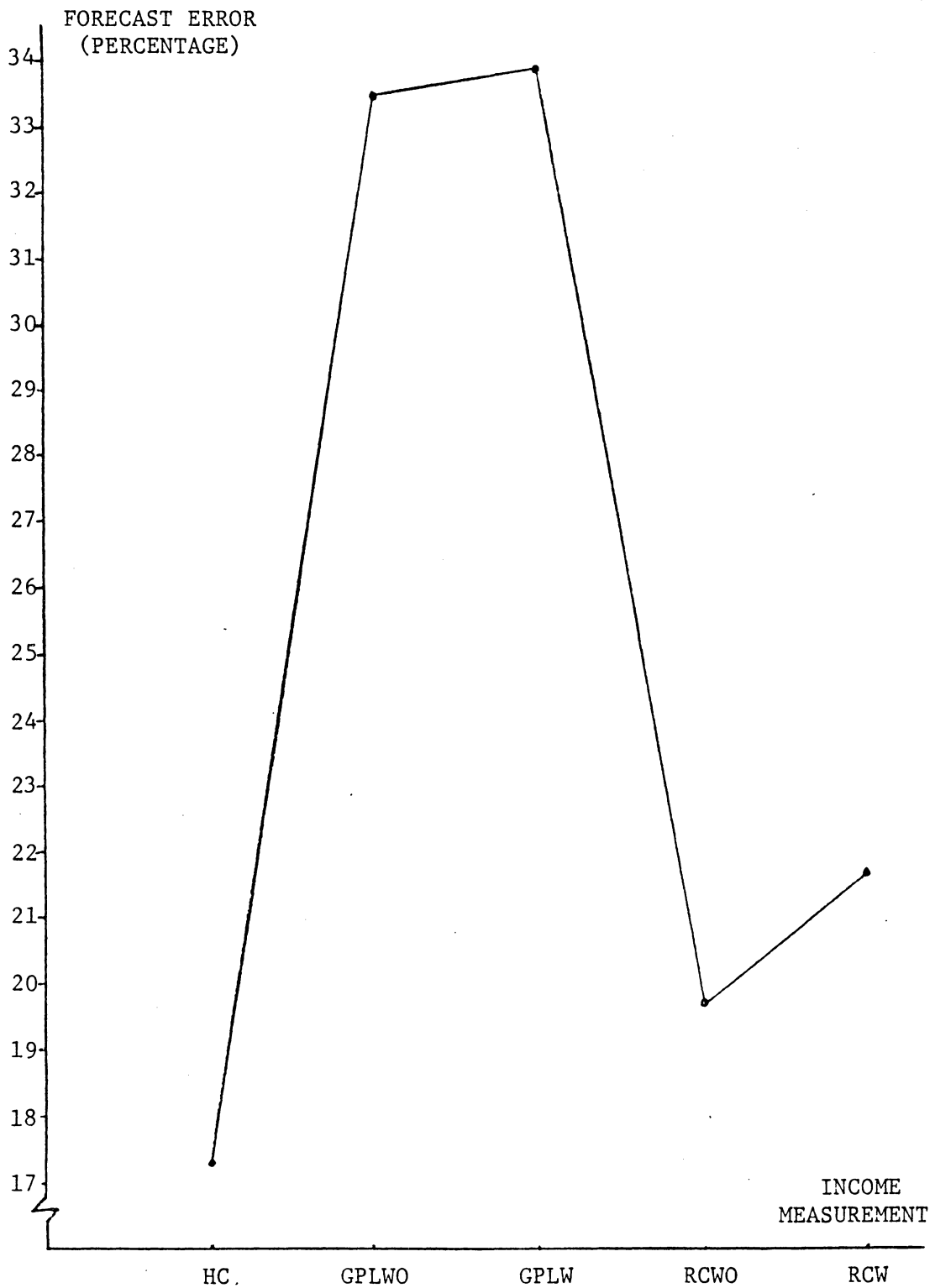
the .10 level of significance. Simultaneous confidence intervals were analyzed to determine the significant differences through pairwise comparisons. The upper and lower limits of these confidence intervals are presented in Table 23. From the T-squared test of forecast error means it can be seen that MLR produced significantly smaller forecast errors than both SLR and EXP. Additionally, the SLR and EXP prediction models did not differ significantly when predicting net-income-plus-depreciation defined cash flow.

As seen from Table 21, the analysis of variance test resulted in a rejection of the null hypothesis of no difference among industries in the prediction of cash flows. Table 24 lists the means of forecast errors for the twelve industry groups for all combinations of income model and prediction model from highest to lowest forecast error.

Duncan's test was conducted on all pairs of these ordered means. Although the four industries discussed above displayed substantially larger forecast errors, only the electrical equipment industry (number 7) proved statistically larger than the other eleven industries. The remaining eleven industries were found not to differ statistically as to forecast error. Duncan's test was conducted at the .05 significance level.

TABLE 23

Simultaneous Confidence Intervals for Prediction Model
Effects

PREDICTION MODELS	LOWER LIMIT	UPPER LIMIT
SLR vs. MLR*	2.7679	4.2851
SLR vs. EXP	-0.2813	2.6275
MLR vs. EXP*	-4.0819	-0.6249

* significant difference at the .05 level

TABLE 24

Ordered Means of Forecast Errors for Industry
Classifications

INDUSTRY	ORDERED FORECAST ERROR MEANS (%)
7	48.55
8	41.11
4	33.15
5	28.59
12	23.67
9	23.23
2	22.50
10	19.28
11	18.53
1	17.92
6	17.55
3	17.38

5.3 COMPARISON OF THE TWO CASH FLOW DEFINITIONS

After the above analyses had been completed, it was decided that further investigation might aid in the interpretation of cash flow error differences between the two cash flow definitions used in this research. To help evaluate the differences in results between the two cash flow measurements that have been discussed in this chapter, correlation analysis was used. The correlation coefficients for each combination of income model and prediction model for the two cash flow definitions are presented in Table 25.

The correlation coefficients for each income measurement averaged over the three prediction models were as follows:

HC	.41
GPLWO	.49
GPLW	.48
RCWO	.63
RCW	.59

These results indicate that there was the least amount of correlation between the forecast errors for the two cash flow definitions that were produced by HC. The next lowest correlation of forecast errors between the two dependent variables was for the two GPL income measures, which

TABLE 25

Correlation Coefficients--Errors of Two Cash Flows

INCOME/PREDICTION MODEL	CORRELATION COEFFICIENTS BETWEEN TWO CASH FLOW FORECAST ERRORS
HC/SLR	.4257
HC/MLR	.3665
HC/EXP	.4458
GPLWO/SLR	.4076
GPLWO/MLR	.4427
GPLWO/EXP	.5646
GPLW/SLR	.4064
GPLW/MLR	.4414
GPLW/EXP	.5537
RCWO/SLR	.4500
RCWO/MLR	.3487
RCWO/EXP	.9192
RCW/SLR	.4179
RCW/MLR	.3403
RCW/EXP	.8325

Note: All correlation coefficients are significant at
       .0001 level, although this high significance level
       could be attributable as much to the large sample
       size as to strength of the relationship.

displayed nearly identical correlation coefficients. Finally, the two RC methods had substantially higher averaged correlation coefficients than the other income methods. This last result was partially caused by very high correlations between forecast errors for the two cash flow measurements produced by EXP prediction. An overall conclusion from this analysis is that there seems to be substantial difference between the forecast errors produced from predicting the two cash flow measurements used in this study. When results of this research are interpreted, the two cash flow measurements should be viewed as separate and distinct objects of prediction in evaluating relative predictive abilities of alternative income and prediction models.

5.4 INCOME PREDICTION VS. CASH FLOW PREDICTION OF CASH FLOWS

An additional objective of this research was to evaluate the abilities of income models to predict cash flows relative to a "control" (naive) model that employs past cash flows to predict future cash flows. Cash flow forecast errors were generated by the naive cash flow model discussed in Chapter 3. The mean forecast errors produced by this naive model over all firms were 18.58 percent and 15.56 percent for working capital from operations and net

income plus depreciation predictions, respectively. A paired t-test (two-sided) was conducted between these "control" forecast errors and each averaged forecast error generated by the five income methods for both cash flow definitions. The p-values for these tests are presented in Table 26.

The interpretation of these comparisons is as follows for working capital from operations prediction: 1) at a significance level of 10 percent the control did not differ statistically from HC or the two GPL income measurements; 2) at 10 percent it appears that the control forecast error was significantly smaller than the errors from the two RC income measurements, although the t-test result is marginal for the RCWO income. The interpretation of the t-tests for net income plus depreciation prediction is that the control forecast error was significantly less than the errors produced by all five of the income measures. ✓The overall conclusion from this analysis is that the naive model produced a cash flow forecast that resulted in significantly smaller prediction errors than all the income methods tested ✓when the object of prediction is net income plus depreciation. In addition, when working capital from operations was the object of prediction the naive model again yielded the lowest overall forecast error, but was

TABLE 26

Results of Comparison of Control vs. Each Income Method

	CONTROL vs. HC	CONTROL vs. GPLWO	CONTROL vs. GPLW	CONTROL vs. RCWO	CONTROL vs. RCW
WCO	.3693	.1510	.1004	.0908*	.0049*
NI+D	.0821*	.0001*	.0001*	.0071*	.0002*

note: WCO refers to significance levels for working capital from operations prediction and NI+D refers to significance levels for net income plus depreciation prediction.

*   significant difference at .10 level

statistically less than the forecast errors only for the two RC incomes (at 10 percent).

5.5   SUMMARY

This chapter has described the results of the analysis of forecast errors under the different conditions of the research presented in Chapter 3. The statistical testing of the research hypotheses and their interpretations have been presented. These results are briefly summarized here and discussed in more detail in Chapter 6.

The results indicate that the particular combination of income measurement method, prediction model and industry/firm size classification has a significant impact on the size of the cash flow forecast error for both definitions of cash flow used in this research. This was true when the three factors were analyzed jointly and when the possible combinations of two factors were analyzed jointly. As a result, caution should be exercised prior to making broad generalizations about the main effects in isolation.

There is a difference in income measurement methods' abilities to predict cash flows. The HC income method produced the lowest forecast error in the prediction of cash flow under both definitions. In forecasting working capital

from operations, HC forecast errors were significantly less than RCW forecast errors; however, when net income plus depreciation was predicted HC forecast errors were significantly less than all other income measurements. In none of the cases did the inclusion of monetary gains/losses significantly improve prediction. In fact, including holding gains/losses in replacement cost income significantly worsened predictions of both cash flow definitions.

There was a significant prediction method effect. For both definitions of cash flow, MLR produced lower forecast errors than SLR. In neither cash flow prediction did the forecast errors for SLR and EXP differ significantly.

There was an industry effect on cash flow prediction errors. For working capital from operations prediction, the steel industry produced significantly higher forecast errors. For net income plus depreciation prediction, the electrical equipment and appliance manufacturers resulted in significantly higher forecat errors.

There was a firm size effect for the prediction of working capital from operations but not for the prediction of net income plus depreciation. The largest firms (total assets of $3 billion and over) produced significantly higher forecast errors than the other three firm size II

classifications. The firm size I grouping of firms did not produce significant differences for either definition of cash flow.

A naive cash flow prediction model was tested against the use of various income measurements as a basis for the prediction of cash flows. This control model produced the lowest overall forecast errors; moreover, they were significantly less than the replacement cost income measurements' forecast errors when working capital from operations was predicted. Also, the control forecast error was significantly less than the forecast errors produced by all the income measurements in the prediction of net income plus depreciation.

Finally, the cash flow forecast errors produced from the prediction of the two cash flow definitions used in this research were not very highly correlated. This implies that the choice of cash flow prediction objective is critical in the evaluation of the relative predictive abilities of alternative income measurements. In the final chapter conclusions are drawn and these results are compared with the earlier research on these issues. Also, areas of additional research on the issues of cash flow prediction and income measurement are suggested.

Chapter VI

SUMMARY AND CONCLUSIONS

6.1   SUMMARY

An objective of financial reporting is to provide information that will aid financial statement users in predicting future cash flows to the enterprise. This research has been designed to contribute empirical evidence about the relative abilities of five income methods and three prediction models to predict two cash flow approximations. Specifically, the four research objectives were:

1. To determine if there is a difference among historical cost, general price level, and replacement cost income models in predicting enterprise cash flows;

2. To determine if there is a difference among the simple linear regression, multiple linear regression, and exponential regression models in predicting enterprise cash flows;

3. To determine if there is an industry effect on the abilities of the five income methods in predicting enterprise cash flows;

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4. To determine if there is a firm size effect on the abilities of the five income methods in predicting enterprise cash flows.

6.2 RESULTS AND CONCLUSIONS

The null hypothesis of no difference among the five income measurement methods was rejected for both cash flow approximations based on statistical tests reported in the previous chapter. This means that the five income methods did not produce the same forecast errors in predicting enterprise cash flows. Different conclusions are drawn about the individual income measurements, however, depending upon which cash flow approximation is being predicted. When working capital from operations was the object of prediction:

1. Predictions from HC, GPLWO, GPLW, and RCWO income measurements were statistically equal;

2. HC income was a better predictor than RCW income;

3. There was no difference in predictions from the GPL income measurements, whether or not monetary gains/losses were included;

4. RC income without holding gains/losses was a better predictor than RC income that included holding gains/losses;

5. Both GPL income measurements were better predictors than the RC income method that included holding gains/losses;

6. There was no difference in prediction for both GPL income measurements and the RC income that excluded holding gains/losses.

When net income plus depreciation was the object of prediction:

1. HC income was a better predictor than the other four alternative income measures;

2. Including monetary gains/losses did not affect the predictive ability of either GPL income measurement method;

3. Including holding gains/losses in RC income gave poorer predictions;

4. Both GPL income measurements were poorer predictors than RC income that excluded the holding gains/losses; further analysis revealed, however, that four capital intensive industries (containers, steel, electrical equipment & appliances, and auto/aircraft manufacturing) were primarily responsible for the substantially higher forecast errors with the GPL income measurements;

5. The predictions from both GPL income measurements and RC income that included holding gains/losses were statistically equal.

The null hypothesis of no difference among the three predictor models was also rejected for both cash flow predictions. This means that the three predictor models did not have equal cash flow prediction errors. Conclusions from these tests were consistent for both cash flows predicted in this study:

1. The MLR model resulted in better predictions than the other two prediction models.

2. The cash flow predictions from the SLR and the EXP models were statistically equal, such that the linear/nonlinear distinction appeared unimportant in this predictive study.

Caution must be exercised in generalizing this result to the point of claiming that MLR would be the preferred method of prediction for every firm, industry, or firm size group. Indeed, SLR and EXP predicted the cash flow approximations used in this study better for some individual firms. Although test results for multicolinearity were not reported herein the fact that the two accounting variables, net income and sales, are highly correlated is well documented in the literature. This multicolinearity effect

may cause the apparent superiority of MLR in this study to be misleading in that the stability of the MLR predictions over time may suffer. Any attempt to identify the cause/effect relationship of the net income/cash flow prediction issue is complicated by multicolinearity between the independent variables included in the MLR model. Moreover, the ability to separately assess the impact of net income and sales on cash flow prediction is hindered.

The null hypotheses associated with the research objectives of industry and firm size effects were rejected. This indicated that the various industry groups and firm size classifications used in this study did not produce equal cash flow forecast errors. Some general conclusions about these results follow:

1. Cash flow prediction varies among industries; in this study, the steel industry prediction errors were significantly higher than the others when working capital from operations was the object of prediction.

2. As already indicated, four capital intensive industries produced prediction errors substantially higher than the others, although only the electrical equipment and appliance manufacturers industry was statistically significant.

3. Firm size factors were important when predicting working capital from operations, with the larger firms producing a significantly higher forecast error.

4. The definition of firm size is apparently critical; when firms were classified into the two groups defined by <u>Statement</u> <u>of</u> <u>Financial</u> <u>Accounting</u> <u>Standards</u> <u>No</u>. <u>33</u>, no significant prediction error differences occurred; conversely, an arbitrary four-group size classification gave the significant results described above.

Because the largest firms within the firm size II classification scheme (see Table 1) had larger forecast errors it might be argued that firms with higher concentrations of assets in the fixed group (property, plant, and equipment) are more affected by general and specific price level adjustments than smaller firms. Nevertheless, cash flow prediction for these larger firms apparently did not follow the general price level and replacement cost conversions of these asset groups. This implies that standard setting debates should consider the possible existence of firm size effects. These results are relevant to the "Big GAAP-Little GAAP" issue and suggest that the various firm size groups could differ with respect

to the income method that better captures its cash flow pattern, and, therefore, should apply different income measurement procedures. Note on Graph 6 that RCWO produced the lowest forecast error rate for the largest firms, but the smaller firms generated the second highest forecast error with RCWO.

Related to this issue of firm size differences in forecast errors it can also be noted from Graph 6 that the smallest firms in the size II groupings produced the second highest forecast errors for all income models. This can possibly be explained as a "tail effect," in that the income models do a better job of predicting cash flows for the average firms and a relatively poorer job forecasting cash flow for those atypical firms in the tails of the distribution.

It was reported in Chapter 5 that the firm size I grouping (two groups) of firms did not result in significant differences. When significant differences were found in a four-group designation of firms, it appeared that an aggregation effect was the cause for these different outcomes. This is important evidence to the Financial Accounting Standards Board in that its desire to isolate possible firm size differences for income measurement requirements is not being fulfilled with the current two-group classification of firms.

Another possible explanation of the significant industry/firm size effects concerns the impact of the economic environment. The vulnerability of some firms to certain national monetary and/or fiscal policies, the related interest rate/inflation rate movements, and normal business cycles could result in various patterns of cash-flow forecast errors when these firms are grouped by industry or firm size. Industry-wide econometric models that input income measurements might yield quite different forecast error patterns than those reported in this study.

The age of assets could be a significant factor among the industries and firm size groups in explaining differences in cash flow forecast errors. The implication is that older assets may not be generating cash flows consistent with the net income measurements under any of the alternatives. The steel and auto/aircraft manufacturers industries were among the highest forecast errors and in both cases the fixed asset bases are considerably older than other industries included in the study. Also, the indexing required for both GPL and RC restatement of older fixed assets might be less precise than for newer asset restatements.

Finally, there may be industry and firm size effects that overlap and confound the identification of the reason

for significantly different forecast errors. The question that could be raised is: Did the firms in the steel industry produce larger forecast errors because they belonged to the largest component of the firm size II classification or because of industry affiliation? Any statement attempting to identify either a firm size or industry effect in isolation should assess this potential overlap problem.

There were other significant results of the analysis that are not specifically covered by the research objectives. First, the "control" forecast model was used in this research to investigate the ability to predict future cash flows from past cash flows. None of the income model cash flow predictions was better than this random walk cash flow prediction. In fact, the control was a better predictor than the RCW income model for working capital from operations and all income models for net income plus depreciation. This result suppports an assertion that the FASB should not justify the alternative income reporting requirement on the assumption that this information enhances cash flow predictive ability. On the other hand, this conclusion is in conflict with the finding by Fisher[87] that

[87] John H. Fisher, "Net Income as an Indicator of Future Net Cash Inflows from Operations," (Ph.D. dissertation, University of Kansas, 1980), pp. 65-72.

net income was a better indication of future net cash flow than past measures of net cash flow from operations. Additional research is needed to clarify this issue.

Second, evidence was produced about the possible value of monetary gains/losses and holding gains/losses on the cash flow prediction issue. As described above, the monetary gain/loss has no effect on the cash flow predictive ability of the GPL income models. Therefore, any additional cost of computing and reporting the monetary gain/loss would not be warranted if based exclusively on a cash flow prediction objective. When the holding gain/loss was included in replacement cost income, the resulting prediction was poorer than when these amounts were excluded. This would suggest that holding gains/losses are of no value in predicting the cash flow approximations used in this research. This conclusion conflicts, however, with the results reported by Welton[88] in which replacement cost total income (includes holding gains/losses) yielded smaller forecast errors than historical cost. A possible reason for this conflict is that Welton used actual reported replacement cost numbers based on the reporting requirements

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[88] Ralph E. Welton, Jr., "A Comparison of the Predictive Ability of Historical Cost and Current Cost Accounting With Regard to the Prediction of Operating Cash Flow," (Ph.D dissertation, Louisiana State University, 1982), pp. 104-112.

of SFAS No. 33 and the present research employs a restatement model to produce the replacement cost numbers consistently for all firms in the sample.

Finally, the overall result produced by the tests conducted in this study is that historical cost is at least as good as (in some cases better than) the alternative income measures in predicting cash flow. This conclusion is consistent with the previously discussed research findings of Means and Bravo. Taken together, these research results appear to support the contention that historical cost net income is more representative of the characteristics of cash flow prediction than alternative incomes when cash flow is defined as working capital from operations and net income plus depreciation. Of course, this conclusion is limited to the context of the research design of this study and should not be interpreted as a blanket condemnation of alternatives to historical cost for other decisions by users of financial information.

6.3   LIMITATIONS OF THE RESEARCH

The two cash flow approximations used in this research were chosen so that results could be legitimately compared with prior research on these issues. Obviously, cash flow approximations are not actual cash flows. Therefore, it may

be appropriate to use a measurement of actual cash flow from operations as the object of prediction. This cash flow could be derived by converting the accrual basis income statement to a cash flow income statement by adjustments for receivables, payables, inventory, prepaid expenses, etc.

The firms included in the sample were not chosen randomly. Although this does not invalidate the findings of this study, it does limit the generalizability to firms and industries excluded from the study. Within the separate industry classifications the number of firms ranged from four to twenty-five. Various manufacturing industries were comprised of the majority of firms in the sample, therefore, the sample is biased toward these industries.

The predictor models were selected from the empirical predictive ability literature. No attempt was made to formulate new predictor models in this research, and the results should not be generalized to other models excluded from the study. All three prediction models used were regression formulations and the results may be limited by the small number of observations available within the data to fit the prediction equations for each firm.

There is the ever present possibility when actual reported financial data is used in accounting research that the relationships of interest will be obscured if different

accounting methods have been used to generate the original data. For example, choice from among acceptable inventory valuation and depreciation methods can result in noncomparability of accounting data across firms unless an adjustment for those differences is made. No such adjustment has been made to ·the data base used in this research, and to the extent that alternative accounting procedures have been applied by the firms the task of identifying the relevant cause and effect relationship between income method and cash flow is even more difficult.

6.4   SUGGESTIONS FOR FUTURE RESEARCH

The results of this study suggest that past cash flows are better predictors of future cash flows than past income numbers. As indicated above, this conflicts with the research findings of Fisher. Because of the recent attention devoted to the cash flow prediction issue in accounting, this apparently unresolved question deserves additional research effort.

The rule-making bodies for financial reporting have debated the possible effects of variations in firm size and industry composition on financial reporting standards concerning general and specific price changes. The present research has suggested that there are indeed firm size and

industry differences in cash flow predictive ability. However, at least one of the firm-size classification schemes was chosen arbitrarily; hence, additional testing of specific firm size groups prior to the establishment of separate reporting standards for different size firms would be important. In addition, the industry groups in this study were limited; therefore, more research is required before specific reporting standards on price changes are established separately for various industries. It would also be important to know if these firm-size and industry differences are consistent over time, or if they occurred by chance for the particular period covered by this study.

It appears to be appropriate to investigate how the alternative income and cash flow information is used by analysts, management, government agencies, and financial institutuions (if at all). This should be required preliminary input to the financial reporting standard-setting debates.

Additional evidence should be generated about the effects of alternative cash flow measurements on the objective of predicting cash flow. As implied earlier, actual measures of cash flow from operations should be tested for comparison with the approximations used in this and other studies. Moreover, alternative methods for

computing replacement cost income are available. Research is needed to compare the results of models such as the Falkenstein-Weil model with other replacement cost restatement procedures.

There also appears to be a need to investigate possible relationships between cash flow reporting and alternative income measurements on other objects of prediction. These other objects of prediction might include stock prices, trading volumes, and bond ratings.

This research provides a first step in the investigation of issues that are of current interest in the accounting and broader business communities. While the objectives of this study have been met, much more can be done to establish a body of a priori and empirical theory to provide support for the continually evolving accounting practice issues investigated herein.

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Appendix A

VALIDATION OF CASH FLOW PREDICTION PROGRAMS

The Statistical Analysis System (SAS) procedure PROC
REG was used to produce the cash flow forecast equations for
each of the three regression models selected in this study.
The income measurement methods produced the independent
variables and the cash flow approximations were the
dependent variables in the application of the several
prediction models selected for this study.

A.1   SLR

As an example of the SLR model application, SAS
estimated the following parameters for Anheuser-Busch for
1976 and 1977:

	1976	1977
INTERCEPT	33.8735	128.2080
INDEPENDENT VARIABLE (HC)	1.3553	.1267

The computer program utilized these regression
estimates to forecast cash flows for 1976 and 1977 in
accordance with the SLR model specified in Chapter 3. Hand

calculations were performed to validate the computer program steps as follows for Anheuser-Busch:

ESTIMATED CASH FLOW FOR 1976:

33.8735 + 1.3553(84.699) = $148.666 million

ESTIMATED CASH FLOW FOR 1977:

128.208 + .1267(55.398) = $135.227 million

The amounts in parentheses are the values of the independent variable (HC here) for 1975 and 1976, respectively. The computer program generated estimated cash flows for 1976 of $148.668 million, and for 1977 of $135.227 million.

The next step required first the computation of the cash flow forecast errors for 1976 and 1977 and second calculation of the average of those two errors. Consistent with the definition of forecast error from Chapter 3 above, the following hand computations were made to validate the computer program for Anheuser-Busch:

GENERAL MODEL FOR FORECAST ERROR:

$$\text{Absolute value of forecast error} = \left| \frac{\text{cash flow forecast} - \text{actual cash flow}}{\text{actual cash flow}} \right|$$

CASH FLOW FORECAST ERROR FOR 1976:

$$\left| \frac{148.666 - 155.41}{155.41} \right| = .043$$

CASH FLOW FORECAST ERROR FOR 1977:

$$\left| \frac{135.227 - 189.0}{189.0} \right| = .285.$$

Then, the average absolute forecast error for the two forecast years was calculated as follows:

$$\frac{.043 + .285}{2} = .164.$$

The computer program produced exactly the same forecast errors and average for Anheuser-Busch:

$$1976 \ = \ .043$$

$$1977 \ = \ .285$$

$$\text{Average} \ = \ .164.$$

These validation procedures, then, indicate that the computer program produced the desired results of forecasting cash flows and the related forecast errors for the SLR

prediction model. Similar hand calculations were performed for two other test companies for each of the other four income measurements used as independent variables in this research. The computer validation procedures were carried out for three test firms using the MLR and EXP prediction models also. An example of the computations under each of these models is reported below.

A.2   <u>MLR</u>

For Aluminum Company of America, SAS produced the following multiple regression parameter estimates for 1976 and 1977:

	<u>1976</u>	<u>1977</u>
INTERCEPT	40.239	42.982
INDEPENDENT VARIABLE (HC)	1.246	1.249
INDEPENDENT VARIABLE (SALES)	.042	.041

Hand computations using these regression estimates proved the accuracy of the computer program:

ESTIMATED CASH FLOW FOR 1976:

40.239 + 1.246(64.797) + .041(2305.88) = $217.823 million

ESTIMATED CASH FLOW FOR 1977:

42.982 + 1.249(143.797) + .041(2924.38) = $342.484 million

The amounts in parentheses are the HC income and sales values, respectively, for 1975 and 1976, respectively. The computer program produced estimated cash flows for 1976 of $218.266 million, andfor 1977 of $341.655 million.

As explained before, these estimated cash flows were used to compute the forecast errors for each forecast year and the average:

CASH FLOW FORECAST ERROR FOR 1976:

$$\left| \frac{217.823 \; - \; 340.75}{340.75} \right| = \; .361$$

CASH FLOW FORECAST ERROR FOR 1977:

$$\left| \frac{342.484 \; - \; 390.875}{390.875} \right| = \; .124$$

AVERAGE ABSOLUTE FORECAST ERROR:

$$\frac{.361 \; + \; .124}{2} = \; .2425.$$

The computer program generated the following forecast errors and average for Aluminum Company of America:

$$1976 \ = \ .3595$$

$$1977 \ = \ .1259$$

$$\text{Average} \ = \ .2430.$$

These comparisons indicate that the computer program generated the desired cash flow forecasts and forecast errors for 1976 and 1977. Similar comparisons were made between hand computations and computer produced results for two other test firms and the four other income measurements as independent variables. All such comparisons showed esentially equivalent results.

A.3   EXP

The final validation phase of the computer program results involved a test of the exponential regression model. Sample computations for Anheuser-Busch are reported below:

	1976	1977
INTERCEPT (NATURAL LOG)	4.069	5.475
INDEPENDENT VARIABLE (NATURAL LOG FOR GPLWO)	.205	-.147

The estimated cash flows based on these estimates and the exponential model follow:

ESTIMATED CASH FLOW FOR 1976:

exponential(4.069 + (.205 x log(56.74))) = $e^{4.8962}$

$= \$133.71$ million

ESTIMATED CASH FLOW FOR 1977:

exponential(5.475 + (-.147 x log(24.51)))= $e^{5.0048}$

$= \$149.05$ million

These cash flow forecasts were used to compute the forecast errors for 1976 and 1977 as follows:

CASH FLOW FORECAST ERROR FOR 1976:

$$\left| \frac{133.713 - 155.41}{155.41} \right| = .1396$$

CASH FLOW FORECAST ERROR FOR 1977:

$$\left| \frac{149.049 - 189.0}{189.0} \right| = .2114$$

AVERAGE ABSOLUTE FORECAST ERROR:

$$\frac{.1396 + .2114}{2} = .1755.$$

The computer program produced the following forecast errors and average for Anheuser-Busch:

$$1976 \ = \ .1393$$

$$1977 \ = \ .2116$$

$$\text{Average} \ = \ .1755.$$

Thus, the comparison of the hand computations and computer computations indicates that the computer program accurately calculated forecast errors and averages for the exponential prediction model. While the above example shows computations only for GPLWO for Anheuser-Busch, similar comparisons were made using income forecasts from the other four income measurement methods as independent variables, and for two other test firms. In each case virtually equivalent results were obtained.

Although each of the above validation examples uses working capital from operations as the dependent variable, the same validation steps were applied to the programs for net income plus depreciation as the dependent variable.

Appendix B

FIRMS IN EACH INDUSTRY GROUP

Industry #1

   Borden Inc.

   Kraft Inc.

   Beatrice Foods Co.

   General Foods Corp.

   General Mills Inc.

   Kellogg Co.

   Nabisco Inc.

   Quaker Oats Co.

   Pillsbury Co.

   Standard Brands Inc.

   Joseph Schlitz Brewing

   Anheuser-Busch Inc.

   Coca-Cola Co.

   Pepsico Inc.

   Esmark Inc.

   H. J. Heinz Co.

   Ralston Purina Co.

Industry #2

   McGraw-Hill Inc.

Harcourt Brace Jovanovich

R. R. Donnelley & Sons Co.

Time Inc.

Industry #3

Proctor & Gamble Co.

Colgate-Palmolive Co.

E. I. DuPont de Nemours

Diamond Shamrock Corp.

Dow Chemical

W. R. Grace & Co.

Allied Chemical Corp.

American Cyanamid Co.

Union Carbide Corp.

Abbott Laboratories

American Home Products Corp.

Merck & Co.

Pfizer Inc.

Schering-Plough

Smithkline Corp.

G. D. Searle & Co.

Upjohn Co.

Warner-Lambert Co.

Avon Products

Bristol-Myers Co.

Gillette Co.

Revlon Inc.

Chesebrough-Ponds Inc.

Lubrizol Corp.

Williams Co.

Industry #4

Corning Glass Works

Libbey-Owens-Ford Co.

American Can Co.

Crown Cork & Seal Co. Inc.

Owens-Illinois Inc.

Owens-Corning Fiberglas Corp.

U. S. Gypsum Co.

Industry #5

Armco Inc.

Bethlehem Steel Corp.

Republic Steel Corp.

U. S. Steel Corp.

Aluminum Company of America

Industry #6

Gardner-Denver Co.

Ingersoll-Rand Co.

Caterpillar Tractor Co.

Clark Equipment Co.

Combustion Engineering Inc.

Foster Wheeler Corp.

AM International Inc.

Control Data Corp.

Burroughs Corp.

International Business Machines Corp.

NCR Corp.

Xerox Corp.

Honeywell Inc.

Sperry Rand Corp.

Black & Decker Manufacturing Co.

Trane Co.

Industry #7

Reliance Electric Co.

McGraw-Edison Co.

Motorola Inc.

Raytheon Co.

Westinghouse Electric Corp.

General Electric Co.

Emerson Electric Co.

Sunbeam Corp.

Whirlpool Corp.

RCA Corp.

Zenith Radio Corp.

AMP Inc.

Texas Instruments Inc.

Square D Co.

Thomas & Betts Corp.

Industry #8

Chrysler Corp.

Ford Motor Co.

General Motors Corp.

Champion Spark Plug

Eaton Corp.

Timken Co.

TRW Inc.

Martin Marietta Corp.

Grumman Corp.

Boeing Co.

McDonnell Douglas Corp.

Cummins Engine

Eagle-Picher Industries

General Dynamics

United Technologies

Industry #9

  Beckman Instruments Inc.

  Perkin-Elmer Corp.

  Polaroid Corp.

  Eastman Kodak Co.

  Johnson & Johnson

  Baxter Travenol Laboratories

  American Hospital Supply

  Minnesota Mining & Manufacturing Co.

  Tektronix Inc.

Industry #10

  Carter Hawley Hale Stores

  Assorted Dry Goods Corp.

  Dayton Hudson Corp.

  Federated Department Stores Inc.

  J. C. Penney Co.

  Sears, Roebuck & Co.

  K-Mart Corp.

Industry #11

  Great Atlantic & Pacific Tea Co.

  Jewel Cos Inc.

Kroger Co.

Lucky Stores Inc.

Southland Corp.

Winn-Dixie Stores Inc.

Industry #12

Jack Eckerd Corp.

Longs Drug Stores Inc.

Revco Drug Stores Inc.

Tandy Corp.

All Other Firms

Scott Paper Co.

Crown Zellerbach

B. F. Goodrich Co.

Goodyear Tire & Rubber Co.

Uniroyal Inc.

American Brands Inc.

Philip Morris Inc.

Inco Ltd.

Amax Inc.

Textron Inc.

International Telephone & Telegraph

Armstrong Cork Co.

CBS Inc.

Englehard Minerals & Chemical Corp.

Genuine Parts Co.

Halliburton Co.

Holiday Inns Inc.

McDonalds Corp.

Melville Corp.

Masonite Corp.

Sedco Inc.

St. Joe Minerals Corp.

AN EMPIRICAL INVESTIGATION OF THE CASH FLOW PREDICTABILITY OF HISTORICAL

COST, GENERAL PRICE LEVEL, AND REPLACEMENT COST INCOME MODELS

By

Godwin Thomas White

(ABSTRACT)

One of the fundamental premises of financial reporting by business enterprises is that it should provide users with information that will assist them in predicting the amounts, timing and uncertainty of future cash flows of the enterprise. The requirement for alternative income measurements was partially justified by an assumed correspondence between the new information and the cash flow prediction objective. The existence of that correspondence, however, has not been precisely verified by the research to date. The overall objective of this research was to contribute additional evidence to address conflicts in the prior research findings, and additionally, to consider possible industry and firm-size effects on the ability to predict cash flow from alternative incomes.

A data base was compiled from COMPUSTAT tapes (historical cost), the Parker model restatement procedures (general price-level) and the Easman data base that used the

Falkenstein-Weil restatement model (replacement cost). One conclusion was that the alternative income measurements produce different cash flow forecast errors. Overall, historical cost net income produced the lowest forecast errors for two approximations of cash flow. The inclusion of monetary gains/losses and holding gains/losses in net income did not improve predictions, and in one case worsened them.

Another conclusion was that a multiple linear regression model produced significantly lower forecast errors for both cash flow definitions. The simple linear and exponential regression prediction models did not produce different forecast errors.

Finally, both an industry effect and a firm-size effect were identified in the prediction of working capital from operations. When net income plus depreciation was the object of prediction, an industry effect was identified but not a firm-size effect.

The overall impact of these findings is that the alternative income measurements should be justified on some basis other than facilitating cash flow prediction. In fact, a random-walk cash flow prediction model performed better than any prediction based on net income. Financial accounting standards in the area of alternative income

measurements should consider possible industry and firm-size differences. The choice of cash flow definition is apparently critical because different conclusions were obtained.