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CORPORATE PROFITABILITY:

DETERMINANTS AND FORECASTS

By

Paul Sheldon Foote

A DISSERTATION

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

Department of Accounting

1983

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1983

ABSTRACT

CORPORATE PROFITABILITY: DETERMINANTS AND FORECASTS

By

Paul Sheldon Foote

Growing interest in financial forecasting has increased accountants' concerns about the disclosure and reliability of forecasted numbers. Proponents of the public disclosure of forecasted income statements claim that managerial disclosures of the determinants of their forecasts are more important than forecast accuracy. Opponents counter that such disclosures are so inaccurate as to be misleading.

Ijiri, in THEORY OF ACCOUNTING MEASUREMENT, offered a seven-point plan for the improvement of the reliability of forecasting processes. Within this framework, empirical insights were sought concerning these accounting issues:

(1) Is it possible to develop benchmarks for use by managers, auditors, investors, and accounting rule makers in evaluating the reliability of a forecasting process?

(2) Is there, in the existing literature or in this study, empirical support for existing proposed guidelines for the public disclosure of forecasted income statements?

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(3) Will additional disaggregation of an income statement permit improved forecasts?

(4) How sensitive are forecast accuracy results to the choice of determinants in income statement models?

(5) Can forecasters improve their accuracy by incorporating distributed lag specifications in income statement models?

(6) Does an increase in the number of firms used to estimate income statement models decrease the accuracy of the forecasts?

(7) Must or should a forecaster consider simultaneous relationships among accounting variables?

Cross-sectional estimates and one year ahead forecasts of six income statement models were based upon 1,674 aggregate model firms or 343 disaggregate model firms. Four econometric estimation techniques were used: (1) ordinary least squares, (2) reduced form, (3) two stage least squares, and (4) two stage least squares derived reduced form.

The study found positive support for the use of cross-sectional benchmarks and of aggregate models. It was possible to achieve more accurate forecasts by using the more aggregate selling, general, and administrative expenses variable than the detailed advertising and research and development expenditure variables. The empirical evidence for the last four questions indicates that accountants need to be less concerned about managerial choices of determinants and more concerned about the use of distributed lags, larger sample sizes, and of simultaneous relationships.

DEDICATION

To my children

David and Sheila

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ACKNOWLEDGEMENTS

My attempt to write a proposal for a dissertation led me to discuss my vague notions of the problem with professors in many different departments at Michigan State University. Kenneth Janson, Gerald Park, and Peter Schmidt served as the initial committee members. Each professor provided different insights based upon their extensive experiences with the literatures of Box-Jenkins time series analysis, systems science, and of econometrics, respectively.

The extensive earlier writings of J. Walter Elliott, an economist at The University of Wisconsin--Milwaukee, provided the starting point for this study. Professor Elliott aided me by providing me with reprints of his articles relating to this study.

Peter Schmidt provided the encouragement for me to start this study. While my background in econometrics, statistics, matrix algebra, and in mathematical economics was weaker than the backgrounds of doctoral candidates in economics with whom he usually works, Professor Schmidt agreed to serve on my committee because of my determination to complete a project of the scope of this study. He relied upon my ability to identify those aspects of the accounting literature I thought were relevant to this study.

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Kenneth R. Janson was an assistant professor of accounting when he agreed to serve as chairperson of the dissertation committee. His background in the Ph. D. program at the University of Wisconsin had provided him with an extensive exposure to Box-Jenkins time series analysis. Professor Janson shared with J. Walter Elliott the desire to compare forecasting methodologies with the same set of firms. His decision to serve on my dissertation committee with two world famous full professors represented an act of courage. The membership of a lone accounting professor on the committee meant that it would be possible to pursue a study involving several academic disciplines.

Gerald L. Park served initially as a committee member to enable me to improve upon the comparisons between econometrics and systems science made by J. Walter Elliott. His textbooks and courses on systems science are filled with examples of models of the economic behavior of firms. Students from many departments at Michigan State University have benefited from his interdisciplinary courses. Professor Park's insights on directions important for accounting research are possible, in part, because of his extensive use of mathematical models. Future doctoral students in business administration could benefit from learning to use the formal research approaches of econometrics and of systems science.

Gerald L. Park became chairperson of the dissertation committee when Kenneth R. Janson left Michigan State University to become an associate professor of accounting at Michigan Technological University. Professor Park's skills in managing doctoral researchers who need to meet deadlines and his willingness to serve beyond the scope of inital commitments provide for future professors examples of leadership,

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courage, and of persistence.

Harold M. Sollenberger, chairperson of the accounting department, agreed to serve as a member of the committee following Kenneth Janson's departure from Michigan State University. During Michigan's major budget cuts, Professor Sollenberger found ways to support the extensive computer runs needed to study 1,674 firms. In spite of his busy schedule, he chose to review numerous extensive revisions of chapters. Professor Sollenberger's contributions strengthed the ties between the accounting literature and the other literatures reviewed for this study.

Stephen Martin, even while away from Michigan State University's Department of Economics for one year on an assignment at the Federal Trade Commission, suggested industrial organization theory readings and commented on several drafts of the dissertation. George Mead, while on leave from Michigan State University's Department of Accounting to work at the Securities and Exchange Commission, supplied me with SEC publications reviewed in this dissertation.

Numerous professors throughout the world have either corresponded with me or have discussed some aspect of this study during presentations of papers at universities in North America. Many of them will notice at least some of their suggestions were incorported in this study.

This study is the product of years of effort. The opportunity costs of the research have been great. My children, David and Sheila, missed summer vacations and many other activities because of my lack of time to be with them. Both of them helped in many ways. David, while a student in elementary school, helped by reading computer manuals. Together, we have been able to decipher many manuals. Some of David's

computer programs were published in Edward H. Carlson's KIDS & THE APPLE. Hopefully, my son's example will show me the path to publishing. My wife, Badri, endured the long years of serving as both a mother and a father to our children. My mother, Norene, helped David and Sheila by taking them to many activities after school and on weekends. David and my mother mastered word processing software to help me on days I was teaching. Philip Foote, my brother, rescued me repeatedly from the disadvantages of home ownership.

While many others have helped me to complete this study, the responsibility for the overall quality and timely completion of this research remains mine. Others cannot be held responsible for any errors I may have made in stating the problem, in reviewing the literature, and in summarizing results.

TABLE OF CONTENTS

List of Tables xv

Chapter 1 Problems in the Development of Forecasting Principles

1.1 Plans for the Improvement of the Reliability of Forecasts 1

1.2 Scope of this Study 3

1.3 Ijiri's Seven-Point Plan and the Implications for this Study 5

1.4 Empirical Research Approach 15

1.5 The Information Content Issue 17

1.6 The Cost of Forecasting 20

1.7 The Relevance of Forecasts 23

1.8 The Reliability of Forecasts 31

1.9 Legal Issues 35

1.10 An Operational Definition of Feasibility 39

1.11 Empirical Considerations 47

Pr

2.

2.

2.

2.

2.

2.

2.

2.

2.

2.

Chapter 2 The Determinants of Corporate Profitability

Preview of Chapter 2	51
2.1 The Elliott Studies	54
2.2 Other Econometric Studies of the Firm	72
2.3 Systems Analysis	77
2.4 Industrial Dynamics Approach to Systems Analysis	98
2.5 Corporate Simulation Models	102
2.6 Monte Carlo Simulation	104
2.7 Programming Models	106
2.8 Behavioral Analyses	107
2.9 Time Series Analysis	108
2.10 Profit Theory	115
2.11 Corporate Models	142

Preview c

3.1 The A

3.2 The F

3.3 The F

3.4 The F

3.5 An Ag

3.5.1 Det

3.5.2 Det

3.5.3 Gros

3.5.4 Dete

3.5.5 Oper

3.5.6 Iden

3.6 A Di

3.6.1 Dete

3.6.2 Dete

3.6.3 Gros

3.6.4 Dete

3.6.5 Dete

3.6.6 Dete

3.6.7 Oper

3.6.8 Iden

Chapter 3 Development of the Models

Preview of Chapter 3 160

3.1 The Approaches to Development of Models of the Firm 162

3.2 The Feasibility of a General Model of the Firm 164

3.3 The Feasibility of Industry-Oriented Models of Firms 164

3.4 The Feasibility of Firm-Specific Models of Firms 169

3.5 An Aggregate Model for Pro Forma Income Statements 173

3.5.1 Determinants of Net Sales 180

3.5.2 Determinants of Cost of Goods Sold 191

3.5.3 Gross Margin 199

3.5.4 Determinants of Selling, General, and Administrative Expenses 200

3.5.5 Operating Income before Depreciation 208

3.5.6 Identification of the Aggregate Model 208

3.6 A Disaggregate Model for Pro Forma Income Statements 217

3.6.1 Determinants of Net Sales 219

3.6.2 Determinants of Cost of Goods Sold 222

3.6.3 Gross Margin 223

3.6.4 Determinants of Advertising Expense 224

3.6.5 Determinants of Research and Development Expense 227

3.6.6 Determinants of Selling, General, and Administrative Expenses (Net) 230

3.6.7 Operating Income before Depreciation 232

3.6.8 Identification of the Disaggregate Model 232

Pre
4.1
4.2
4.3
4.3
4.3
4.4
4.4
4.4.
4.4.
4.4.
4.4.
4.4.
4.4.
4.4.
4.4.
4.4.
4.4.
4.4.
4.4.

Chapter 4 Estimation and Test Methods; Data Sources

Preview of Chapter 4		238
4.1	Classification of the Aggregate and Disaggregate Models	239
4.2	Estimation Methods	240
4.3	Test Methods	243
4.3.1	Goodness-of-Fit Tests	243
4.3.2	Prediction-beyond-the-Data Tests	254
4.4	Forecast Accuracy Measures	256
4.4.1	Mean Error (ME)	258
4.4.2	Mean Absolute Deviation (MAD) or Mean Absolute Error (MAE)	258
4.4.3	Root Mean Square Error (RMSE)	259
4.4.4	Mean Absolute Percentage Error (MAPE)	261
4.4.5	Adjusted Mean Absolute Percentage Error (Adjusted MAPE)	263
4.4.6	Theil's Measure of Inequality (U)	264
4.4.7	Coefficient of Variation (CV)	269
4.4.8	Coefficient of Determination (r-squared)	269
4.4.9	Accuracy Ratio	272
4.4.10	Turning Point Errors (TP)	272
4.4.11	Mean Square Error (MSE)	274
4.4.12	Efficient Predictor	276
4.4.13	Index of Predictive Efficiency (IPE)	277

4.5 Data Sources 278

4.5.1 Sales 278

4.5.2 Cost of Goods Sold 281

4.5.3 Advertising Expense 282

4.5.4 Research and Development Expense 283

4.5.5 Operating Income before Depreciation 284

4.5.6 Receivables 284

4.5.7 Inventories 286

4.5.8 Plant-Net 287

4.5.9 Invested Capital (Total) 288

4.5.10 Order Backlog 289

Preview of C

5.1 1674 A

5.2 Model

5.2.1 Estima

5.2.2 Foreca

5.3 Model

5.3.1 Estima

5.3.2 Forecas

5.4 Model

5.4.1 Estimat

5.4.2 Forecas

5.5 Model 4

5.5.1 Estimat

5.5.2 Forecas

5.6 Model 5

5.6.1 Estimat

5.6.2 Forecas

5.7 Model 6

5.7.1 Estimat

5.7.2 Forecas

Chapter 5 Empirical Results

Preview of Chapter 5	290
5.1 1674 Aggregate Model and 343 Disaggregate Model Firms	292
5.2 Model 1: Aggregate, 1674 Firms, No Distributed Lags	292
5.2.1 Estimation of Model 1	292
5.2.2 Forecast Accuracy of Model 1	307
5.3 Model 2: Aggregate, 1674 Firms, Unconstrained Lags	311
5.3.1 Estimation of Model 2	311
5.3.2 Forecasts of Model 2	323
5.4 Model 3: Aggregate, 343 Firms, No Distributed Lags	327
5.4.1 Estimation of Model 3	327
5.4.2 Forecast Accuracy of Model 3	339
5.5 Model 4: Aggregate, 343 Firms, Unconstrained Lags	343
5.5.1 Estimation of Model 4	343
5.5.2 Forecast Accuracy of Model 4	354
5.6 Model 5: Disaggregate, 343 Firms, No Distributed Lags	358
5.6.1 Estimation of Model 5	358
5.6.2 Forecast Accuracy of Model 5	374
5.7 Model 6: Disaggregate, 343 Firms, Unconstrained Lags	379
5.7.1 Estimation of Model 6	379
5.7.2 Forecast Accuracy of Model 6	401

6.
6.2
6.3
6.3
6.3
6.3
6.3
6.3
6.3
6.3
6.4
Lis

Chapter 6 Conclusions

6.1 Empirical Evidence on Improving the Reliability of Forecasting 407

6.2 Restatement of the Scope with Brief Conclusions 408

6.3 The Ijiri Framework and the Research Findings 417

6.3.1 Input Data 417

6.3.2 Forecasting Methods 420

6.3.3 Forecast Recording 423

6.3.4 Forecast Variance Analyses 423

6.3.5 Forecast Reporting 424

6.3.6 Forecast Auditing 426

6.3.7 Forecast Responsibility 426

6.4 Limitations and Suggestions for Future Research 428

List of References 432

LIST OF TABLES

Table 1	OLS Estimates of Model 1	293
Table 2	OLS Unrestricted Reduced Form Estimates of Model 1	300
Table 3	2SLS Derived Reduced Form Estimates of Model 1	303
Table 4	2SLS Estimates of Model 1	306
Table 5	Forecast Accuracy of Model 1	308
Table 6	OLS Estimates of Model 2	312
Table 7	OLS Unrestricted Reduced Form Estimates of Model 2	315
Table 8	2SLS Derived Reduced Form Estimates of Model 2	318
Table 9	2SLS Estimates of Model 2	321
Table 10	Forecast Accuracy of Model 2	324
Table 11	OLS Estimates of Model 3	328
Table 12	OLS Unrestricted Reduced Form Estimates of Model 3	332
Table 13	2SLS Derived Reduced Form Estimates of Model 3	335
Table 14	2SLS Estimates of Model 3	338
Table 15	Forecast Accuracy of Model 3	340

Tab

Tab

Tab

Tab

Tabl

Tabl

Tabl

Tabl

Tabl

Tabl

Tabl

Tabl

Tabl

Tabl

Tabl

Table 16 OLS Estimates of Model 4 344

Table 17 OLS Unrestricted Reduced Form Estimates of Model 4 347

Table 18 2SLS Derived Reduced Form Estimates of Model 4 350

Table 19 2SLS Estimates of Model 4 353

Table 20 Forecast Accuracy of Model 4 355

Table 21 OLS Estimates of Model 5 359

Table 22 OLS Unrestricted Reduced Form Estimates of Model 5 364

Table 23 2SLS Derived Reduced Form Estimates of Model 5 368

Table 24 2SLS Estimates of Model 5 372

Table 25 Forecast Accuracy of Model 5 375

Table 26 OLS Estimates of Model 6 380

Table 27 OLS Unrestricted Reduced Form Estimates of Model 6 385

Table 28 2SLS Estimates of Model 6 391

Table 29 2SLS Estimates of Model 6 398

Table 30 Forecast Accuracy of Model 6 402

CHAPTER 1

PROBLEMS IN THE DEVELOPMENT OF FORECASTING PRINCIPLES

1.1 PLANS FOR THE IMPROVEMENT OF THE RELIABILITY OF FORECASTS.

American managements disclose forecasted income statements to support bank loan requests and other business-related involvements. Many of these managements also disclose at least some financial forecast data to the public. In recent years, there has been controversy over the prospects of imposing mandatory disclosure requirements for financial forecasts on publicly-held companies by one or more of the accounting rule making bodies.

Disclosure debates are not unique to proposals of financial forecasts. All firms making public disclosures of historical financial statements are subject to specific disclosure requirements. Beaver (1977) reviewed the complex issues involved in proposals for mandatory disclosure requirements. Generally accepted accounting principles (GAAP) for the public disclosure of historical financial statements are

far more detailed than any current guidelines for the disclosure of financial forecasts.

The Securities and Exchange Commission (SEC) has actively reviewed the possibility of requiring specific financial forecast disclosures. In the absence of an existing system of mandatory disclosures, the Management Advisory Services, Accounting Standards Division, and the Forecasts and Projections Task Force of the American Institute of Certified Public Accountants (AICPA) have studied and published separate, detailed guidelines for managements electing to make public disclosures of financial forecasts. In spite of the detail of these guidelines, considerable development of forecast disclosure concepts and reporting frameworks remains to be done. To provide a disclosure environment conducive to public disclosure of financial forecasts is an important task for accounting rule setting bodies. The Financial Accounting Standards Board (FASB), the AICPA, and the SEC need to continue the development of guidelines for the public disclosure of forecasts.

Managers produce goods, services, and information about their firms. Some consumer products are simple and inexpensive. Consumers can evaluate the reliability of these goods. Other consumer products are very technical in nature. In these cases, consumers may choose to subscribe to information from independent research organizations to determine the reliability of the technical products. Information, including all historical and forecasted accounting data, represents a much more complex aspect of reliability considerations. Potentially, forecasts represent one of the least reliable products of managements

because many years may need to pass before complete verification is possible.

Accounting standards for the preparation of historical financial statements fill the pages of lengthy books. The private sector sponsored FASB and the governmental regulatory agency, the SEC, continue to contribute new accounting standards in an attempt to improve the reliability of historical financial disclosures. By comparison, the few existing guidelines for the public disclosure of financial forecasts represent vague generalities.

Ijiri (1975) outlined the major tasks facing accountants seeking to build a framework for financial forecasts. He stressed the importance of developing detailed forecasting principles because "corporate financial information has been standardized to a reasonable degree insofar as it deals with past or present events, but little attempt has been made to standardize the process by which information is forecasted."

1.2 SCOPE OF THIS STUDY.

This study provides empirical insight to the following accounting issues, within Ijiri's framework for the improvement of the forecasting process:

(a) Is it possible to develop benchmarks for use by managers, auditors, investors, and accounting rule makers in evaluating the reliability of a forecasting process?

(b) Is there, in the existing literature or in this study, empirical support for existing proposed guidelines for the public disclosure of forecasted income statements?

(c) Will additional disaggregation of an income statement permit improved forecasts?

(d) How sensitive are forecast accuracy results to the choice of determinants in income statement models?

(e) Can forecasters improve their accuracy by incorporating distributed lag specifications in income statement models?

(f) Does an increase in the number of firms used to estimate income statement models decrease the accuracy of the forecasts?

(g) Must or should a forecaster consider simultaneous relationships among accounting variables?

The scope of most earlier research has been one of the following: (a) proposed guidelines for the public disclosure of forecasted income statements; (b) correlational studies showing firms disclosing forecasts voluntarily are different from firms not disclosing forecasts; (c) econometric studies using a small number of firms, a single income statement model, one econometric estimation technique, and one forecast accuracy measure.

This empirical study uses four econometric estimation techniques and the data of 1,674 firms to estimate six income statement models. The six income statement models differ by level of aggregation and by the presence or absence of distributed lag specifications. All models are used to forecast the 1979 income statements for either 1,674 or 343 firms, representing a one year ahead forecast. Several forecast

accuracy measures are compared for these forecasts.

1.3 IJIRI'S SEVEN-POINT PLAN AND THE IMPLICATIONS FOR THIS STUDY.

The literature review in Chapter 2 will include a summary of the major suggestions for making possible the public disclosure of forecasted financial statements. The most comprehensive suggestions may be found in Ijiri (1975). He provided a detailed framework for improving the reliability of forecasts. His seven-point plan was so comprehensive that no single research study to date has provided a thorough treatment of all the points he raised. This study will be no exception. Some of the problems Ijiri outlined will be reviewed briefly in this chapter only. This section summarizes Ijiri's seven-point plan and how the scope of this study is molded with respect to each point.

(I) PRINCIPLES ON INPUT DATA FOR FORECASTING.

Transactions are the source of basic data input for historical accounting systems. Accounting standards include definitions of transactions and guidelines for the inclusion of transactions in the accounting process. The income statement reflects factors which have already affected a firm's financial status.

Managers enjoy a monopoly over knowledge about decisions on how they plan to convert current balance sheet values into future income statement values. Proponents of greater public disclosure of forecasts desire the disclosure because managers have greater knowledge about their operating plans, not because managers have mastered forecasting techniques. Ijiri regarded the disclosure of operating plans as the

most important input data for forecasting. He assumed that outsiders use historical financial statements, but that they need to know which internal data elements managers use in making their own forecasts. Ijiri assumed also that outsiders use economic and other environmental factors. Managerial disclosures might need to extend to a listing of economic factors managers find useful in preparing their own forecasts.

Principles on input data for forecasting will necessarily include explicit statements on the limits to disclosures. Ijiri declared that firms have a right to protect their competitive advantages. This means that managers need not disclose detailed operating plans. Instead, Ijiri expects managers to disclose the expected consequences of their operating plans. Forecasting principles need to provide guidance as to the level of aggregation of financial forecasts. According to Ijiri, financial forecasts must not be disaggregated to the point that competitors can infer operating plans and respond competitively to the disadvantage of the disclosing firm. Within the United States, this means that managers of firms that disclose financial forecasts voluntarily must not be subjected to disclosure rules which hurt their firms relative to non-disclosing firms. If an accounting rule setting body in the United States mandated the public disclosure of financial forecasts by all American firms, the concern for competitive disadvantage would shift to foreign competitors not subject to mandatory disclosure rules.

Ijiri asserted that the most difficult goal to attain will be the achievement of intercompany comparisons of forecasts. He suggested that future research be directed towards the development of standardized guidelines for the choice of determinants used in forecasting models. The scope of this study will be limited to cross-sectional estimates of the relative importance of firm-level determinants across a large number of firms. The use of cross-sectional data in this study represents an attempt to understand the problems of achieving the goal of uniformity and comparability suggested by Ijiri. However, the use of cross-sectional estimation means also that there will be no variability of economy-level determinants across firms in a single year, a limitation of the scope of this study. As the review of the literature in Chapter 2 will reveal, several researchers have used time series data for a small number of firms. The use of cross-sectional data in this study provides an opportunity to ask questions about comparability rather than to attempt the development of firm-specific models.

The level of aggregation issue will be addressed by the use of two basic models. Aggregate models will contain selling, general, and administrative (SGA) expenses as a separate line item in the income statement. Disaggregate models will replace SGA with three of its major components: advertising expense; research and development expense; SGA (net). The use of competing models within the same study and with the same data base holds the potential of providing empirical support for guidelines to improve the reliability of corporate forecasting processes. It will be possible to compare the forecast accuracies of models differing in the choices of determinants of income statement

variables. If the range of forecast accuracy measures is narrow regardless of the choice of determinants, there may be less need to develop detailed principles on input data for forecasting than for other problems identified by Ijiri. While other disaggregations of accounting variables may be possible, this study will be limited to the disaggregation of SGA expenses. SGA expenses are examples of managerial attempts to gain competitive advantages. Managers may want to conceal the amounts of money they plan to spend on advertising and on research and development, if the purpose of these expenditures is to capture market share from competitors. If, instead, most managements spend the same amounts or percentages of sales on these items merely to match competitors, there may be little managerial concern for the separate disclosure of these components. Ijiri's test for the limits to disclosures is more difficult to operationalize and may not even be an effective test relative to the test used in this study: continue disaggregation of income statement variables as long as forecast accuracy improves.

(II) PRINCIPLES ON FORECASTING METHODS.

Ijiri identified two major issues dealing with forecasting methods. First is the choice of statistical methods. He cited problems arising from the popularity of two major forecasting methods, economic forecasting models and Box-Jenkins time series models. Second is the nature of accounting and economic justification for the forecasts. Ijiri asks whether forecasts were prepared to generate the firm's earnings only the components of the firm's earnings, or for each division of the firm. Also, if top managers choose to ask divisional

managers to prepare divisional forecasts, then guidelines will be necessary for the aggregation of divisional forecasts.

The scope of this study will be limited to what Ijiri termed economic forecasting models. Earlier researchers, reviewed in Chapter 2, used the term "econometric models." Some accounting researchers have been concerned with the "feasibility" of disclosing financial forecasts, where feasible meant it is possible to generate forecast within an arbitrary error tolerance level of say 10%. Ijiri stressed the importance of the reliability of the forecasting process, not the relative forecasting accuracy of competing forecasting methods. Forecast accuracy is important if proposed models generate forecasts less accurate than models of no change or of the same change between years. As forecasts approach perfect forecasts, the need to compare forecasting methods decreases. The scope of this study will be limited to a comparison of competing econometric models. There will be no comparisons with other forecasting methods, such as Box-Jenkins time series analysis. Comparisons with methods using time series data may be appropriate if the econometric models were being developed using time series or panel data. Since the scope of this study has been limited to cross-sectional estimates, a comparison with other forecasting methods would necessitate limiting firms in the study to those meeting the data requirements for both cross-sectional and time series models. A difficulty of using time series data is that structural changes of firms, such as mergers, may complicate the analysis. Further, many studies on the time series properties of earnings indicate that little can be concluded with annual data. Generally, first order

autoregressive models are consistent with annual data. The guidelines of the AICPA show clearly that managers are expected to support their forecasts by citing relationships with firm-, industry-, and economy-level determinants. This means that any forecasting method using only historical values of the accounting variable being forecast is not consistent with proposed AICPA guidelines.

(III) PRINCIPLES ON FORECAST RECORDING.

Historical financial statements are supported by journals, ledgers, trial balances, schedules, and other records. Ijiri proposed guidelines be developed for the specific kinds of forecast working papers firms must maintain to support forecasts. Forecast working papers would include records of input data and of forecasting methods used. The intent is to build a basis for validation and verification of the forecast data.

The scope of the study will be limited further to the use of models consisting entirely of data available to the public. This research decision represents a way of staying within Ijiri's test of not placing a disclosing firm at a competitive disadvantage by the disclosure. As a result of this choice, it will not be possible to provide detailed examples of forecast working papers of the type managers using internal data would find appropriate.

(IV) PRINCIPLES ON FORECAST VARIANCE ANALYSES.

Variance analysis is an integral part of all financial planning and control systems. Segmental reporting and financial ratio analyses are examples of methods used by managers in forecasting and by auditors in searching for possibly inconsistent disclosures. In forecasting, Ijiri cited the similar variance analysis problem of the need to decompose forecast errors. He suggested analyzing forecasting errors, one period following the forecast, by taking the difference between the forecast and the actual. The next step in Ijiri's forecast variance analysis would be the inclusion of changes in managerial expectations found by taking the difference between the actual data at the time of the forecast and the forecast data for the next period. Other variances could be: price and volume; project-by-project; product-line; geographical; and major contingency items.

By limiting the scope of the study to public data, it is not possible to examine empirically all variance analyses suggested by Ijiri. Instead, several forecast accuracy measures will be compared. Forecast variance analysis will be facilitated further by forecasting each line of the income statement models rather than only operating income.

(V) PRINCIPLES ON FORECAST REPORTING.

Generally accepted forecasting standards are needed for: (1) level of aggregation; (2) timing of disclosures; (3) forecast formats; (4) changes in forecasting methods; (5) forecast variance analyses; (6) point estimates or probability statements indicating dispersion of estimates.

This empirical study will provide evidence of the impact on forecast accuracy provided by the disaggregation of a single component of the income statement: SGA expenses. Components of this accounting variable have concerned researchers in accounting and in many other fields. Researchers studying strategic planning, industrial organization, marketing, advertising, and research and development stress the importance of knowing certain components of SGA expenses.

While it is possible to construct econometric models incorporating probability statements, all models used in this study generate only point forecasts. The models of this study were developed to examine empirically the feasibility of using a general model for a large number of firms.

(VI) PRINCIPLES ON FORECAST AUDITING.

Auditors need to have tests for consistent use of forecasting methods over time and internal consistency of assumptions at a given point in time.

All models used in this study are based upon cross sectional data. Managers would use time series data for the development of models for their individual firms. Auditors may need to develop time series data models to aid their evaluation of managerial forecasting processes. Intrilligator (1978) has explained the general problems of comparing cross sectional and time series data models. A specific problem with respect to the development of income statement models using cross sectional data versus time series data is that the choice of some of the determinants will be different. Cross sectional models do not contain economy-level determinants because there is no variability of those determinants across firms in a single year. Comparisons of the signs of coefficients of a benchmark cross-sectional model and of forecast accuracy measures with the signs and measures of a firm's time series data models may be possible. The models of this study provide a starting point for the evaluation of any firm's forecasting process.

(VII) PRINCIPLES ON FORECAST RESPONSIBILITY.

Ijiri concluded the plan with a call for specifying which level of management may approve forecasts prior to publication. Further, the forecasting principles need to include a detailed discussion of legal liabilities and of limits to liabilities.

This chapter contains a brief review of the legal problems related to the public disclosure of forecasts. The scope of the review is limited to an examination of legal issues and to providing suggestions of ways of developing testable hypotheses within the framework of the aggregate and the disaggregate models of this study.

In summary, the scope of this research study is limited to an empirical examination of some of the aspects of improving the reliability of the income statement forecasting process. For reasons to be discussed in Chapter 3, estimation techniques will be limited to: ordinary least squares (OLS); OLS unrestricted reduced form; two stage least squares (2SLS); 2SLS derived reduced form. Several forecast accuracy measures will be compared to evaluate the potential for forecast variance analyses. The introduction of distributed lag specifications will provide an opportunity to examine the extent to which the same lag patterns are the same across a large cross section of firms. The empirical results of this study will provide additional knowledge about what can be done by accounting rule making bodies in preparing detailed guidelines which many managements may be able to follow to improve the reliability of the forecast disclosure process. Ijiri has suggested that a thorough set of generally accepted forecasting standards might need the detail represented by generally accepted accounting principles. American accounting standards have developed over a period of many decades. Forecasting standards, too, will not be developed fully within the scope of this empirical study.

1.4 EMPIRICAL RESEARCH APPROACH.

This empirical study will involve the use of models consisting of one equation for each line of an income statement. The two income statement charts of accounts used in this study are: (a) AGGREGATE MODEL, consisting of: sales; cost of goods sold; gross margin; selling, general, and administrative expenses; operating income before depreciation; (b) DISAGGREGATE MODEL, consisting of: sales; cost of goods sold; gross margin; advertising expense; research and development expense; selling, general, and administrative expenses (net); operating income before depreciation.

The gross margin and operating income equations are accounting identities. The remaining equations are behavioral equations. The choice of determinants in this study will be limited to firm-level variables. Each determinant to be proposed in later chapters represents a hypothesis to be tested. However, since this study involves the use of a system of equations, the following observations differentiate this study from single-equation studies: (a) the choice of determinants for behavioral equations affects the implicit form of identities; (b) the decision to include a determinant in even one equation means that additional decisions must be made to include or to exclude the determinant in all other behavioral equations in the model.

This study differs from several earlier income statement studies in the use of balance sheet variables as determinants. Receivables, inventories, plant, and invested capital appear in the models as determinants. This approach is consistent with the accountant's view of the importance of balance sheet variables in determining future

revenues, expenses, and profits. Further, in a given accounting period, accountants journalize some transactions with simultaneous debits and credits to balance sheet and to income statement accounts. Knowledge of accounting relationships between variables provides a basis for the evaluation of the signs of coefficients in income statement models.

Order backlogs appear as a determinant in the income statement models of this study. This variable differs from all other variables in this study because its value is zero for many firms. The use of order backlogs as a determinant of income provides an opportunity to examine differences in managerial decisions between managers of firms with and without order backlogs.

The choice of firms used in this study was based entirely upon data availability for the six models estimated. The annual industrial COMPUSTAT tapes provide a large base of American firms with a uniform chart of accounts. This approach meant that 1,674 firms were used to estimate the aggregate models and 343 firms were used to estimate the disaggregate models. Earlier researchers have used very small numbers of firms in their feasibility studies. No attempt was made to improve forecast accuracy by imposing additional tests for inclusion in the study. The purpose of the models of this study is to provide a realistic benchmark for the disclosure of forecasts by all firms subjected to public reporting rules.

The year 1978 was selected as the base year for the estimation of all models. One year ahead forecasts for 1979 were based upon the cross sectional model estimated for 1978. These years represent relatively stable economic periods compared with the years used by some of the earlier researchers. However, the use of base periods used by earlier researchers would have meant the inability to estimate disaggregate models. The SEC's segmental reporting requirements has meant a large increase in the number of firms disclosing advertising expense and research and development expense as separate line items on income statements.

Distributed lag specifications appear in some of the models of this study. This research choice provides additional empirical evidence relating to the decision of accountants to require that all research and development and advertising expenditures be treated as expenses in the period incurred.

1.5 THE INFORMATION CONTENT ISSUE.

While stock exchanges have for a century sought the disclosure of historical financial statements as the price for a firm's listing on the exchange of its shares, there is no similar requirement for forecasted financial statements by the firm's management. The feasibility of preparing forecasted financial statements is of little significance unless it can be demonstrated that such statements are relevant to the decisions made by stockholders.

Those who argue for the disclosure of management's forecasts state that forecasts made by security analysts or by anyone else outside the firm cannot be substitutes because only managers know their plans for the firm's future. Some argue also that managers have access to all variables in a firm's accounting information system. The additional detail available to managements gives them an advantage in preparing forecasts.

Gonedes, Dopuch, and Penman (1976) classified research on the information content of earnings forecasts:

(a) prediction accuracy studies. In these studies, one looks at the accuracy of earnings in an absolute sense. The implicit assumption is that the greater the accuracy, the greater the information content (McDonald, 1973 ; Daily, 1971).

(b) benchmark studies. The accuracy of management's forecasts is not important per se. What is important is whether users can make better forecasts after seeing management's forecasts than they could without seeing management's forecasts. One difficulty with this approach is the selection of benchmarks. The usual choice is a naive model (Copeland and Marioni ,1972).

(c) studies using a theoretical framework for resource allocation under uncertainty. Shareholders need information relevant to valuing a firm. This suggests that one needs a theoretical model linking the value of a firm as it relates to resource allocation decisions, such as an asset-pricing framework (Gonedes and Dopuch, 1974; Foster, 1973).

While researchers agree that there is no purpose in asking managers to prepare data having no information content, there is no agreement on how to measure information content. The usual approach in measuring information content has been to measure the stock market's reaction to a new message. This approach has been unsatisfactory for several reasons (Barnea, Sadan, and Schiff, 1979):

(a) It is not possible to separate market reaction and models describing returns generation. The process generating returns over time can change. This leaves us without an independent test for market reaction;

(b) We have no measures of the statistical accuracy associated with market reaction tests;

(c) Our tests are no better than averages across events, investors, and time periods. As an alternative, Barnea, Sadan, and Schiff suggested the analysis of informational value be based upon aggregate decision models. This approach will be reviewed in detail in the next chapter.

1.6 THE COST OF FORECASTING.

If one can demonstrate that management's forecasts convey information relevant to establishing the firm's value (i.e., possess information content), then the next issue becomes one of the production and dissemination of such information. The managements of most major American companies do not disclose forecasted financial statements. Some would regard this situation as a market failure. They would propose to remedy the market failure by mandatory disclosure rules prepared by regulatory bodies, such as the Securities and Exchange Commission (SEC) or by the Financial Accounting Standards Board (FASB). Gonedes, Dopuch, and Penman (1976) concluded that there is no reliable empirical evidence of a market failure in the market for information. Even if one could prove the existence of a market failure, there are options other than mandatory disclosure laws to be considered.

Managers face the costly problem of establishing the authenticity of forecasted accounting information. In order to demonstrate their information is not defective, they may need to turn to independent auditors. This does not solve the problem because auditors must establish the authenticity of the procedures they use with respect to management's forecasts.

Beaver (1977) provided for the Advisory Committee on Corporate Disclosure to the Securities and Exchange Commission additional aspects of the costs of a mandated disclosure system. He began by considering the demand for accounting information. Investment involves trading current consumption for securities representing claims to future, uncertain cash flows. Each investor must make a decision on information

consumption to aid in making the trades. However, an investor does not need to act alone. An investor can select an investment company to make the decisions. However, investment companies compete also with analysts at brokerage and other information-producing firms. Firms, themselves, have an incentive to provide some information about the firm in order to attract capital. Investors who rely upon this private sector usually do not read filings with the SEC. It is important, Beaver argued, to identify the efficiency or equity considerations involved in a regulatory system for corporate disclosures. Managers have no incentive to disclose forecasts, prepared at the cost of their shareholders, if the shareholders in a competing firm can benefit from the knowledge of the success or failure of a product development.

The cost of information production is a further disincentive for corporate disclosures. Current shareholders pay for the production, auditing, and dissemination of disclosures. The indirect costs involved are in terms of reduced competitive advantages. It is possible that a reduction in competitive advantage reduces management's incentives to invest in product development. Chapter 2 will provide a review of the industrial organization theory concerning research and development activities. Both current shareholders and taxpayers bear the cost of regulatory systems.

In spite of the increase in corporate disclosures as a result of the activities of the SEC, there remains a considerable private effort by analysts to obtain superior information in order to achieve abnormal returns for their clients. It is possible, then, for both the public good argument of too little production of information and the argument

that too much information is gathered to be correct. The important question, according to Beaver (1977), is whether or not this is a case of a zero-sum game in which superior returns net to zero across all investors.

Some managements issue forecasts for years they expect to show increased profits and remain silent for years they expect losses to occur. While this behavior is considered unacceptable with respect to historical financial statements, many authors regard forecasts to be something provided only at the pleasure of managements. The absence of full disclosure means that security prices do not reflect fully quality differences among stocks. If managements suppress only unfavorable information, investors will know only that there is uncertainty about the quality of the stock. The nature and the materiality of the suppressed information may mean that securities prices of lower quality stocks may trade at prices higher than would be possible with full disclosure.

Our ability to understand the demand of investors for accounting information is complicated further by investment decisions made with respect to portfolios of more than one security. The proposed disclosure of management's forecasts for an individual firm represent a response to investor demand for firm-specific information. In portfolio theory, an individual security is important to the extent that it contributes to the overall risk and expected return of the portfolio.

There are two types of risk: unsystematic (diversifiable) and systematic (nondiversifiable). Economy-wide events affect the prices of all securities to varying degrees. By contrast, a contract award represents an event whose implications are largely firm-specific. The relative importance of each type of risk can vary significantly from firm to firm. In terms of management's forecasts, some would expect managers to have an advantage over persons outside the firm with respect to the evaluation of specific accounting information. Persons outside the firm may not be at a disadvantage with respect to managements in terms of forecasting economy-wide events. Most investors will choose to minimize unsystematic risk by diversifying their portfolios. If, however, an investor possesses superior information about a firm, that investor might choose to have less diversification in the portfolio. The diversification of investors' portfolios tends to reduce investor demand for firm-specific accounting information. This means that proposed additional disclosures about a firm need to provide major benefits to the investor in order to achieve the benefits achieved easily through diversification of the portfolio.

1.7 THE RELEVANCE OF FORECASTS.

The appeal to economic theory and to quantitative measures of information content, discussed in the preceding two sections, is not the usual approach to the problem of management forecasts. What follows will be a review of qualitative and legal approaches to the description of the problem of public disclosure of management forecasts.

Kidd (1976, 90) suggested the following tests earnings forecasts must pass before their disclosure:

(a) FREEDOM FROM BIAS. The disclosure of a forecast should represent management's best estimate of the firm's most probable future earnings. This means that managers need to be willing to disclose not only the forecasts but also the major assumptions used in preparing them. Investors can then evaluate the forecasts in terms of evidence of over-optimism or of over-pessimism.

(b) SUPPORTABLE. An independent person using the same methods and data should be able to corroborate the original forecast.

(c) RELEVANT. This characteristic receives the most attention in the disclosure literature. It will be reviewed later in this chapter.

(d) QUANTIFIABLE. Vague, narrative discussions of a firm's future prospects are assumed to have little information content. The counter argument, to be cited later in this section, is that those who disclose quantitative forecasts need to do so in a manner that the user does not attach greater precision than exists.

(e) COMPLETE. Managements disclosing forecasts need to reveal all information required by users for the evaluation of the reasonableness of the forecasts.

(f) COMPARABLE. Kidd used a narrow meaning of comparability. He suggested that forecasts be comparable with actual results reported by the firm. This must mean that variables forecasted by management must be the same variables that management has been disclosing in historical financial statements. This means that it is not feasible to develop forecasting procedures containing finer details than a firm's auditors

permit for historical statements using generally accepted accounting principles. The historical statements of firms may or may not be comparable between firms. This problem affects directly all accounting information disclosures. Kidd's criteria do not include a discussion of the aggregation level of disclosures; this topic will be reviewed later.

(g) UNDERSTANDABLE. Kidd intended this to mean simple terminology to describe complex economic descriptions. While terminology can be important if the same words are used differently in explaining forecasts than they are used in daily business contexts by investors, the more important criterion to suggest might be that the forecasting models be parsimonious. By disclosing relatively simple management forecasting models, users need less initial knowledge to evaluate the models. The models may be simple to the point that they can be used year-after-year for at least the same firm.

(h) TIMELY. Management forecasts need to be available to users when those users require forecasted accounting information in making decisions. This means that forecasting models are feasible only if the required variables were available before the period for which the forecast is prepared.

(i) PRACTICAL TO PREPARE. By this, Kidd meant that the cost of preparing the forecasts should be less than the value of those forecasts to the users. The previous section revealed the difficulties of demonstrating that any accounting information passes this test.

The literature supporting and opposing the public disclosure of management forecasts agree usually that relevance is the most important qualitative test. Management forecasts pass the test. Lev (1974) reviewed stock valuation models appearing both in academic journals and in business publications. He concluded that a firm's FUTURE earnings are major explanatory variables in stock valuation models. The examples Lev cited were (p. 111):

(a) THE VALUE LINE RATINGS. The intrinsic value of a stock is found using a time-series regression model with these explanatory variables: average price of the stock for the current year, estimates for the next year of dividends and of earnings-per-share, and a market sentiment index based upon the average annual yields of approximately 50 stocks (Bernhard, 1959);

(b) THE WHITBECK-KISOR MODEL. A cross-sectional linear regression model is used to predict price-earnings ratios as a function of: estimated earnings-per-share growth rates, risk (measured by the standard deviation of the firm's earnings), and the estimated dividend payout ratio (Whitbeck and Kisor, 1963);

(c) THE GORDON MODEL. The value of a share is a function of: current earnings, the firm's estimated retention (investment) rate, estimated rate of return on investment, and an estimate of the rate of profit investors require on the share (Gordon, 1962);

(d) THE MALKIEL MODEL. The determinants of a firm's price-earnings ratio are: the earnings growth rate and the dividend payout ratio. Both are assumed to grow at a constant rate. The same discount rate applies to all securities (Malkiel, 1963).

Lev noted also that it is important to study how these models treat uncertainty. One approach has been to discount the expected value of returns by a risk-adjusted rate. Another approach has been to use past earnings variability as a surrogate for risk. Lev suggested that future earnings be estimated in the form of probability distributions for which investors have different preferences.

As noted earlier, a major assumption in the current literature of finance is that managers are attempting to maximize the current market value of the shares held by the current shareholders (Fama and Miller, 1972). It appears that the financial statements produced by accountants are not relevant to many investors. Why are managements willing to disclose products of accounting historians and not willing to disclose the needed forecasted accounting information?

Beaver (1981, 103-106) offered an answer in the form of three critical links between accounting earnings and the price of a firm's common stock:

> (1) a link between security price and future dividends, (2) a link between future dividends and future earnings, and (3) a link between future earnings and current earnings.

The price of a stock is a function of the expected value of future dividends. However, the level of expected dividends is a function of the level of expected earnings and of nonearnings information. A valuation model provides the link between future dividends and the price of stock. The payout ratio links future dividends and future accounting earnings. Hence, a payout ratio in any given time period is the ratio of two expected values.

Beaver (1981) argued that the relevance of future earnings can be demonstrated to the extent that future earnings are statistically dependent with future dividends. Empirical studies show that earnings changes are correlated with dividend changes (Fama and Babiak, 1968; Watts, 1973). However, Beaver regards this as a weak foundation for the relevancy of earnings. What is needed is a general theory of managerial choice under imperfect or incomplete markets. Such a theory would need to explain how managers make choices in order to maximize the market value of shares and how managers link their expectations of future earnings with the ability of the firm to pay dividends in the future.

The final link to be made, according to Beaver, is between future accounting earnings and current accounting earnings. He made the link by appealing to a stochastic process for earnings. In any time period, there can be atypical events (such as a strike or a catastrophy). The two components of accounting earnings are: permanent earnings and transitory earnings. Permanent accounting earnings are the expected value of future accounting earnings. Unlike economic earnings, accounting earnings do not represent a valuation concept. The relevance of accounting earnings depends upon their ability to reflect events that

alter beliefs about the ability of the firm to pay dividends in the future. At this point, the choice of accounting methods becomes an issue. Using the current financial reporting system, Beaver claimed that unanticipated inflation can have a permanent effect on the level of accounting earnings reported even though the dividend-paying ability of the firm may not have changed. Even if most revenues and expenses increase in line with inflation, depreciation expense will not increase. The firm's earnings will increase faster than the rate of inflation even though its dividend-paying ability has not increased in real terms.

Instead of the approach of studying the time series behavior of accounting earnings, Beaver (1981) suggested a more ambitious approach: forecasting income statements on an item by item basis. Each line of the income statement would be decomposed:

> the forecasting of future accounting earnings includes (1) an assessment of the distribution of (a) future quantities of outputs, (b) future prices of output, (c) future quantities of inputs, and (d) future prices of inputs and (2) the accounting methods used to transform these raw data into earnings numbers.

He offered these examples:

Future sales = future selling price times future quantities of output sold.

Future cost of goods sold = future prices of inputs times the quantity of inputs required to produce the quantity of output sold.

Future depreciation expense = future price of depreciable assets to be purchased times the quantity of depreciable assets to be purchased.

Barnea, Sadan, and Schiff (1979) regarded the relevance of forecasts to be obvious because virtually all security analyses conclude with an estimate of a firm's future earnings.

Hendriksen (1977, 548) concluded that the relevance of forecasts had been demonstrated by Nickerson, Pointer, and Strawser (1974) and by Gray (1974). These studies showed that forecasters need management forecasts to capture turning points that extrapolation techniques miss. According to Hendriksen, the important issues are: (a) which information should management forecast; (b) how can the reliability of forecasts be measured.

In 1977, the advisory committee on corporate disclosure recommended that the SEC encourage managements to publish forward-looking information. The committee offered these reasons (1:351):

(a) In recent legal cases, some courts have ruled that the omission of managements projections constitutes, in certain situations, the omission of material information in violation of federal securities laws (Schneider, 1972);

(b) projections are the key to the present value of securities (Herwitz, 1973),

In sum, the relevance of forecasts is not an issue. However, critics of forecasts would counter that the unreliability of forecasts means that forecasts are either misleading or of little information value to investors.

1.8 THE RELIABILITY OF FORECASTS.

Kohler (1975) defined four meanings of reliability appearing in the accounting literature:

> 1. (auditing) The measure of confidence that may be placed in a set of records or reports. The test of reliability is whether a reconstruction, following accepted accounting practices, would yield approximately the results actually obtained. The closeness with which the records or reports conform to the results thus theoretically obtainable constitutes the degree of reliability.
>
> 2. The confidence generated in a reader of financial statements by their appearance, fullness of information presented, and general capacity to communicate both favorable and unfavorable information.
>
> 3. (management) The condition of operating effectiveness in which continuity of function, adherence to present standards, capacity for avoiding failure, and other desirable factors are believed to be present.
>
> 4. (statistics) Relative ability to repeat results in a given set of trials or experiments.

Concerns expressed over the reliability of forecasts thus can take several forms.

The Accountants International Study Group (1974) dismissed the unreliability objection:

> The difficulty of making a forecast lies in these assumptions and will depend on the length of time to be covered by the forecast, the reliability of the accounting records, the quality of the personnel, the industry in which the forecasting company operates and the knowledge which the company has of the products and markets involved. It is more difficult to prepare reliable profit forecasts in times of economic instability and uncertainty. However these difficulties are not such as to invalidate the preparation of forecasts which might still be required by shareholders, investors and other interested parties.

The group's solution would be to have the regular publication of management forecasts, not publication only when managers expected a good year. In this way, users of the forecasts could collect evidence over

the years of the reliability of the forecasts of a specific firm.

Earnings forecasts, based upon the difference between two big numbers, can be unreliable. The unreliability problem worsens as the ratio of fixed costs to total costs increases. For many firms, a 5% error in forecasting sales volume can be enough to eliminate all profits or to show a doubling of profits depending upon the direction of the error. Ijiri (1975) called this phenomenon the forecast-error multiplier, or the "ratio of the percentage error in forecasting profit and the percentage error in forecasting gross margin." For major American firms, Ijiri expected the multiplier to have values between 10 and 20. This is a severe problem because it would be difficult to provide an auditor with guidelines on how to recognize an unreasonable forecast. Any management could make the defense that they were off by only a few percentage points in their forecasts of sales volume.

The reliability problem, then, stems from generally accepted accounting principles for the presentation of historical financial statements. American firms are not required to provide a breakdown of fixed and of variable costs in their financial statements, even though most managements prepare such analyses for internal decisionmaking purposes. Outside users of financial statements prepared on a full costing basis encounter a greater problem in performing breakeven analyses for a firm than do managers using direct costing data (Solomons, 1968). This fact, alone, damages severely any claim that outside analysts can prepare forecasts better than management forecasts. The forecast-error multiplier will be affected also by management's ability to choose among inventory costing methods permissible under GAAP

(Ijiri, Jaedicke, and Livingstone, 1965). Ijiri was unable to find any evidence that the forecast-error multiplier problem would diminish as the number of product lines of a firm increases. If a firm's management prepared forecasts on a product-by-product basis, optimistic and pessimistic forecasts might not cancel each other out if there is high correlation of observations on different product lines.

Ijiri suggested these options for overcoming the reliability problem (p. 147):

(a) Management can disclose a table in its annual reports of its forecasting track record. The table can show both dollar differences between the forecast and the actual results and a forecast-error index.

(b) Instead of forecasting earnings as the difference between two large numbers, Ijiri urged forecasting the entire financial statement.

Belkaoui (1981) explained that reliability when used to discuss the disclosure of corporate financial forecasts, such as in Ijiri (1974), means the relative accuracy of forecasts. This usage differs from Ijiri's better known definition of reliability of an accounting measurement procedure: the degree of objectivity plus a reliance bias, as measured by mean squared error (Ijiri and Jaedicke, 1966).

Hendriksen (1977, 549) complained that net income, the accounting number most frequently mentioned in the debate over the disclosure of management forecasts, is both the most difficult to predict and the least reliable. In order to forecast accounting income, he explained, you will need to use many subjective variables and make many assumptions about the firm and the economy. The disclosure of management forecasts will be feasible only if management discloses its assumptions regarding

expectations for the industry and for the economy. Used in this way, reliability means the degree to which the user of a forecast would have included the same variables and have made the same assumptions in preparing a forecasting model. Hendriksen argued that too much attention had been given in the literature to forecasts of accounting income. He argued that one who studies normative investment decision models will need: expected sales, budgeted receipts and disbursements, expected changes in prices and in demand for the firm's products, and expected changes in the costs of labor and of goods purchased by the firm.

The distinction between the reliance on an accounting information system and on a forecasting system is important for auditors. Currently, independent auditors review the financial statements prepared by management. In so doing, they rely upon the accounting information system used by the management. If management forecasts are to be disclosed to the public, then independent auditors will be asked to review the forecasts. Auditors will not be able to rely on the forecasting system to the same degree that they rely on the internal control system of the firm (Kidd, 1976, 157). Some auditors have complained that forecasts are based upon opinions and are not subject to third party verification. Further, some claim that managements' forecasts will be so wide so as to make meaningless any attestation.

These auditing positions may overstate the problem. In 1975, the American Institute of Certified Public Accountants (AICPA) published a statement of position on the presentation and disclosure of financial forecasts plus a management advisory service guideline for systems for the preparation of financial forecasts. In 1979, the exposure draft for a proposed guide on the review of a financial forecast appeared. Auditing methodologies are being developed for the third party review of forecasts which may overcome some of the stated objections.

1.9 LEGAL ISSUES.

The literature on the auditing of forecasts contains claims that auditors should not be involved with forecasts because the increase in legal risk for the auditor is greater than any benefits for users of financial statements. The SEC has used the concept of safe harbors to induce companies to participate in experiments in new disclosure requirements. The number of cases and articles on liabilities for forecasts does not appear to support the contentions that auditors will be exposed to losses in the courtroom. Two lawyers studied the possible legal exposure for auditors and identified them as (Mandel and Altschul, 1977):

(a) SECTION 11 OF THE SECURITIES ACT OF 1933. An investor who suffers damages in relying upon misleading registration statements filed under this Act may sue every accountant who prepared or certified any part of the registration statement. An accountant uses a defense of due diligence. The authors identified only one case involving section 11

liability for untrue financial forecasts or projections: BEECHER V. ABLE, 374 F. Supp. 341 (S. D. N. Y. 1974). The court ruled that a reasonable earnings forecast is based upon: (1) facts from which a reasonably prudent investor would conclude that it is highly probable that the forecast will be realized; (2) disclosure of any underlying assumptions whose validity is sufficiently in doubt; (3) the corporation's record of success in forecasting earnings; (4) care exercised in the preparation and review of costs and sales estimates; (5) doubts expressed by persons involved in the review of the forecasts; (6) any facts not known to management but which could be obtained by persons exercising reasonable care.

(b) RULE 10b-5 OF THE SECURITIES ACT OF 1934.

Safe harbor protection from rule 10b-5 liability may be needed because this rule provides for private actions for damages in cases where there is evidence of illicit practices. In determining rule 10b-5 liability, courts use the tests of recklessness and of fraud, not merely a test of negligent nonfeasance. In GREEN V. JONHOP, INC. (358 F. SUPP. 413 D. ORE. 1973), liability was imposed when an underwriter had both no basis for a sales forecast and had made no investigation of its accuracy.

(c) BLUE SKY LAWS. They vary by State.

(d) COMMON LAW NEGLIGENCE.

(e) SEC PROCEEDINGS. The SEC may initiate civil injunctive proceedings under rule 2(e) of its rules of practice. The SEC staff needs to prove only that an accountant acted in an unprofessional manner. Available sanctions are : suspension from practice before the SEC; peer review; compulsory continuing education; adverse publicity.

The authors concluded that accountants can accept engagements to assist in the preparation or the review of financial forecasts or projections as long as they follow a few simple precautions.

THE APPENDIX TO THE REPORT OF THE ADVISORY COMMITTEE ON CORPORATE DISCLOSURE TO THE SECURITIES AND EXCHANGE COMMISSION contains two legal briefs on the legal problems associated with the disclosure of forecasts (pages A-330 through A-408):

(a) FEINTUCH MEMORANDUM. This lawyer argued that courts have been harsher in cases of nondisclosure of relevant information than in cases of the disclosure of information that cannot be objectively clarified. There are some special cases illustrating possible limitations on the feasibility of management forecasts. The first case is one of new firms. The SEC objected to the statements involved in THOMAS BOND, INC., 5 S. E. C. 60 (1939) because a new firm with no history of production made forecasts appearing to be precise. Another limitation is that companies may not disclose forecasts inconsistent with their own internal estimates of earnings (DOLGOW V. ANDERSON, 53 F. R. D. 664; E. D. N. Y. 1971). This ruling has interesting implications for the level of aggregation of forecasts. The model used to produce management forecasts for disclosure to the public must be able to produce forecasts similar to forecasts produced internally using perhaps more variables

and confidential data.

A management has a legal obligation to correct inaccurate and misleading earnings projections made by its underwriters and market makers (GREEN V. JONHOP, INC., 358 F. Supp. 413; D. Ore. 1973).

(b) MOOMJIAN MEMORANDUM. This attorney attempted to review the legal treatment of soft information and of the use of "safe harbor" rules. He quoted Kripke (1970):

"projections are the ultimate purpose of all disclosure."

Much of his review revealed that non-legal issues were a major concern. For example, a management might continue making projections assuming that past determinants would remain operative. A major problem arises when a variable which has been inoperative to date becomes important. Another problem could exist if all other firms in an industry make an assumption not made by a single firm. Who changes their assumptions?

The requirement by the SEC that major firms disclose replacement cost data is an example of the disclosure of soft information. Schneider (1972) listed other soft information to be considered for public disclosure:

> (1) projections, (2) budgets, (3) plans for products, marketing, financing, business strategy, (4) plans for acquisitions of other companies, (5) plans for expansion, contraction or reduction of business and (6) plans for disposal of assets.

After a lengthy review of the issues relating to the possible disclosure of these items, Moomjian concluded:

> The real issue is whether issuers should have to disclose assumptions and if there is to be such disclosure, how comprehensive should it be.

This guidance, he contended, is lacking under broad versions of "safe harbor" rules. He cautioned against narrow views of "safe harbor" rules, in which a firm make disclosures only if it could meet a list of rigid conditions. For example, Moomjian regarded as a loss of meaningful information a situation in which firms may make disclosures only if their predictions for variables can be made within a 10% range. Managements, he argued, should be permitted to disclose projections they regard as realistic.

1.10 AN OPERATIONAL DEFINITION OF FEASIBILITY.

The foregoing review of issues relating to the public disclosure of management forecasts covered some of the major arguments for and against the disclosures. This literature is vast. What is lacking is a literature of analytical and of empirical studies on the problem of management forecasts. In the next chapter, a review of that literature is made. Prior to turning to those studies, it is necessary to operationalize what authors seem to mean when they say the public disclosure of management forecasts is or is not feasible.

The feasibility claim is independent of a mandatory or voluntary disclosure system. It is possible that some firms have been disclosing forecasts when it is not feasible for them to do so. It is possible that there are firms for which the public disclosure of forecasts would be feasible, but for which forecasts will not be prepared unless mandated by the SEC. In the first case, the term "feasible" would need to mean at least that the management using their forecasting model can

forecast correctly the direction of change of accounting variables on more occasions than would a random model. A stronger test of feasibility would be that the management forecasts be more accurate than most or all published forecasts by analysts. In the second case, there might be firms whose internal forecasts year-after-year are almost identical with those of analysts. These managements might conclude that the public has the best possible forecasts available to them. Hence, it would not be worth the legal risk (no matter how slight) to publish a management forecast.

Feasibility does not necessarily mean the ability to produce forecasts capable of lying within a 10% range. Until the accounting literature makes the links between security prices and current accounting earnings, as suggested by Beaver, it is not possible to make statements about the sensitivity of security valuation models to wide swings in estimates of accounting variables. There appears to be no empirical or analytical justification for a 10% rule of thumb.

Most (1977) suggested an indirect approach to feasibility: determine if there is a reduction in the variability of a firm's stock prices after it begins disclosing forecasts. Even if this crude link were made, the questions raised in this chapter about the disclosure of assumptions used in producing the forecasts and about the accounting variables for which managements released forecasts would remain unanswered.

The authors reviewed would regard as feasible forecasts whose accuracy is close to that of the internal models using confidential variables. The implication is that a forecasting model using only data available to the public represents a feasible basis for disclosures if enrichments of the model do not improve forecast accuracy. The level of aggregation necessary for forecasting models remains to be determined. Even though data are available to the public, the public may not be aware of the relevance of certain variables to a business. The disclosure of management forecasts would reveal those variables management regards as important to the firm. If analysts can produce better forecasts than managers can, using only data available to the public, then managements would need to modify their internal forecasting procedures. It is not obvious that the most complex explanatory models produce the most accurate forecasts. Managements need guidance on how to make tradeoffs between explanation and accuracy, if tradeoffs are necessary.

Forecasting models using only the lagged values of the series being forecasted are not adequate for compliance with the expectations for management forecasts. Managers will need to use models based upon economic theory. Determinants of accounting income variables need to be identified.

The feasibility of management forecasts is not measured necessarily by the decline in the forecasts produced by analysts. Competing forecasts need not be perfect substitutes. What remains to be learned is how one compares competing models and how investors could use more than one set of forecasts in their own models.

The importance of firm-specific variables relative to industry-wide and economy-wide variables may be a determinant of managements' abilities to produce feasible forecasts.

Forecasts by managements, analysts, and by users are constrained by generally accepted accounting principles for historical financial statements. It is not feasible to produce forecasts finer in detail than the detail of historical financial statements. In the United States, there is no uniform chart of accounts. Charts of accounts can differ between companies and even between years for the same company. Forecasting models may have to exclude variables suggested by economic theory for the lack of data availability. This means also that forecasting models will tend to contain highly aggregated variables, both in terms of the left-hand side accounting variables and in terms of the right-hand side determinants.

An additional example of an omitted variables problem remains. Several authors have suggested that it will be necessary to explain and to forecast more than net income. Some suggest performing the analysis for each line of the income statement. Others argue that no model is feasible without the disclosure of left-hand side variables not reported by accountants, such as market share or the price of a firm's common stock. Many studies in the accounting literature and in the finance literature have examined only one of three links suggested by Beaver. A further literature review will be needed to determine if the effects are known of examining only one link at a time. There may be no general theory covering all the links.

Feasibility may be a question of degree. The Accountants International Study Group assumed that the ability to forecast improves over time. The implication is that it is feasible for all firms to forecast now and that over time it will become more feasible to do so because a learning curve is at work. A study of management forecast models needs to include several years for the forecasts in order to examine empirically the nature of the improvements.

Ijiri's suggestion to reduce the impact of the forecast-error multiplier by forecasting the entire financial statement assumes that each line will be forecasted ignoring simultaneous relationships. Errors in the specification of a set of simultaneous equations could also multiply the impact of the error. Evidence remains to be found in the literature or to be developed in this study on the sensitivity of forecasting models to errors. These studies would pinpoint which variables are most crucial for us to understand.

The objection that it is not feasible for new firms to prepare forecasts, if accepted, could be used by most American firms because new product introductions, mergers, and acquisitions are a few examples of ways old firms, for all practical purposes, become new firms. For new venture managers, venture capitalists and bankers make no exceptions to requirements for forecasts. It is not obvious why potential investors need to make an exception. This objection appears to be related to the learning curve suggestion.

In terms of updating forecasts, one needs to identify those variables whose changes in values affect quickly earlier forecasts.

A severe test of the feasibility of forecasting, according to some critics, is the ability to detect turning points. A possible reason for failure to detect turning points is the change in significance of determinants of a specific firm's profitability. However, as firms merge, it is not obvious that turning points become more severe over time.

Several researchers have stressed the importance of disclosing assumptions. A further review of the literature in the next chapter will be necessary to determine how many assumptions are necessary to explain and to forecast corporate profitability.

The test of feasibility is ill-defined in the literature. It appears to be a complex test. It is not obvious that historical financial statements could survive this complex test.

For the purposes of this study, the public disclosure of forecasted income statements will be considered to be "feasible" if proposed forecasting models pass all of the following tests:

(1) GENERAL MODEL. The proposed model may be applied to a large number of firms making public disclosures to the SEC. This test ensures that firms other than those voluntarily disclosing forecasts will be included in a study of feasibility. Policymakers at the SEC, FASB, and the AICPA need to be concerned about the impact upon all affected firms following the implementation of new disclosure rules. Auditors use financial ratios to make initial evaluations of historical financial statements prepared by managements. These auditors ask managements to

explain why financial ratios for the current period are different from those of prior periods for their firm or for competitors. There may be excellent reasons for the differences. These reasons could be disclosed to outsiders who would ask the same questions about differences.

(2) MULTIPLE EQUATIONS. Each line of the income statement will have a separate equation. This approach permits a decomposition of forecast errors to determine which income statement variables are more difficult to forecast. Accounting profit variables are residual values. The major components of accounting profit variables will be examined as separate equations.

(3) PUBLIC DATA. The general models will consist only of data available to the public. No new mandatory disclosure rules would be necessary to provide data needed for a general forecasting model. Competitors would have access to no additional accounting variables.

(4) UNIFORM CHART OF INCOME STATEMENT ACCOUNTS. The same forecasting model will be applied to all firms. The level of aggregation used will be that of firms making highly aggregate disclosures. The detailed disclosures of some firms will be aggregated.

(5) FIRM-LEVEL DETERMINANTS. The specification of forecasting models will include determinants consisting of balance sheet and income statement variables with relationships with each included income statement equation. This test excludes forecasting models consisting entirely of lagged values of the income statement variable being forecasted. Known relationships between variables, based on accounting treatments and economic theory, must be incorported into the equations.

(6) OPERATING INCOME. Feasibility considerations will be limited to the easier test of operating income rather than net income. Financing decisions will be excluded from the models. Only operating decisions remain.

(7) ONE YEAR HORIZON. General models must pass the minimal test of forecasting a single year ahead.

(8) IMPROVED ACCURACY BENCHMARKS. In addition to passing all other tests, the forecasting models must produce forecasts more accurate than are possible using naive tests, such as next year's income statement will be the same as this year's income statement. This test ensures that the benchmarks applied to managerial forecasts are more rigorous than is possible with simple extrapolation tests.

1.11 AN OUTLINE OF THIS STUDY.

This study began, in this chapter, with a review of a framework for the improvement of the reliability of forecasts provided by Ijiri (1975). Those aspects of Ijiri's framework which will not be addressed extensively within the scope of this study were reviewed in this chapter. The concerns of Chapter 1 were qualitative, legal, and definitional. Information content and resource allocation studies were reviewed, to the extent that such studies pertain to forecasts. Major qualitative tests which have been applied to the public disclosure of earnings forecasts included: (a) freedom from bias; (b) supportability; (c) relevance; (d) quantifiability; (e) completeness; (f) comparability; (g) understandability; (h) timeliness; and (i) practicality. Ijiri (1975) stressed the importance of improving the reliability of a firm's forecasting process. Other researchers have stressed the feasibility of disclosing forecasts to the public. Chapter 1 contained a review of both arguments and a discussion of how to operationalize such tests in an empirical study. The legal aspects of public disclosures are important because of the potential costs to firms should their managements make disclosures deemed later to be misleading.

Chapter 2 contains an extensive review of the major theoretical and empirical studies relating to the improvement of the reliability of the forecasting process. Few prior studies have involved forecasts of each line of the income statement. The major exceptions have been numerous studies by J. Walter Elliott. In addition to the econometric studies of Elliott and of others, Chapter 2 contains reviews of findings appearing in other literatures, including: systems analysis, simulation,

programming models, behavioral analysis, time series analysis, and profit theory.

Chapter 3 develops six models used in this study. Earlier researchers usually developed a single model which they applied to a single or to a small number of firms. The use in this study of six models and of 1,674 firms provides competing explanations and forecasts of corporate profitability. In particular, the use of six models provides an opportunity to examine empirically questions of the impact of additional disaggregation of income statements and of the introduction of distributed lag specifications on the reliability of the forecasting process.

Some earlier researchers used a single estimation technique for the development of models used in forecasting income statements. By contrast, this study used four estimators: (a) ordinary least squares (OLS); (b) two stage least squares (2SLS); (c) OLS unrestricted reduced form; and (4) 2SLS derived reduced form. By comparing the use of four estimators in the same study, it is possible to examine the importance of simultaneous relationships among income statement variables. Also, it is possible to compare models in terms of which ones provided the best explanations of corporate profitability versus which ones generated the most accurate forecasts. Chapter 4 contains also an extensive review of forecast accuracy measures used in the forecasting literature. This review of forecast accuracy measures provides a basis for evaluating the forecasting results appearing in Chapter 5.

The empirical results of Chapter 5 present the findings of the use of four estimation techniques to generate estimates of sales, cost of goods sold, gross margin, selling, general and administrative expenses, and of operating income before depreciation for 1,674 firms. These cross-sectional estimates represent benchmarks against which managers, auditors, investors, and regulators may compare the public disclosure of income statement forecasts. For 343 of these firms, there are estimates of advertising and of research and development expenditures. The importance of the choice of a forecast accuracy measure will be illustrated by the reporting of not one, but several, forecast accuracy measures: (a) correlation coefficient; (b) correlation coefficient squared; (c) root-mean-squared error; (d) mean absolute error; (e) mean error; (f) regression coefficient of actual on predicted; (g) Theil's Inequality Coefficient (both sets of decompositions of error).

The conclusions of this study, contained in Chapter 6, may have policy implications for accounting rule setting bodies. Earlier guidelines have been based upon the agreement of committee members or upon empirical studies using a small number of firms. The use in a single study of the same data base for comparing competing estimation techniques and forecast accuracy measures provides evidence easier to evaluate than has been possible with a collection of limited feasibility studies. Additionally, this study provides some empirical evidence of the limits to the usefulness of income statement disaggregation and of distributed lag formulations. Some existing accounting standards are based upon incorrect research conclusions drawn from studies not incorporating controls for the evaluation of differences in the

aggregation levels of income statements or in the use of competing distributed lag specifications.

CHAPTER 2

THE DETERMINANTS OF CORPORATE PROFITABILITY

PREVIEW OF CHAPTER 2.

Thousands of American firms would be affected by a mandatory Securities and Exchange Commission requirement that pro forma income statements be disclosed. The purpose of this chapter is to review the literature on the determinants of each line of the income statement. If there is a well-established theory of profits, then it is possible to turn to forecast accuracy considerations.

Some of the major problems in buttressing forecasted income statements with theoretical support are:

(1) American accountants do not have a uniform chart of accounts for firms. This means that more research appears in the literature for sales or for net income than for other lines of the income statement. Profit theory has lacked empirical content for many of its variables. Economists, in general, and industrial organization theorists, in

particular, have been highly critical of accounting data. They have turned to the private data of firms or to the Federal Trade Commission's undisclosed line of business data. Those who have attempted to use the published products of accountants either adjust data series, if possible, or use a small set of firms meeting all of the data requirements on a voluntary basis.

(2) Many researchers have used single-equation models, assuming that simultaneous relationships are insignificant.

(3) Many economists have been concerned with finding firms resembling microeconomics textbook examples. Such single product, single firm studies provide little guidance for researchers seeking to buttress the disclosure of forecasts of multiproduct, multinational firms. Some economists are developing texts on the economics of multiproduct firms and on the economics of multinational enterprises.

(4) The materiality decisions of American accountants conflict with the research studies in many other fields. For example, accountants may choose to group advertising and research and development expenses in a more aggregate category: selling, general, and administrative expenses. Accountants support their decisions by claiming that such items are only 2% or 3% of sales for most firms. Marketing, advertising, research and development, and industrial organization researchers counter that such items have distributed lag effects on sales or on cost of goods sold of firms. If a new firm and an old firm both spend 3% of sales this year on advertising, critics of accountants (and even earlier accounting standards) suggest that one should expect to see differences in the sales-generating impacts of the current expenditures.

(5) Income statement variables are used in the literatures of many fields. However, the techniques of analysis and of forecasting vary considerably in these fields. Econometrics, systems science, Box-Jenkins time series analysis, and Monte Carlo simulation are some of the techniques which have been used to study or to forecast income statements. Rarely, however, do researchers use or cite the use of more than one method in the same study. Further, as reviewed in Chapter 4, it is difficult to construct a measure of forecast accuracy for comparing the forecasts generated by different forecasting methods.

2.1 THE ELLIOTT STUDIES.

While there is a vast literature of opinions for and against the public disclosure of management forecasts, there are only a few studies attempting to produce forecasts consistent with the constraints reviewed in Chapter 1. According to Foster (1978:110), the state of the art in academic journals is represented by Elliott and Uphoff (1972). Foster noted that the causal modeling approach to forecasting accounting variables is motivated by the desire to exploit more information than can be gained by examining only the past sequence of the variable being forecast. He noted also that econometric models and Box-Jenkins time series have been used to improve forecasts at macroeconomic levels (Cooper and Nelson, 1975). Actually, this is only one of several studies by Elliott. His studies relating to the explanation of accounting variables are:

(a) ELLIOTT AND UPHOFF (1972). The authors called this study a feasibility study in predicting the near term profit and loss statement with an econometric model. Unfortunately, the authors did not apply the model to longer time periods. Forecasting texts cite econometric models as having a relative advantage over other forecasting models over the intermediate term. This case study involved a single firm with essentially one product sold in one region. The authors made no attempt to generalize their results. Their purpose was to provide a detailed guide for accomplishing what others have only discussed. The authors selected a single firm with one product in order to avoid the problems involved in separating the influences of different product lines in conglomerates. These authors possessed the additional advantage of

being provided with data unavailable to the public. Econometric models are useful, according to the authors, in several ways: (1) in aiding managers in performing their internal control and planning functions; (2) in providing evidence for accountants in evaluating the feasibility of including projections of financial statements in annual reports; (3) in providing investors and lenders with another basis for evaluating corporate financial performance. In the past, managers have relied upon qualitative models and exponential smoothing procedures. The authors assumed that econometric models would have an advantage over earlier models because of the recognition of simultaneous relationships between income statement variables and determinants (p. 260):

> Our principal hypothesis is that major items of revenue and expense in the income statement are interrelated to an important degree, so that predicting each can best be accomplished by jointly predicting all items. In other words, the variables in the income statement will be treated as a simultaneous mathematical system.

The use of a single company simplified the authors' work with respect to the choice of a chart of accounts. The income statement used by this firm was:

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1	Net Sales (NS)	XXX
2	Cost of Goods Sold (COGS)	XXX
3	Gross Margin (GM)	XXX
	OTHER EXPENSES	
4	Marketing expense (MKT)	XXX
5	Advertising expense (ADV)	XXX
6	Merchandising expense (MER)	XXX
7	Total marketing expense (TOTSEL)	XXX
8	General-administrative plus industrial relations expense (GAIR)	XXX
9	Total other expense (TOTOTHER)	XXX
10	Earnings from operations (OP)	XXX

In order to model the accountant's income statement, one must write an equation for each line.

Instead of measuring and of reporting net sales, the task becomes one of explaining why net sales is the figure reported. Elliott and Uphoff, for reasons cited in the articles, specified that net sales are a function of: (1) a population series; (2) a market share variable; (3) a marketing variable; (4) an advertising variable; (5) a merchandising variable; (6) prior periods' net sales; (7) a strike dummy variable; and (8) an industrial production index series.

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Model specification is a major weakness in the view of accountants who oppose the public disclosure of management forecasts. They argue that different persons preparing models will select different determinants for the same left-hand accounting variable. Some call this theoretical ad hockery. This issue will be discussed in the next chapter during the development of the proposed models. Armstrong (1978:300) provides a counter example of three studies performed to predict air travel in the United States. In each study, the authors had not performed literature reviews. Yet, Armstrong and Grohman (1972), Saginor (1967), and Mize and Ulveling (1970) produced models with a similar selection of causal variables, similar functional forms, the same signs of relationships, similar magnitudes or elasticities for the variables, and similar forecast accuracy. The failure was not one of using econometric models. Rather, the authors had failed to review the theory for suggested variables and the empirical literature for similar studies. In spite of these failings Armstrong was able to conclude in his example that the econometric model building process is highly replicable. This chapter includes a review of several econometric studies to show the extent of similarities in income statement studies.

The task of model specification is simplified to some extent because some of the variables in an accountant's income statement are definitional. Gross margin, for example, was represented by this definitional equation:

$$GM = NS - COGS$$

Another problem remaining is that sometimes one must adjust the data series reported by accountants. In this study of a single firm, the authors adjusted the data for changes in accounting procedures used by subsidiaries of the firm and for the strong seasonal pattern in the data (e.g., this study involved monthly and quarterly income statements, not annual). It remains to be seen how analysts and investors outside the firm can make all important adjustments better than managers can. The authors noted the allocation problem in accounting (Thomas, 1969; Thomas, 1974) but made no attempt to adjust for it.

The results of Elliott and Uphoff were surprising. The average absolute forecasting errors produced by the econometric model were 4.0% for sales and 3.6% for operating profits. Other studies, to be reviewed in this chapter show that profits are harder to forecast than sales. For benchmarks, the authors selected three smoothing models (a constant model, a linear model, and a quadratic model), all of which produced forecasts with larger absolute forecasting errors than the econometric models: 7.3% to 11.8% for sales and 8.1% to 12.8% for operating profits.

(b) ELLIOTT (1972a). Elliott and Uphoff concluded that the next step would need to be the application of econometric models to a broader group of firms, including multi-product firms. Elliott chose for the next study 9 major corporations: Mead, Schering, Delta Airlines, American Distilling, Johns Manville, Owens-Corning, Textron, GAF, and TWA. His selection was not a random sample but was his attempt to pick firms from several different industries.

While Elliott and Uphoff had used data for the period from January 1969 to March 1971, Elliott chose in this study to use data available to the public for the period from 1948 to 1968. The use of long periods of time has the advantage of testing empirically the stability of econometric models over time. Long time periods include both recessions and booms. A major test of an econometric model is whether or not it can anticipate turning points for the profitability of the firm.

Elliott's next strategy was to develop separately models for each of the 9 firms in order to compare how similar models can be. Also, Elliott tried to link relationships between microeconomic theories. The general notion is that any firm operates within one more industries and within one or more regional and national economies. Corporate financial performance, then, is a function of actions taken at the level of the firm and of the general economic environment within which the firm operates.

The concept of a multiplier effect in macroeconomics to Elliott meant that someone attempting to explain economic behavior at the level of the firm must examine how multipliers might operate for the firm. Elliott hypothesized the existence of financial flow multipliers (p. 1500):

> to the extent that systematic joint relationships are found in corporations between (a) sales and cash flow measures, (b) cash flow measures and strategic sales- generating expenditures, and (c) strategic expenditures and sales, a potentially influential multiplier process operates in corporations to magnify the final impact on sales, profits, and other variables of disturbances in any of these variables or relationships.

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This means that cash flows are an important product of sales and that their important uses are for generating sales and for reducing costs. Elliott concluded that sales and profits must be explained jointly. Alternatively, marketing personnel must not work alone preparing sales forecasts while others prepare profit forecasts.

In explaining sales, Elliott chose in this study to explain real sales, not the sales reported by accountants. Real sales are the net sales reported by the firm divided by a price index for the firm's industry output. For multi-product firms, this means constructing indices from those reported for several industries. Such adjustments to accounting data series can be reversed if management wants forecasted accounting variables to be reported.

For industry effects, Elliott wanted variables reflecting shifts in industry prices and output relative to general price and output levels. For this purpose, he selected the price index for the firm's industry output divided by the GNP implicit price deflator and the index of physical output for the firm's industry divided by the Federal Reserve Board Index of Industrial Production.

To this point, the Elliott model has differentiated American firms by general economic and industry effects. In order to differentiate firms within the same industry, Elliott needed firm-level variables. The remaining determinants of real sales needed to be identified are those variables representing sales-generating expenditures.

This aspect of the income statement poses major problems. If the management of a firm decides to purchase or to manufacture inventory for later retail sale, is that decision of the same nature as an expenditure for advertising or for research and development? The current accounting position, to be discussed in more detail in the next chapter, is that such expenditures must be expensed during the year they are incurred. The economics literature contains many studies showing the carry-over effects of expenditures to future periods. Elliott relied upon Melrose (1969) as evidence that there is a cumulative effect of past marketing and research and development expenditures on real sales. This means that a current expenditure on research and development creates an asset (e.g., something having future service potential to the firm). However, this asset is no longer reported on the accountant's balance sheets. The study Elliott relied upon showed empirically for a single firm that marketing assets waste away at a rate of 60% per year, not 100%.

In terms of model building, this means that one must create variables no longer measured and reported by accountants. It means also trying to explain certain accounting variables using economic theory even though the accounting variables represent arbitrary allocations. Lev (1974:86) explained the conflict:

> The most problematic area of conflict between accounting and economic income and the one concerning analysts the most is the treatment of foreseeable changes in the earnings power of the firm, usually known as goodwill changes. Given that investment decisions are based on the future prospects of the firm, it seems obvious that any event expected by management to affect future earnings (e.g., the development of a new product) should be reported in the financial statement. Accountants are naturally reluctant to report the effects on future earnings of expected events because of the highly

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> subjective and unverifiable nature of the information. However, they should realize that any investment decision is based on estimation and valuation of future events. In a world of uncertainty, valuation cannot be both sound and objective. Therefore, the accounting objectivity criterion when in conflict with the relevance of information does not carry much weight, and the financial analyst must secure from the firm any relevant information concerning the effect of expected events on its future performance.

Elliott did not specify that the current level of real sales is determined by the current level of marketing and of research and development expenditures. Instead, Elliott's model shows that the current level of real sales is determined by an intangible stock of productive marketing and research and development assets. This intangible stock, Elliott assumed, is the result of current expenditures and of expenditures made by the firm for the past 3 years. Theory does not dictate the use of 3 years. We have no guidance as to the weighting of each of the 3 years.

Elliott chose arbitrarily the use of Almon weights (Almon, 1965) for measuring the influence of past expenditures on current stocks. He complained that the measurement of distributed lag patterns is difficult in his study because there is high serial correlation in marketing and in research and development expenditures in many firms. There will be an explanation in chapter 3 of how one can determine empirically the nature of distributed lag effects, if they exist.

Another example of an adjustment to a data series Elliott found necessary is his equation for production cost per dollar of real sales. He formed this by dividing the accounting variable Operating Costs by real sales (itself an adjusted accounting variable). This approach is similar to the common-size statement technique used in traditional financial statement analysis and in time-series analysis (Foster, 1978:26-28, 40-41). The differences are in the use of adjusted accounting variables and in the motivation for the adjustments. The common-size statement technique is used to improve comparability of financial statements of the same firm over time and of different firms. Elliott's motivation was to structure an average cost curve consistent with the neoclassical microeconomics of production costs. He is no longer attempting, as he did in Elliott and Uphoff, to predict the income statements of any firm line by line. By studying 9 firms instead of 1, Elliott discovered that there is a wide variety of accounting variables reported by different firms in their income statements.

Elliott's solution to the lack of a uniform chart of accounts in the United States was to group the accounting variables on each firm's income statement to the point where the same aggregate accounting variables could be used for many firms. The increase in comparability by this approach involves a tradeoff with information loss (Lev, 1969:10). Investors, too, face the aggregation problem. It is possible that investors' models are at the level of aggregation of the firms with the vaguest disclosures. The importance of the aggregation problem will be pursued further in the next chapter.

One aggregate accounting variable used by Elliott was: general and administrative expense. He defined it (p. 1509) as: "expenses not included in the other categories but subtracted from a firm's before-tax profits." As a line on the income statement, this variable needed to be explained. According to Elliott, the larger the pool of general and administrative expenses, the smaller the production cost per dollar of real sales because the reason for management is to find ways to lower costs at given output levels.

Operating costs can be reduced also by economies of scale coming from an increased stock of capital and technological assets. Elliott found it necessary to adjust the Net Plant and Equipment account appearing on the balance sheet. The account, as reported by accountants, includes retirements and extraordinary items in the unadjusted series. Elliott created a smoother variable by adding new capital expenditures and subtracting depreciation expense. However, adjusting this series means that one must then determine the rate of flow for the depreciation of that asset. Elliott assumed that depreciation in stock variables occurs at a constant rate proportional to the values of the variable.

The importance of this Elliott study is that it set the standard for what can be achieved using only data available to the public. Managers cannot claim that they need to reveal information their competitors could use against them in order to achieve the results reported by Elliott. The next steps are to extend Elliott's study to a large number of American manufacturing firms and to incorporate advances

in the theoretical literature since his study.

Elliott offered these guidelines for the extension of his research: (1) look for patterns of significant relationships among variables in interfirm studies, not for consistency in the values of measured coefficients; (2) create new variables where traditional ones have failed; (3) use the econometric approach both to explain the economic performance of the firm in terms of economic theory and to explain the accountant's income statement line-by-line (for example, predicted real sales times a price index yields predicted net sales); (4) hold back several years of data in developing models because prediction-beyond-the-data tests of models are more important than goodness-of-fit tests; (5) numerous adjustments in raw series data may be necessary because many companies use mergers as part of a strategy for increasing profitability; (6) try to include in the held back data a major turning point in the general economy, such as a recession, because naive models often forecast more accurately than econometric models at these points; (7) employ an index of predictive accuracy, such as Theil's inequality coefficient (Theil, 1966).

(c) ELLIOTT (1971a). Unlike the first two studies reviewed, this Elliott study concentrates upon a single line of the income statement: research and development expense. He developed models to study the possible determinants of research and development expenditures at the level of the firm. The approach used followed the literature on capital investment. Chenery (1952) used a flexible accelerator structure for the analysis of capital investments. Elliott regarded research and development expenditures as a form of capital investment. The

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management of a firm, according to Elliott, evaluates the adequacy of its stock of research and development capital. Generally, the determinants of research and development used by Elliott were: competitive and industry conditions; firm profitability and liquidity.

(d) ELLIOTT (1971b). Elliott noted that much attention in the literature has been devoted to the effects of advertising and marketing on sales but that little has been done to explain the level of marketing expenditures. The same approach is used in this study as was used in the previous study on research and development expenditures.

(e) ELLIOTT (1972b). As in macroeconomics, Elliott argued that multipliers are at work within the firm. These multipliers take the form of funds-flow multipliers. It is inadequate, according to Elliott, to ignore the individual firm in Friedman-inspired studies of the relationship between changes in money supply and changes in aggregate economic activity. He showed (p. 30) that "the impact of money supply changes upon corporations produces magnified long-run changes in capital, marketing, and R & D expenditure levels." Taxing policies affect the individual firm:

> The capital investment effect operates directly on the economy via the Keynesian multiplier. Marketing and product research effects, as they reach the consumer, eventually shift the consumption function, thereby affecting aggregate equilibrium through affecting the multiplier.

Funds-flow multipliers have been ignored by analysts who explain corporate profitability by single-equation models. The simultaneous relationship between some income statement variables and their determinants produce the multiplier effect (p. 29):

> Multipliers calculated for each exogenous variable suggest that firm-level variables such as new equity acquisitions and debt-equity relationships work more widespread effects on performance of the firm than intuition and simplistic theory suggest, due to their involvement in simultaneous systems of joint dependence. Similarly, industry- level demand and price variables have been found to influence (a) corporate expenditures on marketing, research and development, and capital investment; and (b) corporate long- term debt decisions as well as corporate sales.

(f) ELLIOTT (1973). This text develops a theory of corporate resource allocation. Elliott reviewed the literature of other approaches to explaining or forecasting corporate resource allocation: (1) behavioral analyses; (2) industrial dynamics; (3) corporate simulations; (4) programming models. The suitability of these approaches for the public disclosure of management forecasts will be evaluated later in this chapter.

In chapter 13 of his text, Elliott provided a framework for future research. He regarded as the first step the classification of variables: (1) environmental variables--influence the firm's decisions from outside the firm and are generally exogenous; (2) control variables--within the control of the firm's management and are either endogenous or exogenous; (3) performance variables--measure the firm's economic and financial performance and are usually endogenous.

To show the application of his classification scheme, Elliott gave these examples of how he would classify variables used in several studies attempting to explain certain income statement variables:

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(a) ENVIRONMENTAL VARIABLES AND EXOGENOUS. Examples are: ratio of industry R & D to industry sales; ratio of industry assets to industry sales; ratio of industry advertising to industry sales; industry prices relative to general prices; industry output relative to aggregate output; money supply; government expenditures; yield on bonds; index of time; total potential market; personal disposable income; current interest rates; seasonal shift variables; machinery and allied products index; average price of materials; average wage rate; average industry price for the product; shift variables accounting for periods of zero expenditures; fixed expense.

(b) CONTROL VARIABLES AND ENDOGENOUS. Examples are: firm R & D outlays; gross capital investment; advertising; cash dividend payments; stock of marketing assets; stock of R & D assets; general and administrative expenses; stock of capital assets; marketing expenditure; capital expenditures; depreciation expense; fixed financial charges; long-term debt; demand for debt; debt-equity ratio; inventory investment.

(c) CONTROL VARIABLES AND PREDETERMINED. Examples are: depreciation plus depletion; total R & D undertaken during a previous one-year period; new equity capital; dividend payments.

(d) PERFORMANCE VARIABLES AND ENDOGENOUS. Examples are: sales; unit production costs; production costs; discretionary cash flows; profits before taxes; after-tax profits; firm's market share.

The choice of variables in the above examples represented different objectives by the model builders. For the purpose of explaining the accountant's income statement line by line, Elliott suggested these general theoretical considerations:

(a) ENVIRONMENTAL VARIABLES. Any firm is embedded in an industry environment. General business conditions influence different industry environments through these variables: total volume of demand, product prices, labor costs, material costs, money rates, and general expectations. To the extent that an industry is oligopolistic, industrial influences upon the firm can work back upon industry.

(b) CONTROL VARIABLES. Management has some control over these variables: prices and production levels; the size and type of sales promotion campaigns; research and development programs; capital investment programs; the size and nature of general administration; capital structure (equity, debt, and leverage); liquidity; management and employee development programs; and market and product development, in the form of new products and acquisitions. These variables, Elliott noted, have some influence upon the performance variables. Some of these variables influence each other. Management's understanding of how these variables work is vital to the economic performance of the firm.

(c) PERFORMANCE VARIABLES. The interests of managers and of shareholders are not identical. Elliott maintained that bonus and incentive systems encourage steady growth patterns in sales and in profits. However, management must arbitrate between the conflicting desires of many groups. Stockholders are concerned with: the level of

earnings; growth in earnings; future earnings; sales growth; outlook for the markets in which the firm's products are sold. Bond holders are concerned with: cash flow; debt-equity ratio; liquidity. This means, Elliott claimed, that there is no single figure upon which managements make their decisions.

Elliott's framework is useful for comparing studies of firms. By classifying variables in models, each model builder will exhibit explicitly the objectives of the model and some of the theoretical considerations. Much of the literature in accounting, economics, and in financial economics has been concerned with the relationships between two variables. A general framework suggested by Elliott for future structures of models is: (1) classify your left-hand variables as being either performance or control variables; (2) classify the determinants of performance and of control variables in terms of performance, control, and of environmental variables.

Elliott's model structure provides a classification scheme for comparing all studies relating the management disclosures of earnings forecasts and of forecasts of other income statement variables. Other considerations, not discussed in the guidelines of AICPA, are the choice of the functional form of the models and an understanding of the assumptions being made about the error terms. Even if all could agree on a list of important variables for explaining corporate profitability, there might not be agreement on which of those variables must be omitted from specific equations (because the coefficients are zero). In the absence of a uniform chart of accounts, the number of the equations in the model for each firm would be different. One way of overcoming this

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problem is to group accounting variables in each chart of accounts so that all firms are being compared on the basis of the firm making the crudest disclosures. Our objective is to predict all of performance variables. It is possible that Elliott's hypothesis about the significance of simultaneous relations among performance variables is correct. This is an empirical question awaiting a larger data base than the 9-firm study performed by Elliott. If a simultaneous system of equations is appropriate, then a choice remains for a simultaneous estimation technique. There have been several important developments in simultaneous estimation techniques since Elliott performed his research. Regardless of the choice of estimation techniques, the results found using the best available data will show us only the existing relationships among the variables. While this may provide some insights into the relative performance of the managements of different firms, it does not provide the optimal values for control variables. Hence, the next step is to use developments in economic theory and in econometric techniques since Elliott performed his research to attempt to explain and to forecast accounting variables for a large number of firms.

The simultaneous nature of Elliott's model implies that any analyst must jointly determine each line of the accountant's income statement in order to make a reasonable determination of any single accounting variable. Elliott's theory is:

1. Sales-generating outlays such as marketing respond positively to movements in discretionary cash flow.

2. Sales are substantially affected by sales-generating outlays.

3. Net internal funds and discretionary cash flow generated are an immediate product of sales.

4. These discretionary cash flows lead to further sales-generating expenditures.

5. A similar simultaneous linkage operates through the impact of cost-reducing outlays upon operating costs and upon net internal funds generated, and so forth.

2.2 OTHER ECONOMETRIC STUDIES OF THE FIRM.

While Elliott has made a major contribution in the literature with respect to the task of explaining and forecasting the accountant's income statement line by line, there have been other related econometric studies of the firm from which one can learn about some aspects of corporate profitability. The major attention of applied econometricians has been directed toward macroeconomic issues. Complex models of the economy are used to produce forecasts of many macroeconomic variables. This work is important to the feasibility of disclosing forecasts at the level of the firm. If the future sales of a firm are partially a function of future levels of gross national product, then managers will need forecasts of gross national product. The problem at this stage becomes one of separating the effects of errors in forecasting variables exogenous to the models used by Elliott from the errors of forecasting variables used by Elliott.

Forecasts can be inaccurate for many reasons. Stekler (1968) evaluated the forecasting records of 6 quarterly econometric models. One of the 6 models was more inaccurate than a naive model. A problem for forecasters, noted by Stekler, is that revised data series are reported. The analyst must then decide whether to use the original series or the revised series. In order to isolate causes of forecasting errors, Stekler suggested using known values of exogenous variables. If you possessed perfect information about your exogenous variables, then the inaccuracy of your forecasts can be attributed to model specification or to other characteristics of the model being evaluated.

Dhrymes et. al. (1972) developed criteria for the evaluation of econometric models, including: model selection, parameter estimation, pseudo-forecasts, and structural stability tests. The authors did not regard the large number of new models appearing in the literature as an important accomplishment. Each researcher tends to ignore or to make little effort to compare the new model with earlier ones. One reason for this problem is data availability. Each new researcher attempts to use the most current data. This means that models are not tested with the same data base. While economic theory may suggest to a researcher which variables are important, the theory does not provide much guidance with respect to functional form. A model builder is a decision maker; the decisions made may change over time. This freedom to choose draws objections from accountants who want to see independent researchers producing similar econometric models of the firm.

Prior to Elliott's studies, these works used econometric approaches:

(a) MUELLER (1967). This researcher sought to explain simultaneously 4 control variables important to managements: (1) capital investments; (2) research and development; (3) advertising; and (4) dividend payments. Mueller regarded each firm as having a limited amount of capital available to it. Within the constraints of a budget, he was interested in learning how management makes the tradeoff between making dividend payments and making strategic expenditures. In an attempt to maximize the present net worth of the stockholders, managers will make these tradeoffs depending upon (p. 61):

> (1) the time-preference schedule of the firm's stockholders; (2) the extent to which the market reflects increases in expenditure on the strategies in increases in the value of equity shares; and (3) the expected returns from the three strategies.

Mueller attempted to study the impact on control variables of performance variables, an approach opposite to Elliott's explanation of the income statement. Instead of using the time series data for several firms, Mueller chose to perform a cross-sectional analysis using the observations of 67 firms for each of 4 years (1957 to 1960).

To avoid the risk of heteroskedasticity while using the data of different firms, Mueller deflated all variables, except indices, by sales.

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Instead of selecting a single estimation technique, Mueller used: direct least squares, two stage least squares, unbiased K-class, and limited information procedures. The resulting estimated regression coefficients were interpreted as long run elasticities. However, he concluded that 4 years of data are not sufficient for determining estimates representative of firm behavior.

Mueller made no attempt to forecast with his model. The purpose of the study was to understand policy implications. His conclusions were the same, regardless of the estimation technique selected.

The 67 firms used in the study had provided responses to questionnaires sent to 150 firms. Mueller regarded the usual management disclosures about the firm as inadequate. For example, he regarded as misleading the disclosure of research and development expenditures without disclosing the breakdown between those expenditures financed by the firm and those financed by other sources. Disclosures about some mergers were so skimpy that Mueller regarded as impossible the necessary data adjustments.

(b) SALTZMAN (1967). This was a study of a single firm over 36 successive quarters. The author made no attempt to forecast. The motivation for the study was to determine partial and long-run elasticities. Product engineering expense and administrative expense were the only control variables found to be inelastic with respect to sales.

(c) FROMM AND HYMAN (1971). This unpublished study is available only in the form of a brief summary in Elliott (1973: 295-297). It represents the type of projects undertaken at firms such as Data Resources, Inc. Such firms have been providing large numbers of corporate managements with econometric forecasts of the economy and of major sectors of the economy. The next logical step for these firms was to attempt to link forecasts of a firm's sales and profits with forecasts of macroeconomic variables.

Fromm and Hyman made no attempt to explain each line of the accountant's income statement. They were unconcerned with the reasonableness of structural hypotheses. They evaluated their reduced form system based upon how well it forecasts. For example, the authors specified that sales of Sears are a function of: personal consumption expenditures for durables, new and net used autos, clothing and shoes, and for other nondurables. The sales of DuPont were shown to be a function of: Federal Reserved Board Index--Chemicals and Products, personal consumption expenditures for new and net used autos, and the change in nonfarm business inventories.

Elliott commented that the Fromm and Hyman study represented an interesting contrast to the other studies reviewed in this chapter. His real opinion of this approach can be seen elsewhere in his 1973 text. On page 118 and 119, he noted that it is quite popular in many firms to go on a fishing expedition for variables to include in forecasting models. The inclusion of a variable is based upon statistical fit. The argument is that some models are designed for forecasting while others

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are designed for explanation. Klein (1971:99) remarked:

> For some time, I have maintained the position that there is no point in trying to construct models that are purely of use in prediction and deny that such models have an existence of their own apart from structural models. I would repeat earlier assertions that best predictions will be made from best structural models.

Elliott used the analogy of accepting an unknown potion from a witch doctor. You might recover but you do not know why.

The problem with the plea for underlying structure for systems of equations is that there must be some limit to any management's ability to create an approximating model of reality. On page 140 of his 1973 text, Elliott argued that one must not equate the best system and the most complex system. At some point, adding more complexity to a model will hurt the predictions produced. This means that there will be conflicts between those who claim their models are predicting well and those who claim their models have superior structure. It means also that a way must be found for determining which variables are not included in the model even though the variables appear in the literature. The next two chapters will address these problems.

2.3 SYSTEMS ANALYSIS.

Elliott (1973) included extensive discussions of alternative ways of analyzing the performance of a firm. Some of these other approaches provide explanations and forecasts. The following review of each approach suggested by Elliott will examine the advantages and disadvantages of these approaches with respect to the public disclosure of management forecasts.

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Systems analysis has many names in the literature, some of which are: system dynamics, industrial dynamics, and the systems approach. Elliott found attractive the attention given to feedback loops. He regarded as the equivalent in econometrics the use of simultaneous relationships. Both approaches can be used to examine multiplier effects. The econometrician's distributed lag is the system scientist's delay function. Some authors have written after Elliott's studies that there are crucial differences between approaches to the study of corporate profitability.

Roberts (1978) provided an extensive collection of articles on the managerial applications of system dynamics. The use of system dynamics by major firms could lead them to disclose their forecasts supported by system dynamics. If so, this would mean that managements would look to the SEC for guidance on disclosure formats and that auditors would need a way to review the disclosures. Some of the major studies relating to corporate profitability are:

(a) FORRESTER (1959). In an examination of advertising, Forrester argued that the firm as a system has been ignored. It is possible, he contended, that advertising merely shifts the timing of sales without increasing sales. If so, then the firm has wasted scarce resources on advertising and has incurred additional costs in the form of increased factory and distribution costs. He argued also that the evaluation of short term advertising campaigns can be misleading because long-delayed responses to advertising are responsible. Advertising has been used, too, to promote new products representing nothing more than cosmetic

changes in old products. This means that analyses of a firm's advertising expenditures must provide a way of representing these realities.

Forrester shares with the econometricians reviewed earlier the view that one cannot study only a specialized function in a firm:

> In general terms, this means recognizing the company not as a collection of separate functions but as a system in which the FLOWS of information, materials, manpower, capital equipment, and money set up forces that determine the basic tendencies toward growth, fluctuation, and decline.

Flows occur over time. Forrester called for an explicit recognition of how time relationships affect advertising. For example, he cited the folly of attempting to increase advertising in order to maintain a sales growth rate throughout the entire product life cycle and market saturation. He concluded that advertising has an important relationship with investment in plant. Managers will be concerned about minimizing excess plant capacity. In an effort to even production schedules, managers may decide to advertise heavily now rather than inventory the products in excess of demand. The author provided many diagrams of the relationship between variables over time. However, this study contained no data to support the shapes of the hypothesized relationships. Some of the variables suggested would be difficult to define and to measure: number of prospective customers; awareness of advertising; time between noticing an advertisement one or more times and making a purchase.

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(b) FORRESTER (1968). The same author attempted to develop via computer simulation implications for marketing at the level of the firm. He noted that any discussion of a system implies a structure of interacting functions. The behavior of a system depends upon both separate functions and the interrelationships between them. In dynamic systems, the interaction of the parts over time can change system conditions.

Forrester regarded as simplistic the approaches of so many studies in which the researcher looks for a relationship between marketing expenditures and sales. His contention was that interrelationships between marketing and other functions within a firm are so important that they cannot be ignored in a study of corporate profitability.

Forrester identified these significant relationships with the marketing function in a firm:

(1) RESEARCH AND DEVELOPMENT. A research department is guided to some extent by what can be sold commercially. Commercial sales mean the production of a new product to the point where the unit costs of production are lower than the costs of current ways of accomplishing tasks. The research department needs some guidance from the marketing department as to what customers might be willing to pay. To some extent, too, the marketing department relies upon the research department to suggest changes that have become feasible because of a technological breakthrough. This means that the introduction of a new product has involved additional expenditures on both research and development plus marketing. Tradeoffs between research and development

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and marketing expenditures may be possible, such as an increase in marketing to compensate for a decrease in research and development.

(2) PRICING POLICY. The pricing policy of a firm depends upon its profit goals and upon its understanding of the demand for a product at different price levels.

(3) PRODUCTION. Ideas for new products do not become reality unless someone provides the capital for productive facilities. If capital is not available for the smallest economical productive facility, then the manufacturing can be licensed to others having either excess productive capacity or capital for the facilities. A profit cannot be earned unless products are available for potential customers. The quality of the product to be offered at a price needs to be determined.

(4) PERSONNEL. The expansion of a marketing campaign depends upon how quickly a firm can attract and train new personnel.

(5) INFORMATION SYSTEM. Marketing information is one input into the firm's corporate information system. The importance of the input depends upon the resource allocation models used by a firm.

Forrester argued that global suboptimization occurs if a management stresses one interrelationship and ignores the remainder. The profitability of a firm is the result of management's skill in balancing the relationships between the functions of the firm.

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A major difficulty with this approach is that the detail of variables used are not usually disclosed by firms. While such analyses may be possible for a consultant using confidential data in a firm, they are not possible for comparison with Elliott's econometric studies. Managers do not disclose the number of salesmen they plan to hire next year. They might disclose the amount in dollars they plan to spend on marketing expenditures next year. The problem here is to provide guidelines for the amount of detail to appear in models.

A more severe difficulty with Forrester's approach is the use of table functions. In making diagrams for analyzing a system, Forrester's approach is to identify levels, rates of flows, and delays involved. For example, he created a table to explain the relationship between a sales effectiveness from delay multiplier and delivery delay recognized by the market. The shape of this function is a pure guess.

Pindyck and Rubinfeld (1981:379) have termed his approach the data-less approach to modeling. They regard as unacceptable any approach to model building in which theory does not confront data. Without statistical tests of relationships, the model builder is free to make any assertions whatsoever. Armstrong (1978) reviewed the forecasting literature and could find no evidence of the predictive validity of the methods of industrial dynamics.

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(c) WEIL, BERGAN, AND ROBERTS (1973). These authors were concerned with a firm's R & D strategy. They claimed that too much attention has been devoted to short-term tactics related to individual projects. Two firms could be spending the same amount of dollars on research and development but allocating those dollars very differently. Research and development can be directed toward: new technologies; refinement of existing technologies; new products. The authors commented that an enormous web of inter-related factors must be considered in order to study the complex systems problem of R & D strategy formulation.

The major variables representing levels in their system were: advancedness of existent technology; advancedness of proven product concepts; advancedness of products in the market; mastery of existent technology. Each level is subject to decay.

While the authors identified some of the issues relating to research and development expenditures at the level of the firm, they offered no way of determining which of the endless relationships can be ignored because of insignificance. The variables identified by the authors are likely incapable of measurement. In order to determine a value for advancedness of existent technology, one would need to know the theoretical optimum in each application.

(d) SPENCER (1966). This study was conducted at a division of Dow Chemical Company using actual data. The author wanted to learn the relative importance of various factors in determining sales and profits growth rates. With that understanding, he hoped to determine the probable results of policy changes. The variables used in the model

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include items such as the growth rate of total customers and the number of customers per salesman. Dow Chemical's historical records and educated guesses provided the values needed for all variables. Hence, this study involves real data.

The author explained carefully how systems analysis differs from statistical forecasting. His contention was that statistical forecasts are bound by the past. His approach, in contrast, is based upon a foundation of the past. The next step is to select any size deviation in a control variable and then observe the probable result of such a deviation. Unfortunately, the author failed to make probability statements with the model or even to explain how such statements could be made. He shared the view of the econometricians reviewed earlier about the need to compare the output of the model with historical data. Spencer accomplished this by drawing a validation curve for sales of the division from 1958 to 1964. The chart showed actual sales and a line of values produced by the model. The author concluded from visual examination that the model produced a good trend. He offered no quantitative measure for the goodness of the fit. In spite of the limitations noted, the author has avoided many of the criticisms aimed at Forrester's data-less simulation.

(e) ROBERTS, ABRAMS, AND WEIL (1968). These authors addressed the problems of multiple goals in a vertically-integrated firm. This approach is quite different from the economists who debate whether managers are sales maximizers or are profit maximizers and from the financial economists who assume that managers seek to maximize the value of the stock of their current stockholders.

Management responds, according to these authors, to gaps between the firm's goals and performance measures. Over time, a firm's objectives can change along with the performance variables used. The authors assumed that managers have some control over the selection of performance variables used by the firm.

The difficulty with multiple performance measures is that some of them are likely to conflict. Conflicts are greater in vertically-integrated firms than in other firms because of interdivisional conflicts over profit center measurements.

A large, diversified company active in the supermarket, department store, food manufacturing, and in restaurant fields provided data for the researchers.

The authors explained that they preferred Industrial Dynamics over other analytical approaches in this study because:

(1) a vertical organization with interacting levels represents a closed-loop feedback-type system;

(2) it is easier to model qualitative behavioral relationships, such as reactions to organizational pressures or incentives;

(3) empirical data were not available for some important relationships, such as: retail price elasticity and consumer response to advertising. The authors conceded that they attempt to use data when available because statistical analysis provides added confidence in model formulation. However, the authors would not abandon a study for the lack of data. The advantage of Industrial Dynamics, they claimed, is that one can test the sensitivity of company performance to

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deviations from one's initial estimates of relationships. This procedure relies upon interviews with management to determine their subjective or intuitive priors as to the deviations to be considered. A Bayesian econometrician, by contrast, would seek to construct data-based priors using empirical studies of a similar problem (Maddala, 1977:428).

(4) relatively less mathematical sophistication is required to use the Industrial Dynamics approach than is required for other analytical approaches. This means that it is easier and cheaper for managements to use this approach.

The performance measures for this firm's retail food division were: sales volume and profitability. The firm's president monitored performance by comparing results against a monthly dollar sales budget and a desired retail gross margin percentage.

The major performance measure for this firm's manufacturing division was manufacturing contribution. The contribution margin is a profit concept excluding arbitrary allocations of corporate overhead charges.

The choice of this firm limits the generalizability of the study because the major manufacturing facility was a bakery. Bakery products are highly perishable, subject to extensive impulse selling, and are easily substituted for similar products. This means that inventory levels are not large relative to many manufacturing firms. The authors regarded the problem as representative of the Christmas tree or newspaper problem in the management science literature.

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In stark contrast with the econometric models of Elliott, this model contained equations for 110 variables. The authors apologized for the simplification of reality, as is true with all models, but concluded that 110 variables captured the major behavior-determining decisions and interactions. The authors did not reference any literature from economics. Instead, they explained that every relationship was documented by interviews with the management. Further, this firm's management accepted the model as being sufficiently realistic for policy testing.

The use of only one firm in this study denies us the opportunity of learning how many variables the authors would need for different firms. In Elliott's study of 9 firms, he found it necessary to use the general accounting income statement variables reported on the COMPUSTAT tapes. This meant a higher level of aggregation than some firms had reported.

In the Industrial Dynamics approach, the researcher assumes that there will be a large web of important interrelationships. The researchers in this study devoted considerable effort to identifying every variable and relationship regarded as important by a large number of decision makers within the firm. It is not apparent from the literature reviewed to this point how the researcher weights relationships or even rejects relationships as insignificant.

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This article provided only a brief explanation of the relationships and variables disclosed by management to the researchers. The first point made by the managers was that it makes no sense to incur sales-generating expenditures unless a firm has adequate inventory at the place of retail sale. In order to distribute inventory to retail selling points, a firm must produce in excess of current demand. This involves incurring excess production and distribution costs for which capital must be available. The products selected by management for a major sales campaign tend to be those with relatively large gross margin percentages. If retailers are able to sell products at the list price, this means good profits for the retail division. If the sales-generating expenditures are unsuccessful, the retail division still has the option of lowering prices to move the inventory.

The management of this firm revealed that there are 6 major determinants of potential retail unit sales:

(a) the amount of effort devoted by dairymen to bakery products;
(b) dollars spent on advertising and in-store promotion;
(c) retail prices;
(d) the number of bakery specials;
(e) the price elasticity of bakery items, especially of the specials;
(f) total market size.

The authors experienced difficulties in developing response curves to advertising for each of the firm's products. Records of the retail division showed that one variety of bread could have tripled sales for a 50% reduction in price. The retail division can sell 5 times as many pies at a 60% price reduction but will experience also some decrease in sales of other bakery items. The authors' response to the paucity of data was to use a conservative 50% difference between the maximum and minimum elasticities.

There is a conflict between the goals of increasing sales and of increasing gross margin. Any firm can increase sales quickly by lowering prices sharply. Managers prefer, instead, to find ways of generating sales by non-price competition. The retail division was very reluctant to raise prices regardless of the pressure from top management to improve gross margins. So, the retail division found itself trying to balance the pressure to cut prices to stimulate sales and the pressure to raise gross margins.

Productive capacity is not the only constraint on a sales campaign. An increase in a firm's sales is possible if other variables have changed, such as: growth of the market; increase in the firm's market share.

After analyzing their computer simulations, the authors concluded that the use of the traditional profit measure in retail operations, gross margin percentage, is a mistake. They argued that a firm can spend gross margin dollars, not a percentage. By reporting gross margin dollars, the authors hoped that decision makers would take advantage of

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opportunities to increase total profits by accepting a smaller gross margin percentage in return for much larger sales.

(f) VEIT (1976). In another application of system dynamics, a major insurance company decided to analyze the marketing of a new product: the variable annuity. Actuaries at Aetna used asset share and profit models. The use of the traditional models involved making fixed assumptions about the levels and trends of many variables over long periods of time. The actuaries would then calculate present values for specific points in the future.

Aetna switched to system dynamics because it permitted them to model more complex multiple relationships over time. For example, if they wanted to express an expense item as a percentage of sales with their traditional models, they would calculate in advance the appropriate percentages at different volumes of sales. Using system dynamics, the model employs a table function. To the model, the author could add any number of variables modifying the trend.

The firm used in the model variables not easily quantifiable. Their approach was to assign a value of 1.00 to any subjective variable and then ask management to express their expectations under certain conditions. If management believed that a subjective variable would increase by 20%, then the author used 1.20.

Veit neither reported nor claimed an interest in forecast accuracy. He claimed, instead, that system dynamics models are strategy models. Their purpose is not to make forecasts but to indicate trends of key variables in complex situations.

The author abandoned the traditional profit model in the analysis of the new variable annuity product because: (1) no one in the industry had been selling the product long enough to produce data on lapse rates and on unit costs; (2) he regarded the caeteris paribus assumption as inappropriate in a dynamic analysis of a complex system.

Aetna retained Pugh-Roberts Associates, Inc., of Cambridge, Massachusetts, as the consulting firm to develop the model. He reported these 12 major steps they used in model building:

(1) all senior decision-making executives, not staff personnel, must agree to participate in the model building process;

(2) the decision makers must list the questions they want the model to answer. The consultants limited the model building only to those aspects of the firm's insurance business closely related to variable annuities. The author explained that it is important to attempt to model neither too much nor too little. There is no discussion, however, on the treatment of exogenous variables.

(3) the consultants determine from the decision makers all key variables and relationships. In this study, the consultants included more than 600 variables in the model. The article did not even list the 600 variables. This is an indication that this approach would not be feasible for the public disclosure of management forecasts. Either a model can capture reality with far fewer variables or accountants need to rethink their concept of materiality in preparing disclosures of historical financial statements.

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(4) the decision makers agree on the relationships between variables. The author discovered there are numerous two-way relations operating between variables within a firm. As an example, he cited: if the firm changes the price of a product, then its sales will change; if sales volume changes, unit costs change; and, if unit costs change, you change prices. Veit stressed that system dynamics involves the modeling of how a firm really operates, not how it ought to be functioning. This approach is very different from the econometrics studies reviewed earlier. Econometricians have attempted to build more complex models upon the foundation of existing economic theories. System scientists turn to management as the best source for modeling.

(5) the consultant separates variables into functional sectors for more detailed analysis. This is accomplished by drawing word and arrow diagrams (what Elliott called a block diagram) indicating the direction of cause and effect relationships. The author did not explain how one decides to stop separating variables. Veit did stress, as did Elliott, the importance of identifying multiplier effects. To use Veit's terminology, a researcher must be careful to discover those loops in the system having the role reinforcing or of diluting relationships.

(6) the decision makers decide the length of the planning horizon important to them. For this model, they selected 10 years. Yet, earlier in the study, Veit had explained that he turned to system dynamics in order to prepare a new 5-year plan. The choice of 10 years is interesting also because Aetna had only 4 years of historical data relevant to variable annuities.

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The choice of time periods over which computer simulations are run is a source of major criticism of system dynamics studies. Some studies have reported 200 years of simulation. If such long periods are to represent forecasts, then this approach is contrary to the studies in the forecasting literature on how far into the future one may forecast with limited historical data. If, instead, the system scientists are merely demonstrating that their model does not explode over very long periods of time, then this approach is similar to the precautions taken by econometricians. In a discussion of econometric simulation models, Pindyck and Rubinfeld (1981:356) explained that the stability of a solution is important. Only small, linear models can be checked analytically. Large linear models and nonlinear models must be checked by computer simulation.

In a discussion of extrapolation methods, such as exponential smoothing, Armstrong (1978:151) commented that Ayres (1969:100) understated the need for data in short-term forecasting and overstated the need in long-term forecasting by using the rule of thumb that one can extrapolate into the future only as many periods as one has historical data in the past. Armstrong's rule is that the number of periods of historical data needed equals 4 times the square root of the number of periods to be forecast. For example, you need 4 periods of historical data to forecast 1 period into the future, 16 periods of historical data for a 16-period forecast, and 100 periods of data to forecast 40 periods. Applying these rules, Aetna needed between 10 and 13 years of historical data to support a 10-year forecast.

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In Box-Jenkins time series analysis, as the forecasting horizon becomes larger for stationary models, the forecasts approach the mean of the process (Nelson, 1973:147). This means that multistep-ahead forecasts are limited by the lack of additional data for forecasts one makes today.

In econometrics, there are no simple rules of thumb. An econometrician tries to make statements about the likelihood of future events based upon information available at the time of the forecast. All econometric models involve the use of variables other than the variables one wishes to forecast. In unconditional forecasts, such as an ex post forecast, the values of all explanatory variables are known with certainty. In a conditional forecast, one must have forecasts of the explanatory variables.

Hence, one limitation on the ability to forecast with econometric models is the extent to which one can forecast explanatory variables. The task becomes easier if the explanatory variables have long time lags.

At the level of the firm, the variability of the dependent variables may be greater than in macroeconomic studies. Further, if the values of the variables grow over time, then the values in the forecast horizon will be farther away from the average value observed in the historical period. This means that forecasts can become more unreliable over time even if the econometric model has been specified correctly.

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Using a single-equation regression model to forecast interest rates, Pindyck and Rubinfeld (1981:215) explained that they would use the model to the point where actual interest rates fell outside a 95 percent confidence interval. That occurred after 9 months. The Durbin-Watson statistic revealed that the error terms were serially correlated. While a forecasting model can be revised to take advantage of serial correlation, the usefulness of this revision decreases as the forecasting horizon increases.

Econometric simulation models are similar to the system dynamics model described by Veit. A large econometric simulation model might have 100 or 200 characteristic roots. As explained by Pindyck and Rubinfeld (1981:390), an econometrician looks for characteristic roots with magnitudes greater than 1 because these will yield an unstable model and for complex (i.e., having imaginary components) characteristic roots because these will contribute to oscillatory behavior.

It is possible that the period of oscillation is more than 200 time periods. If so, there would be no effect on the feasibility of disclosing management forecasts up to that point.

The next problem, however, would be the possibility that the solution could become unstable or oscillatory with only a small change in a coefficient. For large models, this problem cannot be addressed analytically. The econometrician performs computer simulations.

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If the model is nonlinear, computer solution algorithms are needed for a linearization of the model. Existing analytical methods from control theory, such as Lyapunov's direct method, have not been applied to large models (Fox, Sengupta, and Thorbecke, 1966; Chow, 1975). Pindyck and Rubinfeld concluded that this aspect of model building, with the trial and error experimentation with different values, is more art then science currently.

While Veit addressed model validation in later steps, he did not explain the limits to the timeframe he selected. Instead, he pointed to the advantage of system dynamics in the recognition of delays in cause and effect transactions. This is not unique to system dynamics. Pindyck and Rubinfeld (1981) use lags in their block diagrams. Delay functions and distributed lags seem to be equivalent responses to delays experienced in the real world. The difference is in the construction of the functions.

(7) allowing each variable to vary from time period to time period according to the multipliers in the model.

(8) linking the separate sectors of the model. At this point, the consultants discover how well the assumptions of separate groups of decision makers work together in the overall model. Veit defended criticisms of system dynamics models for using subjective data by stating that one cannot expect the model to use better data than real decision makers use.

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(9) test the structure of the model by determining if the model can reproduce historical values of key variables within 10%. The model is refined until this goal can be achieved. Veit provided no statement or data showing that the model achieved the historical values of the variables within 10%.

(10) perform base runs. Of more than 600 variables in the model, only a few were exogenous. An example of an exogenous variable used is inflation. The decision makers regarded this as a variable they did not control. Therefore, the simulation was performed several times using different inflation rates. In econometrics, a system of simultaneous equations would not be identifiable with so few predetermined variables (Schmidt, 1976:128-144).

(11) perform sensitivity runs. This means that users of the model consider different values and response times for many of the variables in order to find potential bottlenecks and other problems.

(12) consider changes in the system. Management might not be satisfied with the performance of the firm as expressed by the model. They might, for example, want to consider installing a computer where operations are performed manually. This would mean making major adjustments to the values of some of the variables.

The studies reviewed did not attempt to model the accountant's income statement line by line, as Elliott had done with an econometric model. Alfeld and Graham (1976) discussed briefly how balance sheet variables would be treated as levels and income statement variables would be treated as rates. Manetsch and Park (1977) incorporated many

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accounting variables in their model of a firm's production-inventory system. They wanted to determine the impact over time of inventory and production management variables upon company profit, production, sales, costs, and inventory. Smith (1971) proposed using systems analysis to provide a framework for all of accounting theory. Makridakis and Wheelwright (1978a:524) praised the forecasting potential of systems analysis because the models contain both exploratory and normative components.

2.4 INDUSTRIAL DYNAMICS APPROACH TO SYSTEMS ANALYSIS.

The writings of Jay W. Forrester have inspired a large number of studies involving applications other than relating to corporate profitability. His writings have also inspired blistering attacks in the literature. The Club of Rome commissioned several of his students to construct a world system dynamic simulation model. They made a model for the whole world. Critics dubbed the model a model of doom and branded the researchers with the title Malthus with a computer (Meadows et. al., 1972; Cole et. al., 1973).

Berlinski (1976) wrote an entire book condemning the entire field of systems analysis, as practiced currently. His major criticisms were:

(1) If you make your studies so general as to count anything as a system, your theory will contain only logical truths (statements with form but not content, such as: if P, then P or Q) (p. 9).

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(2) One should begin a study by building upon a body of theoretical principles rather than starting with global, highly aggregated, and nonlinear collections of mathematical models.

(3) The systems analysis studies use autonomous dynamical equations of the form $dx/dt = f(x)$ when the situation requires equations that are not autonomous, of the form $dy/dt = g(x,t)$. The laws of physics are autonomous; a set of relationships may not vary although relationships between variables may change over time. The opposite is true in econometrics (p. 67): "structural relationships between economic agents DO decay, especially since the relationships one has are apt to reflect nothing so magisterial as the laws of nature." Berlinski overstated the criticism. Social systems consist of people subject to physical and to biological laws. Structural relationships are dependent, to some extent, upon the physical environment within which they operate.

(4) The global character of the studies is indefinite because the theory underdetermines itself by having chief functional relationships mathematically unspecified. Philosophers are concerned about the indeterminacy of a theory. Econometricians are concerned about the identification problem. The systems analysis theories are underdetermined both by themselves and by the data.

(5) In using systems of differential equations, the systems analysts are showing immediate changes of state. By contrast, econometricians recognize that effects lag behind their causes and study the nature of such lags. Berlinski erred if he claims systems analysts use only systems of differential equations. The literature of systems

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analysis includes extensive examples of delay functions.

(6) Systems analysts are using simple, less accurate procedures in numerical computations for simulations than could be obtained by using improved Euler systems, such as the Runge-Kutta method. Such computations are subject to errors of interpolation, round-off, discretization, or truncation (p. 71).

(7) The more inadequate the theory in your field, the more concern you must have for the cultivation of data. There must be a substantial body of technique between an original theory and its applications (p. 71).

(8) Systems analysis glosses over topics of major concern in fields such as econometrics: (a) relations are specified in economic theory in structural form, but in econometric theory they are in reduced or final form. Reduced forms are important in any forecasting model. (b) structural and reduced equations differ only in form. Final form equations are not fit for estimation because variables may be missing, relationships may be misspecified, and parameters may be mis-estimated. If you are not dealing with accounting identities, you may need to add a stochastic-error term to represent your uncertainty. (c) Systems analysis ignored the aggregation problem. Econometric data involves aggregated time series or cross sections. Aggregations pose one of the problems coming between observed facts and the theories explaining them. Other problems not ignored by econometricians are: multicollinearity, serial correlation, structural change, and identification. The fitting of data involves additional problems if the underlying theory is not essentially linear. (d) More work needs to be done after estimating a

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model. Forecasting models require the creation of a forecast horizon within which specific forecasts will be bounded by confidence intervals.

In creating forecasting models, Berlinski insisted that the role of theory is the central issue. Mere projection techniques must assume some simple continuity in the behavior of economic agents (p. 76). Qualitative defects in the Klein-Goldberger model of the United States economy, for example, were found only after the system was simulated using periods involving business cycles. The high risk of qualitative defects is the reason for the use of probabilistic models in econometrics. The global theories used in systems analysis deal with the stochastic nature of social life. Stochastic differential equations, rather than deterministic equations, seem more appropriate (p. 85).

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2.5 CORPORATE SIMULATION MODELS.

Econometricians and systems analysts use simulation extensively. However, the term simulation is so general that Elliott pointed to an alternative way of analyzing corporate profitability: corporate simulation models.

Simulation, as used by Pindyck and Rubinfeld (1981:356), means "the mathematical solution of a simultaneous set of difference equations." A simulation model is the set of equations. An econometric simulation model is "made up of equations which (except for accounting identities) are estimated using the standard econometric techniques."

In order to distinguish econometric and noneconometric simulation models, the authors provided a detailed description of a financial simulation model developed by Dynamics Associates, Inc., Cambridge, Massachusetts (pp. 447-456). These corporate simulation models are used extensively in major corporations for corporate planning and forecasting purposes. All equations are accounting identities. They can be used for dynamic simulation because some of the equations are time dependent. Using XSIM simulation language, management can generate pro forma financial statements. This financial simulation model will solve for 37 unknown variables (including: earnings available for common dividends; earnings after taxes; earnings before taxes; and earnings per share) if management can provide values for 22 parameters (such as the retention rate as a percentage of earnings). Management must input all future values of sales to use the model. By using the financial simulation model, the managers seek to learn the asset requirements for the firm.

Elliott (1973:263-268) cited the Xerox and Dow Chemical systems as examples of corporate use of simulation. Details of these models are available in Schrieber (1970).

In chapter 6 of Naylor et. al. (1966), the authors provided examples of simulations of economic systems. They relied upon Cohen (1960) and Cohen and Cyert (1961) for the distinction between econometric models and computer simulations of economic systems. The traditional use of econometric models, these authors explained, is to determine changes from one period to the next. Each period, new values are assigned to the lagged endogenous variables. Each period, the econometrician assumes that any errors resulting from the last period's determination of the endogenous variables have been corrected. By contrast, computer simulation models deal with a closed dynamic system. Each period, the model determines the values to be used for predetermined variables. Actual values are not used.

Throughout the discussion of simulation models, the authors argue that a major reason for their popularity is that it is feasible to use them. While they concede that mathematical economics is useful for forcing a researcher to consider explicitly aspects of a problem overlooked to date, they contend that most economic problems are so complex that either techniques do not exist for solving them or else solution techniques are beyond the capabilities of computers. Economists must turn to computer simulation when nonlinearities appear in models and when higher order equation systems are used. As firms develop more realistic models, managements have found it necessary to

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add computer simulation to their list of analytical approaches.

Naylor noted, too, that Forrester's industrial dynamics is not a simulation model. Rather, it is a methodology for studying business and economic systems which uses computer simulation as a tool.

2.6 MONTE CARLO SIMULATION.

In the accounting literature, Chang and Liao (1977) argued that Monte Carlo simulation can be used to improve the preparation and disclosure of earnings forecasts. They claimed that it is the only approach compatible with AICPA and with SEC guidelines. The feature of Monte Carlo simulation that prompted this statement is the stress placed upon the probabilistic nature of a forecast. The authors believe that the public cannot be misled into believing a forecast is precise if they see explicit reporting of probabilities.

They rejected outright time series analysis because of these shortcomings: (1) such forecasts are based entirely upon past earnings data, not upon management's judgment about future conditions and actions; (2) probable changes in future managerial actions are treated as random influences having a probability structure with zero mean and finite variance.

However, the authors failed to provide much evidence to support their claims. Instead of performing simulations with real company data, the authors created a hypothetical single product company. For this firm, the authors simulated possible combinations of prices, volumes, and of costs.

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Chang and Liao erred also in claiming that only Monte Carlo simulation has the unique property of dispelling the illusion of forecast precision. Box and Jenkins (1976:132-138) illustrated both with a table and with a graph how to report forecasts and their probability limits. In econometrics, as noted earlier, it is usual to include in graphs of forecasts and actual results the 95% confidence interval. Box and Jenkins illustrated both 95% and 50% probability limits.

Armstrong (1978) suggested the use of Monte Carlo simulation in those cases in which the model builder could not represent adequately a forecasting situation with econometric models. The role of Monte Carlo simulation would be to determine which items are most responsible for uncertainty in a forecast.

If you find uncertainty in econometric models, Armstrong identified these sources (p. 221): (1) estimates of the current status; (2) estimates of the forecast coefficients; (3) forecasts of the causal variables; (4) excluded variables. A model builder would need to develop an expected distribution for each of these types of errors. There are several approaches in Monte Carlo simulation for estimating these distributions. For current status, one may make estimates: (a) subjectively; (b) by comparing estimates made by different sources; (c) by examining differences between preliminary estimates and final estimates. Forecast coefficients are estimated by pooling standard errors from a priori estimates and from regression analyses. If there have been no previous attempts to forecast the causal variables, you

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would try to determine subjectively the possible range of values of the variables. Analysis of residuals provides the basis for estimating subjectively errors due to excluded variables.

2.7 PROGRAMMING MODELS.

Programming models consist of objective functions and constraints upon the achievement of those objectives. Profits could be expressed as a function of the possible production outputs of a firm. Elliott (1973) listed typical constraints in these models: market absorption rates, labor availability, plant space, machine time, warehouse space, and working capital needs. This approach to analysis of the firm provides insights into optimal solutions for inputs and for outputs and into the value of relaxing a constraint.

Boise Cascade uses a 5,800-equation linear programming model involving 25,000 variables. The business of Boise Cascade is largely one of buying timber for the production of plywood, lumber, and of paper products. Elliott concluded that it would not be feasible for a multiproduct firm to attempt to follow Boise Cascade's lead. Even under the ideal conditions of a single industry, Elliott noted that the models do not make primary predictions of performance and operational variables. The data required for inputs to programming models include: future market share, market prices, and input prices. How management develops such inputs would not be part of the formal programming models (Elliott, 1973:268-273).

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The set of transactions produced by a programming model is optimal only if users accept management's representation of objective functions and of constraints. From this set of transactions, one could produce pro forma financial statements. For examples simpler than Boise Cascade's model, the references have been gathered by Dopuch, Birnberg, and Demski (1974:397).

2.8 BEHAVIORAL ANALYSES.

Elliott (1973:254-259) mentioned two studies (Cyert and March, 1963; Bonini, 1963) cited often as an alternative to the use of classical economic equilibrium models in the analysis of the firm. The classical approach involves making assumptions of rational behavior, perfect information, and of profit maximization. There can be multiple goals of the management of a firm. These goals can be changed over time as the expectations of the managers change. Elliott concluded that behavioral approaches are limited to routine processes within which managers want to search for desirable changes in their decision-making processes.

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2.9 TIME SERIES ANALYSIS.

Elliott (1973) did not discuss the new Box-Jenkins methodology. Naive models, however, played an important role in his studies by providing a minimum standard of forecast accuracy. The first test Elliott applied to forecasts was Theil's Inequality Coefficient. A forecast of no change from period to period would have a value of 1.0. Any proposed forecasting procedure, to be considered feasible, needs to do better than the naive forecast that next year's profits will be the same as this year's profits. For comparison, Elliott used other naive models. A forecaster could assume that the change in the next period will be the same as the change in the last period: $Yt - Yt\text{-}1 = Yt\text{-}1 - Yt\text{-}2$. If Elliott observed trends in the data, he used a simple autoregressive model as a benchmark for his econometric models: $Yt = a + bYt\text{-}1$. Elliott's choice of a simple time series model, $Yt = a + bt$, provided a benchmark for forecasts in which he assumed that he could forecast the dependent variable as a linear function of time.

As good as naive models are as benchmarks, Elliott regarded them as poor standards (p. 126) because of "their absolute failure to predict turning points in an economic time series." He argued that decision makers need good forecasts more at turning points than at any other time. The usual measures of forecast accuracy, at the time Elliott performed his research, were Theil's Inequality Coefficient and average absolute errors of forecast. These measures can be misleading at turning points because mid-expansion, mid-contraction, and turning point performances are weighted equally.

The recent forecasting literature stresses, as Elliott did, the importance of turning point errors. Forecasters use the criterion that the best forecasting model is the one predicting correctly the largest number of correct turning points over the period of interest. These forecasters find turning points more difficult to forecast than seasonal patterns (Makridakis and Wheelwright, 1978b:638). With turning points, you are really making two forecasts: (1) the continuation of a cycle; (2) changes in the cycle (Makridakis and Wheelwright, 1978a:436). The number of forecasting errors is not as important as the cost associated with each type of error. Armstrong (1978:326) argued that in any forecasting situation in economics the costs of missing the direction of change will be great.

Time series analysts disagree with the need for evaluating forecasting methods with a turning-point error criterion. They claim that turning points are important only if one can show that the turning points represent systematic cycles and trends in economic time series. Nelson (1973:211) concluded:

> However, as we have seen from simulations of the ARIMA representations of GNP, cycles are not necessarily systematic in nature but rather may be merely artifacts of random shocks working their way through the economy as Eugen Slutzky and Ragnar Frisch suggested some time ago. Thus, it appears ex post that if turning points had been foreseen, prediction errors for subsequent observations could have been reduced. Turning points are usually associated with the occurrence of unusually large shocks to the system, and presumably success in anticipating ANY large disturbance would contribute to the accuracy of predictions of subsequent observations. If that is the case, then we should not restrict our attention only to the large disturbances which produce turning points but rather should be interested in anticipation of all large disturbances. In other words, to say that turning points are important because they are difficult to predict is to say that

> only large disturbances are associated with large prediction errors. Statistical decision theory offers further clarification on this point; namely, once the loss associated with errors has been specified, then conditions for optimal predictions may be stated, for example, in minimization of mean square error. Thereafter, turning-point errors are of no special interest in and of themselves.

Some forecasters prefer regression models over times series analysis models because regression models represent a causal or explanatory approach to forecasting. Causal approaches require the forecaster to find factors to explain the variability observed in the dependent variable other than historical observations of the dependent variable. Time series analysts have attempted to dispute this charge. With univariate time series methods, it is possible to use paired indices for leading indicators. Multivariate time series analyses (MARMA models) are being developed based upon the use of autocorrelation and cross autocorrelation coefficients. However, published applications of MARMA models have been limited to one independent variable (Makridakis and Wheelwright, 1978b:383-388). Glass, Willson, and Gottman (1975) explained how researcher can design time series experiments in order to be able to make causal claims. To do this, the authors explained that one must be able to distinguish the possible levels of causal inference: (1) concomitant variation; (2) shifts in series noted in ex post facto experiments; (3) causal relationships found in planned experiments.

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For concomitant variation, they cited the example of sunspot numbers compared with thunderstorms in Siberia. They concluded from studies involving series with concomitant variation that this is the most primitive level of causal inference. You can expect information only in negative sense (p.6): "If two series are uncorrelated it is unlikely that they are causally connected."

The authors provided a business example for ex post facto experiments: the response of stock price indices to strikes, wars and major non-recurring events. They concluded from such studies (p. 12):

> Scanning for shifts in the series is accomplished by considering the series to be an interrupted time-series experiment. It becomes difficult to generalize from one such quasi-experiment without cross-validation. Even when several similar events can be associated with similar shifts in the series, strong causal inferences are impossible without the use of planned experimentation.

Some time series analysts would stress forecast accuracy, not causal claims, as the strength of their models. The evidence is not clearcut on this issue either. Armstrong (1978:158-160) cited several empirical studies comparing Box-Jenkins forecasts with exponential smoothing and with simple naive models. He found no evidence that Box-Jenkins models are superior. The need for subjective inputs by time series analysts is so great, according to Chatfield and Prothero (1973), that a researcher might as well use BFE (Bold freehand extrapolation)!

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In spite of these extensive criticisms of time series analysis, a large body of literature has developed in the accounting journals using time series models. Lev (1974:36-45) reviewed earlier attempts to apply time series analysis to the problem of predicting future financial ratios. A central issue in the financial statement analysis literature has been the usefulness of financial data in predicting business events, such as earnings growth. Economy-wide, industry-wide, and firm-specific factors have varied so much in the different samples of firms used that different conclusions have been reached about prediction models. Some researchers have blamed the problems of ratio analysis on: (a) the growth of corporate diversification to the point that aggregate data become meaningless; (b) the allocation problem in accounting. Such researchers have suggested that net income be replaced in future studies by the contribution margin of each segment of a business.

Foster (1978) reviewed the extensive literature on the time-series properties of earnings, of financial ratios, and of the relationship of these properties to forecasting accounting numbers. His conclusion was that time series analysis has made an important contribution in the form of providing important information for developing prediction models. For example, if you can show that a random-walk model (i.e., $z_t = z_{t-1} + u_t$) is appropriate, then the implication is that the best (i.e., minimum mean square forecast error) forecast of z_t is z_{t-1}. You would be unable to find a better forecast BASED ONLY ON THE PAST SEQUENCE OF z_t. Systematic patterns in the data, such as seasonality, may suggest possible explanations for the patterns. One might decide to create a

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quarterly prediction model rather than an annual prediction model to exploit the patterns.

The contribution of Box and Jenkins has been the ending of the traditional approach of trying an exponential smoothing model or some other extrapolation technique on a firm's data. With time series analysis, a researcher can now narrow quickly the appropriate special case models of the ARIMA general model. Seasonal models have been used long before time series analysis was introduced. Again, Box and Jenkins provided a way to develop efficient seasonal models. Their approach does not answer, however, the question of whether the best forecasting model based only on the past sequence of zt is also better than forecasting models exploiting other data series.

The financial statement literature has identified many unresolved issues affecting the potential future use of time series analysis in forecasting problems:

(1) the absence of a theory of time series behavior of accounting data. Accounting numbers are the product of a basic underlying economic series and of the accounting techniques used by a firm to represent that series. Foster concluded (p. 90):

> At present, we lack a theory which would specify the characteristics of the basic series. Variables such as the concentration of firms in the industry, barriers to entry, and the shape of cost functions are likely candidates. Moreover, we also have little analysis of how specific accounting techniques transform the basic series, e.g., the effect of LIFO vs. FIFO on the reported series. Assertions are often made about the effect on reported earnings of using accounting alternatives without any attempt to examine if they apply under only certain conditions. For instance, it is often asserted that the use of LIFO over FIFO will result in lower reported earnings if input prices are rising. Note, however, that if a firm is reducing its inventory, the use of LIFO over

FIFO may well produce higher reported earnings even if input prices are rising, i.e., when the firm 'dips' into older LIFO layers.

(2) large sample sizes are needed to reduce sampling variation. Frequently, in accounting research (especially with annual earnings data), the lack of data impairs model specification (called "identification" in time series analysis).

(3) structural change. The farther back in time you go for data, the more likely that there were changes in the firm (such as a merger). Changes in a firm's structure could be responsible for observed changes in its performance. It is not the same firm. Some firms report two sets of data for the same accounting variables: the as-reported series and the restated series. The question remains as to which series decision makers used.

(4) accounting classification and measurement changes. The change observed in the time series does not mean there has been a change in the underlying economic series.

(5) new firms. In analyzing recently-formed firms, it may be necessary to use the average results of a study of a group of firms.

(6) deflated and underflated series may follow different time series processes.

(7) failure to include work in the econometric literature on the question of forecasting aggregate series from disaggregate series.

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More recent time series applications have revealed the problem that earlier results have been specific to the sample of firms analyzed (Brown and Rozeff, 1978; Lorek, 1979). Lorek concluded (p. 202):

> Perhaps this phenomenon is simply a reflection of the diversity exhibited by underlying time series, so the search for an optimal parsimonious model for quarterly earnings may prove futile.

2.10 PROFIT THEORY.

Elliott's studies were based upon relationships found in earlier empirical studies in econometrics. From his experiences, he developed a theory of corporate resource allocation. The system dynamics literature makes no references to profit theory. System scientists interview top management in each firm to discover hundreds of variables and the relationships between the variables. Time series analysts use only the historical data series in making forecasting models. In attempting to explain their results, some of the time series analysts have attempted to invoke outside the model industrial organization theory variables. If the AICPA wants a line-by-line explanation of any firm's chart of accounts, then it is time to examine the state of profit theory and of industrial organization theory. These theoretical bases may not be rich enough currently to include the thousands of accounting variables and relationships between the variables used in many corporate models.

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The major works on the theory of profit are:

(a) LAMBERTON (1965). All fields of economic theory are concerned with profit because: (1) it is the assumed objective of business behavior; (2) it is a source of income; (3) it is a major determinant of the amount of capital supplies to a firm. Governments are interested in profit in terms of: the growth and stability of firms; the control of monopolies; taxation. A profit variable appears in most micro- and macro-economic models. In spite of all this, Lamberton claimed that little has been done to develop a theory of profit. What is needed, he argued, is an extension of the theory of the firm. The traditional theory of the firm should be called a theory of markets because it is so abstract that it has failed to capture these essential characteristics of any firm (p. 1): "its structure, objectives, modes of decision-making, and activities directed to the attainment of its objectives."

The zero profit condition has been the starting point for a number of theories of profit. Assuming perfect competition, competitive equilibrium will be achieved at zero pure profit levels. If any difference is observed between ex post and ex ante income, then uncertainty is the usual reason mentioned. This is a measure of forecasting error, not a functional return. We can begin to understand this aspect of profitability, Lamberton noted, when managements begin disclosing budget data. The equilibrium state is not reached in the real world because of ever-changing disequilibrium conditions. Further, perfect competition is not the usual situation in real world industries.

Knight (1921) had stressed the importance of understanding the relationships between uncertainty and monopoly considerations. Lamberton was more specific. He argued that one needs to model the determinants of a firm's uncertainty-bearing capacity and of a firm's willingness to bear uncertainty. Management can choose actions to reduce the uncertainty for their firm or to increase the uncertainty for competitors. An oligopolistic firm will avoid price competition if it finds that product research, market research, and advertising reduce uncertainty.

Lamberton would direct profit researchers to find the information decision makers are using. He noted that it is not clear how the firm uses accounting data. Past profits per se have been shown not to be a determinant of capital expenditures (Eisner, 1960).

Another aspect of corporate profitability long ignored in economic theory is the managerial choice between which functions will be performed by the firm itself and which will be performed outside the firm. Cole (1959) concluded that the traditional economic discussions of the productive factors of a firm had ignored the use of consultants, advertising agencies, credit reporting services, industrial research bureaus, educational institutions, and professional organizations. This means that two firms in different locations, having the same traditional productive factors, could differ in profitability. Weston (1950 and 1954) stressed that the economic basis of outside institutions was their ability to reduce or eliminate risk for the firm.

A variation of the uncertainty theory of profit is the uncertainty equivalent approach. Lamberton regarded this approach as unsatisfactory. In order to produce certainty-equivalent data to be used by decision makers, the likelihoods assigned are not probabilities but subjective feelings based, according to Baumol (1959:89), upon: 'a combination of experience, analysis, and hunch.' Modigliani and Miller (1958) added that the mean is not the only moment of a distribution affected. For example, managers may choose to use debt rather than equity in order to increase the expected return to the firm only to discover an increased dispersion of possible outcomes. Hart (1940) claimed that the certainty-equivalent approach ignored the flexibility available to firms with liquid assets. Liquidity provides for a firm the flexibility to respond to both favorable and unfavorable events. For example, management has the option of creating a buffer stock for its usual inventory levels.

In accounting, Lamberton noted, there are serious limitations on the measurement of realized profits. To test uncertainty theories of profit, one is talking about the even more difficult notion of measuring expectations. In order to do this, management would need to disclose planning or budget records on a product basis. There would be no guarantee that management would not disclose minimum targets rather than their true expectations. An alternative approach would be to study management's dividend decisions. However, dividends paid are not a function of current estimates of profit alone. Lamberton thought that liquidity is another major factor in dividend decisions.

Dissatisfaction with the uncertainty theory of profit and with profit maximization spurred other theories of profit. A number of economists have proposed theories of satisfactory, normal, or fair profits. These proposals are based upon observations of how some firms seem to operate. A multi-product, oligopolistic firm may adopt a profit target for all of its new projects. Some new product lines may be added and old lines dropped. The advantage of maintaining a steady level of profit is that the firm will have a more certain source of finance and borrowing capacity.

The equating of marginal revenue and marginal cost functions is not as clearcut as theory suggests. The equilibrium approach, according to Lamberton, has abstracted from questions of time and uncertainty. There is no way that cost and revenue functions can account for all possible future developments. Estimates of cost and revenue need not be point estimates. In order to maximize future profits, there must be some way of assigning weights to those profits. A firm's behavior with a new division, in a new market could differ from that of an older division in an established market. Uncertainty is avoided completely by a theory trying to explain price behavior in terms of marginal curves derived from long-term demand and cost curves (Rothschild, 1947). The aim of a firm is first to survive and second to grow (Robinson, 1953). At some point, the management may choose to trade some profit margin for other goals of the firm, such as: sales maximization or technical leadership. Marshall (1919) suggested that a firm would strive for a normal profit only in order to discourage potential competitors and government

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intervention. Boulding (1958) regarded the profit rate as a homeostatic variable: if it drops too low, management responds by cutting costs or making sales- generating expenditures; if it goes too high, management makes concessions to customers. Lamberton cited as evidence for satisfactory profits statistics showing that gross margins at both industry and firm levels remain stable for long periods of time. Further, many firms use the same profit rate criterion for investments for many years. He stressed the need to know the difference between expected and realized profits.

Baumol (1959) argued that the separation of ownership and control in firms has meant that management compensation can be tied to sales more than it is to profits. Clark (1958) claimed that American managers prefer to make the same profit, and perhaps even less, at high levels of output rather than low levels of output.

In Lamberton's view, the satisfactory profit arguments have not yet succeeded because satisfactory has not been defined. If the determinants of corporate profit are largely factors external to the firm, then any theory of profit would need to explain the determination of a satisfactory profit using those factors. Bain's industrial organization approach, Lamberton asserted, overstated barriers to new competition because a firm can concentrate upon a sub-market, cross industry boundaries, or capitalize upon new opportunities in a growing industry.

Lamberton's objective was to piece together from the economic literature the major issues leading to the development of a theory of profit. He made few references to empirical studies. However, he did provide an extensive discussion of what would be necessary to operationalize a theory of profit. This included a discussion of the problems of using accounting data.

If one is to have models explaining each line of the accountant's income statement using economic theory, then the first step is to distinguish between the definitions of profit used in accounting and in economics. Lamberton did this using the following notation:

R = sales revenue

C = currently incurred costs such as raw materials, wages, and maintenance charges

D = expenditures made in earlier periods which have to be charged against the current sales revenue, for example, depreciation of plant and equipment and stocks of materials purchased in earlier periods

V = equity capital input, that is, shareholders' direct investment and accumulated undistributed profits

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i = opportunity cost applicable per unit of V

In economics, profit is R-C-D-iV. In accounting, profit is R-C-D. The accountant excludes the opportunity cost of the capital input because the amount is not objectively verifiable.

Many studies use a profit rate rather than a level of profit. The profit rate on sales is (R-C-D-iV)/R. The profit rate on capital employed is (R-C-D-iV)/V. In some studies, capital employed includes loans, bank overdrafts, and trade credit.

If one wants to compare firms, and even if the appropriate rate for i is known, the usual procedure is to make an allowance for differences in the ratio V/R.

Two firms with equal sales revenue, R, selling identical end products could have very different costs and profits caused only by substantial differences in the degrees of integration of their operations. Lamberton cited also reciprocal relationships between firms. Also, the same firm could report the same sales for two years but have different profits because of a shift in the proportion of sales versus leases. International Business Machines is a recent example of such a shift. Lamberton provided examples of several other problems. His point is that no matter how well accountants may have measured sales revenue it may be very difficult for researchers to understand corporate profits if truly material disclosures are not made.

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Currently incurred costs, C, tend to be overstated by accountants. To the extent that this is happening, reported profits are understated. While any accounting period used is artificial, the main problem is that accountants are very reluctant to capitalize expenditures for items such as research and development, employee training, advertising, and other expenditures having value to the firm for more than one accounting period. Lamberton recognized that accountants are reluctant to watch a firm make huge expenditures over a long period of time only to find there was no market for the new product.

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Administrative costs warrant separate disclosure by accountants. To Lamberton, administrative costs represent organizational resources. Such resources are represented poorly by the variables: number of personnel or cost of personnel. Each firm may adopt different organizational techniques. Money spent for administrative expenditures represents an economic decision that the expenditure could substitute for say technical costs. An example would be that better supervision means a greater savings in labor and material costs. At certain stages, a firm might want excess organizational resources. In anticipation of rapid growth, a firm would need excess organizational capacity. So, the relationship between administrative expenses and the firm's growth rate over time needs to be represented in a model of corporate profitability. Maintaining excess capacity when it is not needed has the opposite effect on the firm's growth rate. The larger the firm, the greater the opportunity to build excess capacity.

There needs to be separate disclosure of costs reflecting current price levels and of those not reflecting current price levels. While raw materials and wages tend to reflect current price levels, interest payments may not.

The accountant's model needs to capture also differences between firms owning their own equipment and those leasing their equipment. Otherwise, capital-output ratios will be misleading.

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Firms producing the same product can have very different cost structures because of different factor proportions.

Expenditures made in earlier periods, but charged against current sales revenue (D), are sometimes difficult to interpret because accountants have not followed the matching principle. Instead of using judgment in matching costs and revenues, accountants may follow a conventional method or may be conservative by using accelerated depreciation.

Lamberton criticized the lack of agreement among accountants or the lack of sufficient concern about the problem of normal capacity utilization. There are inter-industry and international differences due largely to factor availabilities. In a specific accounting period, there might be charges against current sales revenue representing redundant capacity. This means that past allocations were incorrect. Another error involves charges representing excess capacity. Lamberton suggested that accountants are erring if they include depreciation charges in this allocated group of expenditures rather than separating out for current expenses differences in depreciation when a depreciable asset is used and when it is not used.

A further complication with allocated costs is that they do not reflect changes in price levels unless a firm discloses asset revaluations. Usually, a firm does not sell its entire inventory the day it arrives. This means that there will be a difference in price levels between the time of acquiring the inventory and the time of the sale.

Capital employed, V, can vary between studies. Definitions can range from only the capital invested and retained by shareholders to bank loans and trade credit. An alternative approach in profit studies has been to use total assets. There are problems with using total assets. Some assets, such as an investment in land for future plant sites, may not produce revenues for several years. In multi-product firms, it is possible for each product to have stable but different gross profit margins. Traditional accounting disclosures do not provide measures of assets employed on a product by product basis. Since Lamberton's study, however, segmental reporting has provided some additional disclosures.

In the absence of good measures of capital employed, some researchers have chosen to use stock market valuations. Modigliani and Miller (1958) assumed that the important test of an investment project is whether it will increase the market value of a firm's shares. While share prices are current prices, unlike balance sheet variables, Lamberton cautioned that they are also highly volatile variables. The thinness of markets for firm's securities may compel a researcher to use average share prices. Wells (1957) showed that there is a tendency for firms in the same industry to have the same yields on their shares, regardless of the size of the firm. Florence (1957), using data for English firms, found that the increase in the market value of a firm's shares is a poor measure of the growth of a firm because investors reward a firm for divesting itself of assets by paying dividends. Other determinants of a firm's share prices cited by Lamberton were: (a) price

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levels (Szatrowski, 1945); leverage during times of inflation (Kessel, 1956); (c) stock dividends and stock splits (Prais, 1957). Low-priced shares tend to have larger percentage changes in market value than high-priced shares.

Insurance valuations of a firm's assets have not been a good alternative because a firm usually insures only some of its assets, if any.

The opportunity cost applicable per unit of equity capital input, i, cannot be measured precisely. Lamberton suggested that this opportunity cost must be net of risk allowance and relate to an investment for a comparable period.

Most contributions to the theory of profit, according to Lamberton, have involved profits before taxes. If, however, one is concerned about the financial productivity of the firm, then profits after taxes must be explained. Lamberton found considerable controversy in the literature on the effect on the firm of taxes. Some contend that conventional accounting methods have meant excessive taxes, depletion of funds, and increased reliance on capital markets. There is no agreement as to whether a firm can shift taxes. Some have argued that taxes have no direct effects on costs or on demand. Others have countered that sales revenue must be increased or production costs reduced. Taxation complicates also the view of the firm expressed by Elliott that a firm must decide between competing sales-generating and cost-reducing expenditures. Instead of attempting to reduce the firm's costs by research and development or by administrative expenditures, a firm could use its capital to buy other firms with tax losses or to fund lobbyists

to influence tax legislation.

Lamberton's statement of the theory of profit did not include many references to empirical studies involving attempts to find the determinants of each line of the income statement. He mentioned briefly studies showing relationships between profits or profit rates and: (a) volume of production (Stern, 1955) (b) size of the firm (Crum, 1939; McConnell, 1945 and 1946) (c) high barriers to new competition (Bain, 1956). Within given industries over long periods of time, the rankings of firms in terms of profitability has remained stable (Downie, 1958).

(b) WOOD (1975). While both Lamberton and Wood attempted to develop a theory of profits, their approaches were quite different. Lamberton reviewed in detail the theoretical literature on profit theory and what little empirical research could be found. Wood developed a model of the determination of the profit margin of an individual firm and then extended it to the determination of the share of profits in national income in the long run. While Wood did not test the model empirically, he did describe at length many of the determinants for variables in the model.

Although Wood did not reference Lamberton, he did share the view that there is no general theory of profits. There are several schools of thought.

Wood used accounting definitions in his model rather than governmental definitions because he assumed that managers use accounting data in making decisions. Following British company accounts, he defined profits (p. 1):

> By 'profits' we shall mean the gross trading profits of privately owned industrial and commercial companies. That is, profits will be measured gross of interest payments, taxation and depreciation provisions, but net of non-trading income (such as interest on financial assets owned by companies), and we shall exclude the 'profits' of nationalized industries, financial companies and unincorporated businesses. Nationalized industries and financial companies are excluded because, from the viewpoint of the present theory, their behavior is fundamentally different from that of privately owned industrial and commercial companies. The same is true of most unincorporated businesses, especially those which are small and those in which not much capital is employed. But the present theory, with minor modifications, would apply to large unincorporated industrial and commercial businesses; we exclude them merely for convenience, because in quantitative terms they are of minor importance in modern capitalist economies.

The purpose of Wood's model was to explain the long run profit margin of the individual firm. He rejected the use of the profit rate (i.e., profits/value of capital stock) because difficulties relating to the valuation of capital stock would make the profit rate inferior to the profit margin statistically. Further, he wanted to explain the distribution of income.

Lamberton had noted that Baumol (1959) was representative of the sales maximization school. Wood, too, based his model on the assumption that the major goal of a firm is to cause its sales to grow. Management attempts to generate sales by increasing its productive capacity. This requires an increase in investment in fixed assets and in inventory. The main source for such investments is retained earnings. Hence, profit goals are a function of investment plans. There are limits on investment plans. Competition from other firms limits the ability of the firm to increase sales and profits.

Wood's theory differed from neoclassical economists and some financial economists who claim that availability of finance is not a problem for a firm. Any firm willing to finance a project out of retained earnings, according to the neoclassicists, is willing and able to finance the investment by borrowing.

The neoclassical position begins with the assumption of a world of certainty: all future outcomes of all events are known to everyone. There are no transactions costs. The capital market is perfect: individual borrowers and lenders cannot affect the prevailing interest rate. Even if the firm has no retained earnings, lenders will advance funds as long as projects have a positive net present value at prevailing rates of interest.

After relaxing the assumption of a world of uncertainty, Wood explained that neoclassicists would need to make these assumptions: (1) uncertain expectations of the future are shared by all agents in the capital market; (2) if a firm is willing to undertake the project with retained earnings, then it must be willing to borrow at the relevant risk-adjusted interest rate; (3) lenders will finance any project as long as the interest on the loan compensates for the risk they perceive.

The first assumption fails, according to Wood, because expectations are subjective. It is possible that a firm would finance the project if it possessed retained earnings but would not borrow because the lender insists upon an interest rate higher than the firm regards as reasonable.

The second assumption fails because the risks of losing borrowed money are greater than the risks of losing retained earnings. Bankruptcy or loss of control of the firm awaits the management losing borrowed money.

The third assumption fails because lenders can refuse to lend at any rate. Lenders secure loans with the firm's unpledged easily available assets, not with promises of future profits.

Wood developed his model for the profit margin by first explaining the financial behavior of firms in terms of three ratios:

(1) the gross retention ratio: r = internal finance/profits

(2) the external finance ratio: x = external finance/investment

(3) the financial asset ratio: f = financial assets/investment

By investment, Wood meant gross physical capital formation. This usage of investment included fixed assets and inventory but excluded financial assets. Wood used I to denote the level of investment.

Internal finance means retained earnings and depreciation provisions. After denoting the level of profits as P in the gross retention ratio, internal finance can be denoted: rP. According to Wood, the accounting equivalent for internal finance is:

Profits

+Non-Trading Income

-Interest Payments

-Taxation

-Dividends

=Internal Finance

External finance means new borrowing and share issues. The accountant's sources of funds statement ties these variables:

Internal Finance

+Proceeds of New Share Issues

+New Net Borrowing

=Total Sources of Funds

Financial assets include cash and marketable securities. The accountant's uses of funds statement contains these major components:

Investment

+Acquisition of Financial Assets

=Total Uses of Funds

The usual presentation is to combine both uses and sources in a single statement, showing that total sources must equal total uses.

Wood used f/I to denote financial assets. Hence, the total uses of funds became: (1 + f) I. For external finance, he used xI. The difference between these two is another way of representing the amount that must be financed internally: (1 + f - x) I.

With these components, Wood was able to relate the level of profits with the level of investment:

$rP = (1 + f - x)\ I$

$P = (1 + f - x)/r * I$ According to Wood's theory of profits, the gross retention ratio must be positive. Further, (x - f) must be less than unity. This means that a firm needs internal finance and that profits must generate some of that internal finance.

Wood's model explains neither depreciation nor taxation. These variables are treated as exogenously given.

Concern with the long run profit margin is motivated by the strategic problems facing most firms. While the exact number of years representing long run can vary by firm, Wood stated that 3 to 5 years is typical. The key long run decision by management is the investment in fixed assets. Fixed assets can have economic lives of many decades. After making the capacity decision for the firm, management will face short run overutilization and underutilization problems. Investment in capacity is a function of long run demand for the firm's output as estimated by its management.

Wood's theory of the short run financial behavior of firms is based upon the liquidity cushion concept of Kaldor (1966). While management would like to minimize the liquidity cushion, that cushion is planned to cover: (a) deficits in the capital account; (b) expected availability of short term credit; (c) possible losses incurred because of interruptions in planned investment expenditures; (d) the rate of return on financial assets; (e) the need to acquire control over crucial suppliers or other firms.

The acquisition and disposal of financial assets provided the liquidity cushion for the purposes listed above. If, in addition, a firm needs short term borrowings, it is usually for working capital: inventory or work in process. It may need short term financing, also, for financing preparation for fixed investment projects. Wood assumed that trade credit for most firms cancels out (i.e., firms buy and sell

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on credit to the same extent). If this is not the case, he suggested including net trade credit in calculating the required level of financial working capital.

The firm's ability to borrow short term funds varies over time as a function of: government's operation of the discount window; size of the firm; the riskiness of the firm's current businesses; the realizability of its assets; and outstanding debt. This means that new, small, risky firms have shorter strategic planning horizons than well-established firms. The implication is that disclosure rules may need to be modified for new firms.

Of greater importance to management is its long run financial strategy. Wood included preferred stock issues with debentures. Bank credit/total debt is a function of working capital/fixed capital.

The key variable in explaining a firm's borrowing behavior is its gearing ratio:

gearing ratio = total outstanding debt/current realizable assets

Wood noted that in times of significant inflation, it is important to consider the current realizable value of a firm's total assets because the money value of physical assets increases while the money value of debt remains constant. However, in order to approximate current realizable assets, anyone outside the firm depends upon management to disclose the current replacement cost of total assets less depreciation.

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The higher a firm's gearing ratio, the higher the interest rate it must pay. However, there are limits to a lender's willingness to advance funds at high rates for very risky firms. Further, usury laws may prevent lenders from advancing funds beyond a certain rate. Another risk over time for a firm is that lenders may advance funds for a specific period only to withdraw those funds later. In order to repay the loan, management might need to sell assets. This could mean a reduction in the ability to earn a profit or the closure of the firm.

There are other risks to the firm of a high gearing ratio. If the firm has a history of stable dividend payments, the reduction or elimination of dividends to repay loans could have a major impact on its long run strategies. A high gearing ratio means also less availability of short term loans, and hence the need to maintain a larger liquidity cushion. In terms of the public disclosure of management forecasts, Wood stated that the higher the gearing ratio the more volatile the firm's profits.

Over long periods of time, most managements attempt to maintain a stable gearing ratio. The average gearing ratio for both American and British industrial and commercial firms is approximately 20%. However, the more volatile a firm's profits, the lower will be the gearing ratio. The cyclical fluctuations of firms in capital goods industries are so much greater than firms in consumer goods industries that the gearing ratios of capital goods firms are lower (Marris, 1971; Gordon, 1962; Singh and Whittington, 1968).

A firm's long term borrowing, then, is a function of the gearing ratio its management selects and the growth in value of total assets it achieves. This growth is a function of: (1) investment; (2) financial assets; (3) depreciation; (4) appreciation caused by inflation. While initially the gearing ratio depends upon the money interest rate, over time it can depend upon the real interest rate through new borrowings based upon increased values of the firm's existing assets.

Wood disagrees also with economists who assume that shareholders are highly mobile. He cited evidence that most shareholders keep a single firm's stock for 5 to 10 years (Nerlove, 1968; Revell and Moyle, 1966). He attributed the clientele effect chiefly to most shareholders being unable to predict a firm's future and the stock market's reaction to that future. The longer a stockholder keeps a stock, the less important timing decisions become. Further, transaction costs are minimized.

Wood criticized also the dividends don't count claims of neoclassical economists (Modigliani and Miller, 1961, 1967). Their position, in the simplest case of certainty in a perfect capital market, no taxes, and no transaction costs, would be that management should retain earnings up to the point at which the rate of return on the marginal investment outlay equals the prevailing interest rate. If, after investing in physical or in financial assets, the management found residual current earnings, then they would return this inconsequential residual to shareholders in the form of a dividend.

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Wood's attack on the neoclassical position again takes the form of showing its assumptions are unrealistic. The weakest assumption, according to Wood, is that shareholders can declare their own dividends. This means that for every dollar the firm retains the value of the firm's shares will increase by at least the same amount. Using that argument, a shareholder can receive the dividend not paid by selling some stock. However, there are transaction costs. If there are excess dividends, the shareholder must pay income taxes (King, 1974a,b). Management is motivated to increase the size of the firm, not only the market value of its shares. The stock market is dominated by short term traders (p. 44):

> At the very least, however, one may state without fear of contradiction that the price of a share in a company is a great deal more uncertain (ex ante) and volatile (ex post) than are the fortunes and profits of the company itself.

Therefore, there is no reason to believe that the retention of earnings can serve as the sole basis for predicting consistent changes in the market value of a firm's shares.

If management retains a large proportion of earnings, then Wood claimed the riskiness of the firm's shares increases in risk in the sense that the shareholder is uncertain about how the market will value the future stream of dividends or of earnings, even if the stream is certain.

Wood named 4 major factors influencing shareholders' preferences about dividend policy (p. 45):

(1) shareholder expectations concerning the volatility and uncertainty of the stock market.

> Clearly, the greater the expected volatility of the price of a company's shares, the greater will be the expected costs of being obliged to sell or to buy shares at particular times, and thus, other things being equal, the stronger will be the preference of shareholders for a high payout ratio.

(2) shareholders' liquidity preferences. If shareholders desire a certain guaranteed income, then their expectations of their future expenditure requirements will determine their willingness to accept uncertain receipts. So, "the stronger a shareholder's liquidity preference, the more will he be inclined to favour a high payout ratio."

(3) shareholders' risk aversion. Hence, "the less risk averse the shareholder, the lower will be his preferred payout ratio."

(4) tax positions of shareholders and of the firm. This implies: "the higher the effective relative tax rate on dividends, the stronger will be the shareholder's preference for a low payout ratio."

Shareholders are accustomed to seeing stable payout ratios. The change in dividend policy by a management carries with it information effects because shareholders will conclude that management has new earnings expectations (Lintner, 1965).

Wood disagreed with neoclassical economists also on the issuance of additional common stock by a firm. He argued that the reason that most firms make few new issues is that long term shareholders dislike them. An increase in the firm's shares outstanding tends to drive down the price of the shares held by existing shareholders. Modigliani and Miller (1967) asserted that shareholders would be unhappy only if the return on the investment to be made with the proceeds is less than the prevailing interest rate.

A review of the key aspects of Wood's model along with recent developments in industrial organization theory will appear in the next chapter to show the extent of disagreement in the literatures on the specification of equations involving the variables of the accountant's income statement.

(c) FELLNER (1965). Wood built, but did not test, a theory of profit. Lamberton attempted to narrow the controversies in the history of the theory of profit and to show the type of empirical evidence needed for a general theory. Fellner explained what needs to be done to theories of profit to overcome the objections of Bayesians.

The Bayesian position is that decision making always takes place under uncertainty. One cannot develop the concept of profit maximization without relying upon the theory of subjective probability and utility. Fellner cautioned that it might not be possible to discover conclusively how economic decisions are made because researchers cannot test the probability judgments and utility functions of top managements experimentally (p. 202).

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While Fellner did not develop a theory of profit, he did provide some examples of how he would introduce probability in elaborating on traditional profit theory. One example is the claim that profit maximization occurs at the intersection of the marginal revenue and marginal cost functions. The problem with this approach is that the utility functions of decision makers are very unlikely to be linear. Therefore, maximizing money profits does not mean also maximizing utility. An example of the elaboration of the theory of profit is (p. 178):

'the statement "I am going to charge AVC plus a profit margin" MAY acquire the meaning "I am a conventional profit maximizer; and as such, I am going to charge AVC plus a percentage markup the size of which will stay unchanged as long as my estimate of the demand elasticity in the relevant range does not change much.'

(d) ACCOUNTING STUDIES. The accounting literature contains many studies on the theory and measurement of business income. Edwards and Bell (1961) attempted to narrow the gap between economists and accountants. They cited Fisher (1906) as having potential applicability to the accounting theory of business income. The difference between the two approaches has been that accountants wanted to find objective measures of past economic events and economists stressed the importance of expectations of future events. Paton (1965) did not attempt to develop a theory of profits but did explain what is misleading about accounting practices. He argued that corporate profits have been misunderstood because accountants overstate profits by stressing profits

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before taxes in ratios and because accountants find it easier to make systems following tax rules than economic theory. Bedford (1965) reviewed discussions of profit in many literatures, including philosophy, psychology, and sociology. As with other accounting authors, he stressed the importance of making distinctions in reporting accounting variables. In terms of expectations, for example, he argued that this is an important consideration for accountants so that they can determine what constitutes windfall gains and losses. Sterling (1970) relied upon Fisher (1930) but cautioned that Fisher had erred with respect to corporate profitability. Fisher rejected the corporation because it is a fictitious person; he looked to its shareholders. Sterling and many other accountants prefer Hicks's definition of income because of the emphasis on decision making (Hicks, 1946:172):

> The purpose of income calculations in practical affairs is to give people an indication of the amount which they can consume without impoverishing themselves. Following out this idea, it would seem that we ought to define a man's income as the maximum value which he can consume during a week, and still expect to be as well off at the end of the week as he was at the beginning. Thus, when a person saves, he plans to be better off in the future; when he lives beyond his income, he plans to be worse off. Remembering that the practical purpose of income is to serve as a guide for prudent conduct, I think it is fairly clear that this is what the central meaning must be.

On page 166, Sterling claimed that management forecasts are at least as important to users as are accounting statements describing the current position of the firm. Livingstone and Burns (1971) collected major articles on income theory in accounting. These contributions tended to concentrate upon special aspects, such as depreciation theory, or upon explaining the difference between the accountant's and the economist's

definitions of income.

2.11 CORPORATE MODELS.

Financial software publications, such as ICP INTERFACE ADMINISTRATIVE & ACCOUNTING, provide directories of business forecasting software, the features, the prices, and the number of installations to date. Large numbers of major American firms purchase, lease, or use on a timesharing basis a large number of business forecasts. Welch and Panas (1981) provide a summary of the software packages being used currently. As with management forecasts, many persons in business are not willing to disclose details of forecasting systems they have developed at considerable expense. Those who do provide a look at how current practice compares with academic literature. Some recent examples are:

(a) MEYER (1977). The author provided a thorough discussion of the corporate financial planning model used by Pennzoil Company. Meyer revealed that a primary reason for developing the model was to provide forecasts to shareholders (p. 154):

> Financial forecast data has to be of special interest to investors; in fact, these projections are the principal output of outside investment analysts. The corporation's own forecast will normally be more accurate than one prepared by an outsider. Some managements and auditors feel that this information should be published with historical statements. This was one of the first uses of the Pennzoil model. Although we did not advertise the figures as coming from a corporate financial model, our management published forecasts for the next quarter and twelve months in addition to the actual historic quarterly earnings in the financial media. Later we stopped doing this. Because of the uncertainties introduced by the OPEC oil embargo and the associated uncertainties in the national economy, our management must

> have felt that there was as much chance of misleading our shareholders and the investment community as there was of helping them. It is difficult to explain to an outsider that a forecast is only a concensus of the best thinking at a certain time and that it is far from infallible. Publishing corporate forecasts, however desirable, is a thankless task--sort of like giving investment advice. If the forecast proves out, it is only what was expected; if it does not, it becomes a good way to lose friends. This is not to say that it is not a good idea to publish projections, but it may be that the accounting profession should lay down standard ground rules, hedged with suitable warnings to the unsophisticated reader. Properly presented and understood, earnings forecasts could be the nicest thing corporate management could do for its shareholders. On the other hand, it hardly seems fair for one company to predict voluntarily an earnings decline (or even to predict in an uncertain situation) unless other companies were also publishing predictions based on similar accounting practice.

According to Meyer, firms classify financial planning models according to the time period covered: (a) budget, for one year; (b) short-term planning model, for 2 or 3 years; (c) long-term planning model, for 5, 10, or more years. Not only do the models differ in terms of the time horizon but also in terms of the detail. A good strategic planning model has much less detail than a budget: it avoids being so general that it becomes meaningless. Pennzoil uses a deterministic planning model. While stochastic models have been prepared, management usually ignores the output other than for the most likely values. Optimizing models are used on some assignments but are not suitable for corporate planning because there are usually reasons why the decisions cannot be made. Planning models must be modular, both in building and in running. This means that parts of the model can be built by different persons and run separately.

The major building block for Pennzoil's model was the income statement. For each line of the income statement, the model builder prepares matrices showing in general terms the elements representing actual values or forecasts. The top-down procedure is then used to build the model to base the plan around the income statement. By using this approach, the model builder considers the higher-level reports in the organization. At top management level, there is a stable corporate accounting philosophy. The danger of the bottom-up approach is that excessive detail and costs will result only to be lost when the firm divests a division. Meyer noted that some operations of a firm are more stable than others. In stable operations, the model needs only higher-level data.

The author was aware of system dynamics models and regarded them as the most honest approach to corporate modeling because (p. 30: (a) the model builder must determine actual relations between corporate behavior and decisions; (b) delays are incorporated. He argued, too, that system dynamics models free the model builder from the existing accounting format in the firm in order to concentrate on control variables. Finally, it permits the model to stress policy rather than isolated decisions because management decisions must be included in the model as systematic responses to deviations from plans. In spite of these advantages, Meyer would not use system dynamics for the overall corporate financial planning model. His most severe criticism was that it is difficult to evaluate or audit model output because there is no way of comparing the output with actual figures. Further, the approach

violates his belief that a model should be parsimonious. The mathematics required means that a firm must turn to outside specialists to prepare the models. In his opinion, most firms use the matrix model approach.

The author had no use for quick and dirty financial planning software packages offered to his firm by software houses. He complained that salesmen visit his office, ask for the last 3 or 4 annual reports, dial their home office, and in a few minutes hand him 5-year forecasts. They achieve this by using simple trend extrapolation techniques, compound growth rates, and ratio analyses. In addition to being an unreliable procedure, Meyer argued that this approach is not acceptable to a company having more available to it than data given to the public. He did regard this approach acceptable for users having needs for only crude data. For example: (a) a company might want to make a crude determination if another company met its standards for credit, becoming a dealer, or similar determinations; (b) a bank might want to know which clients need to be watched more closely; (c) a stock market analyst might want to screen companies for characteristics to reduce the number to be studied closely to a manageable number. With only the small amount of data available to the public, Meyer cautioned against overmodeling. In the case of a firm preparing a model for itself with all available data, he expected to see a comprehensive, well-structured model.

Meyer explained that it is important to distinguish the planning and forecasting functions of the model. A forecasting model is useful to management if it provides future values based upon the implications of decisions already made. This is not enough, however. Management needs to consider the implications of decisions it has not yet made.

The distinction between a plan and a forecast means that a number of formats for reporting to management or for disclosure to the public are needed:

(1) PLAN-PLAN, SAME PERIOD. This reveals changes in forecasts as a result of changes in assumptions, such as about price levels.

(2) FORECAST-FORECAST, SAME PERIODS. Each time you update a forecast, you have another estimate for a specific period. In a 5-year forecast, there would be several forecasts over those 5 years of year 5. This disclosure would reveal consistent bias and the effectiveness of the model over time.

(3) FORECAST-FORECAST, DIFFERENT PERIODS. This is useful for studying trends in forecasts. On a line-by-line basis, it can pinpoint causes of change.

(4) FORECAST-ACTUAL, SAME PERIODS. These comparisons are used at Pennzoil for revising existing forecasts of the next period.

(5) FORECAST-ACTUAL, DIFFERENT PERIODS. The usual comparison is between the forecast of the current period and the actual results of the last period.

Pennzoil makes extensive use of satellite models. Here one finds stochastic models, Monte Carlo simulations, mathematical programming models, econometric models, tax models, and system dynamics models. This permits decision makers to develop and to support their inputs to the corporate financial planning model. While this keeps the overall model parsimonious, it does mean that other important variables to some decision makers are not explained by the overall model.

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(b) ROSENKRANZ (1979). Meyer stressed the choice of model building approaches, the use of work sheets, the choice of programming languages, and other implementation considerations for corporate models. Rosenkranz, in describing the CIBA-GEIGY Corporate Modeling System and Language, stressed model construction, estimation, and validation.

Meyer's impressions of the use of corporate models was supported by extensive references cited by Rosenkranz. Of firms using corporate models, most of them use models for financial planning, marketing decisions, production decisions, and for cash flow analysis (Grinyer and Wooller, 1975). Major specific applications include: cash flow analysis, financial forecasting, balance sheet projections, financial analysis, pro forma financial reports, profit planning, and long-term forecasts (Naylor and Schauland, 1976). While many companies use the models to produce reports at the subsidiary, division, and operating unit levels, the most common reports are at corporate level: profit and loss; balance sheet; cash flow; financial ratio analysis; source and use of funds statement (Grinyer and Wooller, 1975). The typical planning horizon is from 5 to 8 years. Most firms use only annual data, though some use also quarterly and monthly data (Gershefski, 1970).

There have even been attempts to survey firms about the structures of their models. Some authors hoped to be able to compare models by the number of equations contained in them. A rough range is from 20 equations to several thousand equations (Burill and Quinto, 1972; Rosenkranz and Pellegrini, 1976). Rosenkranz commented that a system of several thousand equations could be reduced to a hundred equations if

authors used matrix notation. A large proportion of equations in corporate models are definitional; the minority are behavioral equations. This reflects the output desires of the firms. The same models could be simplified by substitutions. With so many identities, the models are usually solved by substitution or by recursive methods. Most firms use deterministic models. A minority of firms solve simultaneous equations, use statistical estimation techniques, use stochastic variables, or employ risk analysis. A majority of firms surveyed used external information purchased from econometric forecasting services (Naylor and Schauland, 1976). This information is linked to the corporate models.

Rosenkranz found the traditional theory of the firm to be inadequate for the development of corporate models. The equations used in the theory were deterministic and did not depend upon time.

The following enhancements have been necessary for the theory of the firm in order to use it for predictive or explicative purposes in corporate models:

(1) The objective function was generalized. Further (p. 22):

> it was made dynamic to allow for a description of transient states of input and output variables that had to be taken care of whenever lags and leads in the production and transformation process were observed.

(2) The important inequality relationships were included.

(3) Solutions were developed for problems of the uncertainties over model structures (Tintner, 1941; Theil, 1961; Raiffa, 1961; Hertz, 1964).

Rosenkranz used a classification scheme for structural equations (p. 152) based upon Tinbergen (1955):

(1) BEHAVIORAL RELATIONS. These equations express a hypothesis about the economic behavior of the firm or its environment. They must contain explicitly decision variables or random variables. Price-demand equations are an example. The corporate model builder subjects these relations to verification and validation.

(2) IDENTITIES AND DEFINITIONAL EQUATIONS. A common example in corporate models is: Revenues(t) = Sales(t) - Costs(t).

(3) TECHNOLOGICAL OR INSTITUTIONAL RELATIONS. These equations relate endogenous and exogenous variables in a model. They do not contain decision variables. The model builder assumes that the goals of the firm are achieved with the factor combinations expressed by a technological relationship. An example would be an equation expressing quantities of finished goods as a function of raw material quantities. An example of an institutional relationship would be an equation relating sales and profit taxes.

(4) EQUILIBRIUM OR BOUNDARY CONDITIONS. These equations restrict the value of an endogenous variable in time and by value. The time involved can range from instantaneous to infinite. If an instantaneous equilibrium condition is used, an endogenous variable is related at every state to other endogenous or exogenous variables. Short term

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equilibrium conditions are used often to substitute for more complicated behavioral equations. An example would be an equation showing that a firm adjusts its inventory to the level of the firm's average monthly sales. Mosbaeck and Wold (1970) used an infinite time horizon for a long range equilibrium condition. Such conditions do not represent assumptions about model structure. Rather, they represent implications of model structure. With long range equilibrium conditions, one can test a model's plausibility. However, Rosenkranz noted that firms prefer to use medium range conditions over the model's time horizon. These medium range conditions may contain lagged variables. Typical boundary value conditions are non-negativity constraints or constraints resulting from a linearization of a model (Tinbergen, 1955).

Rosenkranz reviewed the analytical methods used in corporate simulation and planning systems. His critical comments provide a basis for the development of guidelines for the disclosure of management forecasts. Firms use:

(1) SIMPLE GROWTH, PROJECTION, AND INTERPOLATION METHODS. CIBA-GEIGY uses rule of thumb models in its middle-range financial planning models.

(2) SMOOTHING AND DIFFERENCING MODELS. Operations on the data series are performed only once, not iteratively.

(3) MOVING AVERAGES. For non-stationary data series, this approach has the disadvantage of lagging behind.

(4) DIFFERENCING. The model builder assumes that past cyclical or seasonal patterns will be repeated in the future.

Rosenkranz noted that these methods have many disadvantages. First, there is no explanatory power. One must assume that unweighted values of the past determine the inertia of a process. Second, an outlier can distort a series for a long time. Third, it is easy to disguise structural changes in the process.

(5) WEIGHTED MOVING AVERAGE MODELS. Computer manufacturers include these models in their software. Trend polynomials up to triple exponential smoothing find application in short term demand forecasting for inventory control.

Box and Jenkins have criticized this approach because the choice of weights is arbitrary. However, firms continue to use this approach because large amounts of computer time are not needed to apply time series analysis for thousands of inventory items.

(6) BOX-JENKINS TIME SERIES ANALYSIS. These models have an advantage over the previous models because analysis of the data reduces the need to make assumptions about the appropriate model to use. Rosenkranz offered several practical reasons why firms cannot use time series analysis in some applications. A major limitation is the large amount of data needed in the historical series. Further, the models possess a specific functional form: linear in the parameters; the variables and the structure do not change over time. Several authors claim to have found better models (Chatfield and Prothero, 1973; Chatfield, 1977; Granger and Newbold, 1977; Geurts and Ibrahim, 1975;

and Wheelwright, 1977).

(7) TREND ANALYSIS. In using exponential smoothing models, one assumes that the functional form remains constant over time. With trend models, one makes an additional assumption that the parameters of the model remain constant over time. Trend models are not adaptive. Updating involves complete reestimation over the data available. Linear and nonlinear multiple regression techniques are usually used for estimation. Applications of logistic trend models include product life cycle concepts, such as new introductions and market saturation. The forecaster is fitting curves using discrete historical data points. Treatment of the stochastic disturbance term can affect the estimates made.

(8) ECONOMETRIC MODELS. This approach represents an attempt to use as much a priori knowledge about economic behavior as is possible. Models are built using economic theory, common sense, and experimental experience. Rosenkranz noted that econometricians have been criticized for being alchemists because they can pick and choose variables. Economic theory, however, is too general to permit a model builder to specify directly a model. The criticism of econometric models has been overstated, according to Rosenkranz, because it is possible to eliminate many bad models. A major advantage of econometric models is that they are stochastic. They may contain deterministic relationships. CIBA-GEIGY uses econometric models for sales and several other variables. Rosenkranz cited numerous econometric studies involving sales: Armstrong (1970); Bass (1969); Frank and Massy (1971); Green and Frank (1967); Montgomery and Urban (1969); Montgomery and Silk (1972).

Rosenkranz identified several important considerations in developing econometric models of firms:

(1) TIME SERIES VERSUS CROSS SECTIONAL APPROACHES. Model building involves many choices. The example offered by Rosenkranz was the problem of modeling the marketing process. He started by deciding that either market share or sales must be an endogenous variable. To someone working in a firm, good data are available for both sales volume and sales value. The same is not true for market share. One relies upon consumer or producer panels. After settling upon the endogenous variables, the major decision is whether to take a time series approach, a cross sectional approach, or a combination of both.

If ample data were available, Rosenkranz would use the combination approach. If not, he has found time series models to be more reliable. Cross-sectional studies pose a problem because it is difficult to define well different sales regions in order to avoid location carry over effects. Further, one must assume that the estimated parameters are valid for all sales regions. The problem is that certain variables can have different effects in different regions. Time series models have the problem that one assumes that one model and one set of parameters for all the time horizon. Consumer tastes can change rapidly. Further, positive autocorrelation is usually found in these applications because of time trends, cycles, and seasonalities. He suggested Theil (1971) as a starting point for techniques for dealing with these problems.

(2) THE LINEAR MODEL AND ASSUMPTIONS. In building corporate models, one often finds assumptions of the general linear model being violated. The response is either to use variable differencing and functional transformations or use extended estimation methods (Durbin, 1969 and 1970; Box and Pierce, 1970; Malinvaud, 1970).

(3) DIFFERENCING AND TRANSFORMATION. There remain choices on how to difference and how to make functional transformations. Rosenkranz prefers to use the transformation formula and evaluation procedure developed by Box because in incorporates logarithmic, inverse, and square root transformations (Box and Cox, 1964; Box and Jenkins, 1970:496).

(4) NONLINEAR MODELS. In the experience of Rosenkranz, linear models become more unrealistic the more values of variables vary or the more one models at microlevels rather than at highly aggregated levels. If a model builder concludes that a linear model is not appropriate, the next decisions pertain to formulation of the model and to estimation techniques. The estimation techniques used in practice are nonlinear least squares methods (Marquardt, 1963; Box and Jenkins, 1970:504) and maximum likelihood estimation (Goldfeld and Quandt, 1972).

(5) DISTRIBUTED LAGS. Using the sales example, Rosenkranz commented that advertising expenditures do not necessarily lead to instantaneous changes in sales. Further, purchase decisions can represent a response to several advertisements over time. CIBA-GEIGY uses linear distributed lag models extensively. One must choose among many techniques for determining the coefficients of distributed-lag

models.

(6) SIMULTANEOUS EQUATIONS. As one builds a corporate model, the problem will arise as to the order of the equations in the model. In some cases, a recursive OLS estimation of the model parameters is possible (Wold, 1964). However, usually the interactions are of the type that simultaneous equations must be used. The use of OLS in this case would mean biased estimates. One must choose among estimation techniques, such as: two stage least squares, three stage least squares, full information maximum likelihood, or fixed point estimation. If the model contains lagged endogenous or predetermined variables, then additional steps are required (Cochrane and Orcutt, 1949; Chow, 1968; Fair, 1970; Godfrey, 1976).

(7) AUXILIARY VARIABLES. A manufacturer may discover that wholesalers and retailers are ordering in the same quantities in regular intervals. This could mean that the wholesalers and retailers are using safety stocks to even demand. If a corporate model builder wants to understand and to predict the response to advertising, then a way must be found to model factory sales. Dummy, instrumental, or proxy variables may be needed.

(8) UNOBSERVABLE VARIABLES. In some cases, theory may suggest that a variable is important but there are no data series available. Rather than using guesses, one might decide to find highly correlated variables for which data series are available (Theil, 1971; Griliches, 1974).

(9) AGGREGATED AND DISAGGREGATED MODELS. Another concern is whether direct estimation of an aggregated model will yield results compatible with the aggregation of micro-models. The macro-model may not be suitable for direct OLS estimation because of non-linearities, interacting model variables, measurement errors, and several stochastic disturbances. Further, Rosenkranz noted that omitted latent variables are a problem for aggregated models.

(10) FORECASTING. In order to use econometric models for forecasting, one must decide how much historical data to set aside for validation of the model's forecasting performance. Further, one will want to perform ex ante forecasts to generate expected values and confidence intervals. One would need a way also of forecasting the exogenous variables (Feldstein, 1971).

(11) CAUSALITY. There are many possible models consistent with economic theory. Econometricians use trial and error. The problem is that different model builders could derive plausible but different models. Time series analysts have proposed a solution to this problem. They start by using a test for causal relations based upon estimated cross-correlation functions of estimated random disturbances (Haugh and Box, 1977; Pierce , 1977). From this test, they claim they can distinguish recursive and simultaneous relations between variables. This forms the basis for the specification and estimation of simultaneous or recursive explicative Box-Jenkins models (Box and Jenkins, 1970; Granger and Newbold, 1977; Helmer and Johansson, 1977). The extended time series analysis includes also qualitative variables

(Box and Tiao, 1975). Rosenkranz noted that this approach cannot be applied until the researchers demonstrate a way to perform the analysis for more than two variables. Further, the procedures require large amounts of data because of degrees of freedom losses in the prewhitening analysis. Rosenkranz concluded that neither purely econometric nor purely time series modeling systems satisfy all corporate modeling needs.

(12) STATISTICAL SPECIFICATION TESTING. Some firms have incorporated into their systems statistical tests to verify hypotheses concerning (p. 300): (1) the significance of single parameters, of groups of parameters, and especially of linear relations between parameters, or to detect a wrong specification of a model as might result from (2) omitted variables in a relation, (3) an incorrect functional form of a stochastic model equation, (4) a neglected simultaneity of model variables, (5) time dependent stochastic disturbances, (6) auto-correlated disturbances, (7) non-normal disturbances.

While Rosenkranz includes such tests in his system, he uses them only to eliminate a large number of hypotheses from further investigation. Model comparison of the remaining models, however, reveals these limitations:

(a) In order to use parametric statistical tests of model misspecification, you must make assumptions regarding the nature of the real system. A validation problem remains.

(b) Several misspecifications can occur in the model simultaneously.

(c) Different models can fail different tests.

(d) The probability of type one errors and of type two errors increases as the number of tests increases.

In other words, Rosenkranz concluded that a corporate model builder does not always know which model to select or even which revisions need to be made (Dhrymes et. al., 1972; Howrey, 1973; Snee, 1977).

(13) GOODNESS OF FIT AND VALIDATION BY FORECASTING. Another way to compare models is to compare their outputs with the outputs of the real system. On page 302, Rosenkranz listed the qualitative criteria (Cyert, 1966; Naylor, 1971; Howrey, 1973): (1) the number of turning points, (2) the timing of turning points, (3) the direction of turning points, (4) the average amplitude of fluctuations for corresponding time segments, (5) the average values of variables, (6) the simultaneity of turning points for different variables, (7) the probability distribution, the mean and measures of variation about the mean of different variables.

Rosenkranz suggested that some of the following quantitative statistical techniques be included in corporate systems: (Theil's inequality coefficient or information inaccuracy test (Theil, 1958, 1966, and 1967; Bliemel, 1973; Pindyck and Rubinfeld, 1976; (2) Wold's Janus coefficient (Gadd and Wold, 1964); (3) the von Neumann ratio (Granger and Newbold, 1973).

CHAPTER 3

DEVELOPMENT OF THE MODELS

PREVIEW OF CHAPTER 3.

Chapter 3 explains the development of the 6 models used in this study. All models are based upon annual, firm-level variables reported by accountants. Some earlier researchers have included industry-level and economy-level variables in their models. A major assumption of this study is that it is possible to separate operating and financing decisions. Explanations and forecasts of operating decisions are the sole concern of this study.

Aggregate models, in this study, are models whose income statements contain these endogenous variables: (1) sales; (2) cost of goods sold; (3) gross margin; (4) selling, general, and administrative expenses; (5) operating income before depreciation. Disaggregate models, in this study, contain as endogenous variables three major components of selling, general, and administrative expenses: advertising expense;

research and development expense; selling, general, and administrative expenses (net).

Another distinction between the types of models used in this study is the presence or the absence of distributed lags. For models containing distributed lag specifications, the distributed lags are lagged values of selling, general, and administrative expenses or of the three major components.

Unlike earlier studies using a single model, the use of 6 models of this study permits comparisons of estimates and of forecasts for firms with different disclosure practices. Accountants, in particular, are concerned with finding ways to make adequate rather than excessive disclosures.

3.1 THE APPROACHES TO DEVELOPMENT OF MODELS OF THE FIRM.

The studies of Chapter 2 represented 3 apparently different approaches to the development of models of the firm:

(1) attempts to use a single, general model of the firm to explain and to forecast any firm's economic behavior;

(2) the use of a general approach to the selection of determinants with firms differing only in terms of the operationalization of the variables. Each firm's model contains the industrial variables deemed appropriate for the firm's major industry;

(3) the use of a firm's accounting time series, including accounting variables not disclosed to the public, without regard to whether other firms have the same accounting variables. Firm-specific models, if published for many firms, could lead eventually to the development of more general models treating each firm-specific model as a special case.

The proposed guidelines in the accounting literature lack empirical support for the initial choice of an approach to supporting the public disclosure of forecasts. While accountants have not provided general models of a firm's determinants of economic behavior, general models, if feasible, would represent an answer to the complaints of managers that the selection of determinants to date has represented a fishing expedition or theoretical ad hockery. Accountants have developed detailed industrial audit guidelines for the review of historical financial statements. This represents a practical response to the

presumed importance of capturing in historical financial statements industrial membership effects on a firm. Industry-level audit guidelines represent also a practical way of training auditors to specialize in a group of clients in the same or in similar industries.

Future accounting guidelines on the public disclosure of forecasts need to address the choice of the approach for the development of support for forecasts. In accounting, line-of-business reporting has stressed the importance of separating membership of a firm in more than one industry. In financial economics, researchers have attempted to determine the relative importance of the stock market, industrial membership, and of firm-specific attributes on the behavior of a firm's share prices. The empirical question is which major determinants capture best the membership of a firm in one or more industries. The testing of more than one model on the same data base will offer additional evidence with respect to the theory of economic forecasting: Do superior explanatory models also forecast better?

3.2 THE FEASIBILITY OF A GENERAL MODEL OF THE FIRM.

The feasibility of using the same model for all firms depends upon the explanatory power and forecasting accuracy of a general model for the population of firms being considered for public disclosures of their forecasts in addition to their current disclosure of historical financial statements. As noted in Chapter 2, many earlier accounting studies considered feasibility only in terms of forecast accuracy. Earlier accounting researchers have used as benchmarks a variety of naive models, Box-Jenkins time series models, and of forecast accuracy measures to demonstrate the feasibility of using their forecasting models.

The more difficult issue, less developed in the accounting literature, is the feasibility of developing a general model in terms of theory closure with respect to the determinants of accounting variables. The studies reviewed in Chapter 2 varied considerably in the researchers' choices of the determinants of accounting variables. The use of more general variables in this study provides a base for comparison with disaggregated models. Chapter 6 will contain a discussion of how this study suggests revisions for accounting guidelines for supporting the underlying assumptions of forecasts.

3.3 THE FEASIBILITY OF INDUSTRY-ORIENTED MODELS OF FIRMS.

The general model approach employed the selection as determinants: macroeconomic variables, one or more variables to capture industry membership, and firm-level variables common to all firms.

It is possible to use macroeconomic variables in explaining the economic behavior of firms under certain conditions:

(1) The researcher plans to use time series or panel data and is willing to accept the strong assumptions of independence over time. Using cross-sectional data for a single year would preclude the use of macroeconomic variables because the values of the variables would be the same for all firms. It is feasible to achieve some variability in cross- sectional studies only to the extent that accounting variables are available on a quarterly basis. Macroeconomic variable data series tend to be available on monthly or quarterly bases. It would be possible to group firms with different fiscal years in different quarters and then to use different values of macroeconomic variables from those quarters. However, the detail of the accountant's quarterly financial statements is considerably less than that of annual financial statements. A good reason for the difference in detail is that as the period over which an accountant must prepare financial statements becomes shorter, the need to develop arbitrary allocation methods between periods increases. This situation limits the extent to which researchers using cross- sectional data can enrich their models with additional explanatory variables.

(2) One needs economic theories linking directly or indirectly macroeconomic variables and microeconomic variables. Some econometric research firms have attempted to develop

computer-based packages to permit managers to use forecasts of macroeconomic variables in their strategic planning at the level of the firm.

(3) There would need to be coordination between the disclosure of macroeconomic data series, such as those appearing on CITIBASE, and the detail of disclosure of firm- level accounting variables by accountants, such as those appearing on the COMPUSTAT tapes. For example, if the Federal Government discloses government expenditures on research and development in the private sector, there needs to be coordination by accountants by distinguishing research and development expenditures funded by the firm from those funded by the Federal Government. In the absence of coordinated disclosures, researchers using more aggregate variables will either be unable to explain important aspects of managerial decision making or will conclude in error that there are no significant relationships.

The use of industry-level variables in models of firms is affected also by accounting disclosure practices:

(1) The Federal Government maintains detailed industrial classification codes. The COMPUSTAT tapes, based upon accounting data available to the public, uses only the first 4 digits of the industrial classification codes and uses them only for the firm's largest business segment. This practice is the result of unsegmented accounting disclosures by

multinational, diversified firms until the 1970's. The Federal Trade Commission, under its line-of-business reporting program, receives from firms confidential segmented data. While managers may have valid reasons for fearing the disclosure of disaggregated data to the public or to their competitors, this differential disclosure practice means that researchers at the Federal Trade Commission are least constrained in the development of industry-oriented models of the firm. The expanded disclosures of the 1970's, made possible by the SEC's segmental reporting disclosures in Form 10-K, are limited to 10 segments. Accountants have considerable latitude in regrouping segments over time.

(2) If a firm is involved in a merger or acquisition or if a firm changes accounting methods, comparable data on an industry-basis may not be available in a given year or restatement is limited to the number of years accountants presume to be relevant. If the focus of the research is on managerial decision making, both firm-level variables and industry-level variables found in historical data series, whether unavailable or restated, are not the values used by managers in making decisions.

(3) The aggregation of data at the industry level is meaningful to the extent that comparable firm-level variables have been aggregated. Whether a researcher attempts the computation of industry-level variables from firm-level disclosures (such as from the COMPUSTAT tapes or from the

original Form 10-K available from Disclosure, Inc.), someone has made assumptions that accounting variables of different firms at some level of aggregation are comparable enough to be included in further aggregations. In the absence of a uniform chart of accounts in the United States, there is room for considerable error in the aggregation process.

3.4 THE FEASIBILITY OF FIRM-SPECIFIC MODELS OF FIRMS.

The problems of using macroeconomic and industry-level variables in explaining and forecasting the economic behavior of firms has led some researchers to concentrate upon developing models of the firm using only firm-level variables. In such cases, the firm's chart of accounts is known. The detail of the firm's chart of accounts is greater than that disclosed in financial statements. Researchers within a firm could concentrate upon developing Box-Jenkins time series models or other methodologies requiring the historical accounting data series as the only input for generating forecasts of future values of the same accounting series. Forecast accuracy has been the major test of such firm-specific models. While it is possible to construct systems of equations using only firm-level variables, the problems resulting from model misspecification may be worse than the aggregation problems affecting industry-oriented and general models. Further, it is unlikely that any manager would claim that the economic performance of a firm is the result entirely of firm-level variables over which managers exercise complete control. Pretending that a firm operates in a vacuum would not make it so.

Some managers have developed models with thousands of variables to explain the complex tasks they manage, just as some economists forecast gross national product using models ranging from single- equation models with 4 determinants to using large systems of equations employing thousands of explanatory variables. Many managers prefer firm-specific model approaches, just as some persons prefer custom- tailored suits, because they believe that nothing else can capture the unique aspects of

their special situation. However, there are limits to such appeals for firm-specific variables. The accountant's concept of materiality permits the extensive aggregation of data at the level of the firm. How materiality decisions are made is a subject of considerable controversy in the accounting literature. The point is that the accountants who proposed the public disclosure of forecasts have advocated only that such forecasts be supported by reference to major determinants of a firm's economic behavior. In other words, managers cannot support forecasts only by pointing to their historical success in terms of forecast accuracy. There must be additional support for disclosures of forecasts in terms of variables other than those accounting data series contained in the forecasts.

The forecast disclosure controversy has placed many managers in untenable positions. If one takes the position that all material information for stockholders has been disclosed to the public in the annual report or in Form 10-K, then it should be possible for each firm's strategic planners to disclose how they combine those material variables in making their own forecasts. This indication of the relative importance of firm-level variables in their own analyses would provide guidance to users of financial statements with less access to everyday developments in the firm. If, instead, the managers must admit that they use other firm-level variables in their own forecasting which are not available to stockholders or to the public as separate line items, then a different type of materiality argument is being used. In this case, managers would be conceding that the nondisclosure of an aggregate variable would be material while the disclosure of the

aggregate variable would be material but not useful in understanding the economic behavior or prospects of the firm.

The ability of management to forecast without any knowledge of the industries in which they operate or the economies in which they operate would require considerable explanation. Managers make acquisitions, remain in an industry, or make divestitures based upon their expectations of being able to compete successfully for profits with specific products in specific markets, given their firm's resources relative to those of current and potential rivals.

The use of only the historical accounting series in time-series models means that a researcher in a firm needs to have long time series. The longer the time series, however, the greater the need for adjustments in the series because of mergers, changes of industries, strikes, changes of accounting methods, and any other change over time having a major effect on the economic behavior of the firm. If the firm's researchers find this difficult to do, users of the firm's financial statements should find the task no easier. The disclosure of historical financial statements involves numerous forecasts, including that this firm is an on-going concern (hence, liquidation accounting methods need not be used) and the choice of allowance methods for depreciation and for doubtful accounts. The controversy over the public disclosure of forecasts, regardless of the approach used, has brought attention to the need for accountants to buttress forecasts (whether in the form of disguised forecasts in historical financial statements or in the form of statements bearing the title of forecasts).

The choice of an approach has an important bearing on guidelines for the disclosure of forecasts by new firms. If long time series are needed to support a one-year ahead forecast for any firm, then new firms must be exempted from disclosure requirements for many years. It would be necessary to develop disclosure guidelines to cover the case of a new firm formed from the merger of two old firms. Managers could claim that their ability to understand their own businesses was lost when the business merged with another one.

Guidelines would be necessary, also, to justify the use of different forecasting approaches. It is not clear from the studies reviewed in the previous chapters whether the approaches selected by the researchers reflected assumptions of the researchers about the relative importance of economic, industry-level, and firm-level or whether the approaches reflected differences in data availability.

3.5 AN AGGREGATE MODEL FOR PRO FORMA INCOME STATEMENTS.

The literature in accounting and in many other fields contains many single-equation research studies providing explanations of the behavior of accounting variables. As was noted in the previous chapters, few researchers have attempted to explain the accountant's financial statements line by line. The extensive use of misspecified accounting models could be misleading researchers relative to which determinants are important to corporate profitability. The future use of systems of equations may not provide better answers if the level of aggregation of accounting variables is so high that it is not possible to use the accounting data in models with industry-level and macroeconomic variables.

A major impediment along the path towards an explanation of the accountant's income statement line by line is the development of an income statement format into which large numbers of firms income statements can be converted accurately. The United States is not a uniform chart of accounts country. Disclosure, Inc., with its monopoly over the distribution for firm's disclosures submitted to the SEC, has not chosen to attempt the production of comparable income statements for more than 12,000 major American firms. Standard & Poor's Compustat Services, Inc. has attempted, with the help of accounting firms, to produce a comparable data base for a smaller number of firms. Elliott chose the COMPUSTAT tapes as the source of data for his 9-firm study; he chose for another study the private data of a single firm whose name could not be used in the article reporting on the results.

COMPUSTAT's basic income statement illustrates the difficulties of explaining an income statement line by line:

ANNUAL INDUSTRIAL

Sales--Net

less: Cost of Goods Sold

less: Selling, General, and Administrative Expenses

equals:Operating Income before Depreciation

less: Depreciation and Amortization

less: Interest Expense

less: Non-operating Income/Expense

less: Special Items

equals:Pretax Income

less: Income Taxes (Total)

less: Minority Interest

equals:Income before Extraordinary Items and Discontinued Operations

QUARTERLY INDUSTRIAL

Sales--Net

less: Operating Expense

equals:Operating Income before Depreciation

less: Depreciation and Amortization

less: Interest Expense

less: Other Income/Expense

equals:Pretax Income

less: Income Taxes (Total)

less: Minority Interest

equals:Income before Extraordinary Items and Discontinued Operations

The two basic income statements show that there is a considerable difference in the aggregation of accounting variables disclosed in annual and in quarterly financial statements. This difference, whether justifiable or not, does affect the limit to which an outside user of financial statements can build models to explain and to forecast the economic behavior of firms.

In terms of data availability, the above annual accounting variables will appear on the COMPUSTAT tapes for most of the approximately 2,500 annual industrial firms for the most recent 20 years, if the data were both reported by firms and were comparable to those of other firms. Quarterly data appear on the COMPUSTAT tapes only in 40 quarter or 20 quarter formats.

What little research which exists for explaining the accounting income statement line by line stops with operating income before depreciation. There is little or no guidance in the literature for specifying equations to explain and to forecast non-operating income and expense activities of firms, special items, minority interest, extraordinary items, or discontinued operations. Given our current knowledge about the economic behavior of firms, little support for the disclosure of line-by-line forecasts of the income statements using explanatory models exists beyond operating income before depreciation. The data availability tables in the COMPUSTAT manual indicate that nearly all firms report values each year for the accounting variables in the basic income statement, including "extraordinary" items. If published forecasts were mandated today for each line of COMPUSTAT's basic income statement, only forecasting methods requiring no knowledge of why accounting variables behave the way they do could be used. However, there is no reason to believe that managers could provide any additional information to users other than to say that they have reason to believe that naive projections of historical accounting data series would give rise to false expectations. The SEC expects managements to minimize the existence of false expectations. This obligation can be met only by citing explanations of the behavior of accounting variables to the extent possible. While it would be possible to construct a system of equations for each line of COMPUSTAT's basic income statement, most of the equations below operating income before depreciation would show as determinants simple relationships with little explanatory power.

For example, many popular financial models used in industry today are based upon financial ratios. The analysts ask top managers if, in the opinion of the managers, any of the historical financial ratios are likely to change in the future. If so, the new values are substituted into the computer programs and simulations are prepared. This is not an explanation. If income taxes vary little as a percentage of pretax income over long periods of time, the specification of an income tax equation with pretax income as the sole determinant will provide little in the way of an explanation for this behavior. There is no variability to explain. However, the income taxes could be the result of taxation at different rates in a large number of states and of countries.

Earlier research studies used a very small number of firms in estimating models of abbreviated income statements. Some researchers used time-series data; others used cross-sectional data. The interest was keen in terms of finding explanations for the managerial decisions as to how to make expenditures on different accounting variables to achieve corporate objectives. Earlier researchers were interested also in determining the extent, if any, to which distributed lag relationships are important to the workings of a firms. Elliott, in particular, was interested in exploiting any distributed lag relationships to forecast the future economic behavior of firms.

The starting point of the research reported in this manuscript is the development of an aggregate model to explain and to forecast the economic behavior for the largest population of American firms with comparable income statement data. In terms of the COMPUSTAT tapes, the aggregate model consists of:

Sales--Net (Annual Data Item 12)

less: Cost of Goods Sold (Annual Data Item 41)

equals:Gross Margin (computed from 12 less 41)

less: Selling, General, and Administrative Expenses
(computed from 12 minus 13 minus 41)

equals:Operating Income before Depreciation (Data Item 13)

The use of only two accounting profit variables, gross margin and operating income before depreciation, is based upon the limitations of theoretical bases for explaining more of the COMPUSTAT basic income statement. The choice of a stopping point for the model was not based upon the preferences of some managers for one profit variable over another. Paton (1965) provided a discussion and a rejection of the claims of some managers that profit variables should be limited to those including only the expenses managers think they can control.

The Annual Industrial COMPUSTAT population of firms provides a data base best suited for cross-sectional estimates of the aggregate model. While Elliott used the COMPUSTAT tapes in a feasibility study with 9 firms to demonstrate the potential of econometric models for explaining and for forecasting income statements, a data matrix of 2,500 firms by 20 years can be put to better use in estimating the relative importance of determinants for the largest possible number of firms. The use of a cross-sectional model instead of one based on time series data means that some variables suggested in the time series studies cannot be used because there will be no variability across firms in the same year.

Panel data studies were not performed by earlier researchers attempting to explain the income statement line by line. Pindyck and Rubinfeld (1981, 252-261) explained that the practice of pooling cross-sectional and time-series data is limited usually to problems in which a researcher has insufficient data for either a time-series or a cross-sectional model. The COMPUSTAT firms provide a large base for cross-sectional estimation of models. Further, so little research has been done with models of the income statement that there is little evidence that cross-sectional parameters do or do not shift over time. Model specification is a major concern in pooled models because of the likelihood that there will be a complex disturbance term consisting of time-series related disturbances, cross-sectional disturbances, and a combination of both types of disturbances.

3.5.1 DETERMINANTS OF NET SALES.

The starting point for any explanation of the accountant's income statement is dollar sales revenue. The income statement represents an aggregation over the period of one year the sum of all historical sales transactions: the unit selling price of each product in each transaction times the number of units of each product sold at each different price. Inflation accounting and quarterly reporting represent attempts by accountants to deal with the problems of aggregating data over time. However, additional problems accompany proposed remedies. As accounting reporting periods decrease, accounting allocation problems increase. Seasonal patterns must be explained. As shown in the comparison of the annual and quarterly COMPUSTAT basic income statements, quarterly disclosures by American firms tend to be less detailed than annual disclosures.

Marketing and advertising journals contain many models for forecasting sales. While there is an abundance of sales forecasting models, especially of the single equation variety, the emphasis has usually been placed on forecast accuracy rather than on explanatory power. This emphasis could be well-placed if most other firm-level variables of interest are stable proportions of sales. Within the firm, a production manager might be interested in the most accurate forecast of demand, not of sales, in order to make the best capacity planning decisions. Other decision makers may be concerned about the breakdown between cash and credit sales for financial planning purposes. There is a major gap between economic theory and accounting theory in terms of specifying sales equations. Economic theorists stress the importance of

understanding pricing and the demand experienced at a given price. There is no way an accountant for a multinational firm producing thousands of products would even consider disclosing on a product-by-product basis the number of units sold and at which prices. While such disclosures might further the research of industrial organization theorists in terms of the importance of market structures on a firm's economic behavior and make possible more precise calculations of weighted average market shares, concentration ratios, and of various spending intensity variables, it is unlikely that a single firm's experiences are so different in each of thousands of narrowly defined product markets as to mandate the disclosure of each on a separate basis. Further, while Scherer (1980) may be correct in stating that many of our questions about the economic performance of firms may go unanswered until the Federal Trade Commission releases detailed line-of-business data, it is not obvious that earlier attempts to explain the accountant's income statement with the data of 9 firms on the COMPUSTAT tapes has exhausted what we can learn from the COMPUSTAT tapes or from segmental disclosures in Form 10-K.

The Forecasts and Projections Task Force of the American Institute of Certified Public Accountants (AICPA), in a proposed guide for the review of financial forecasts provided this example of the amount of detail considered necessary to support adequately the public disclosure of a sales forecast:

> SALES. The overall market for the Company's products has grown over the past five years at an average rate of 2% above the actual increase in Gross National Product, and the Company's market share has remained steady at 14-16%. Selling prices generally increase in line with cost of manufacturing,

> and gross margins are not expected to vary from experience over the past five years. Sales are forecasted to increase 5% from 19x2 (which is 2% above the Bureau of Economic Analysis of the Department of Commerce's estimate of the rise in Gross National Product in the forecast period), with a market share of 15% and unit prices increased to cover forecasted increased cost of manufacturing.

Similar examples of the disclosure of assumptions of forecasts appear in British, Canadian, and American accounting publications (Barnea, Sadan, and Schiff (1979); Kidd (1976); Presentation and Disclosure of Financial Forecasts (1975); Guidelines for Systems for the Preparation of Financial Forecasts (1975); Published Profit Forecasts (1974)).

In the AICPA's example, such a disclosure of assumptions is more appropriate for a single-product firm than for a highly diversified firm. Market share statistics are not readily available for all firms. Some markets are easier to define than are others. The mechanism through which growth in GNP works to keep the demand for the firm's products growing faster is not explained. However, the expectations of the management of this firm, however well- or poorly documented, are clear with respect to market share and the growth in demand for their products. The managers expect to be able to increase sales without increasing market share. Such a statement would place a burden on financial analysts to document why the expectations for the firm should be other than what recent historical experience and management's written expectations would suggest. The managers have explained briefly and clearly how they expect sales, costs, and gross margins to behave over the next accounting period. For managers of diversified firms and of multinational firms, similar disclosures could be much longer.

In order to provide an empirical test of the adequacy of highly aggregate explanations of the profitability of firms and a test of the forecast accuracy of such models, the starting point for the development of the aggregate model will be the empirical studies reviewed in the previous chapter. More recent studies in the organization theory literature will be compared with the earlier specifications of models.

Mueller (1967) treated sales as an exogenous variable in a cross-sectional study of 67 firms. Hence, there was no specification for sales to use for comparison with the Elliott studies.

Elliott's approach, in several studies, was to consider sales-generating expenditures as the major determinants of sales. By sales-generating expenditures, he meant chiefly advertising and research and development. However, he rejected the recent accounting treatment of such expenditures (i.e., the mandatory expensing of all research and development expenditures in the year incurred) in favor of the earlier American accounting treatment of permitting a portion of research and development expenditures to be treated as assets having future service potential to the firm. The current accounting disclosure rules do not mean that accountants reject the possibility of expenditures in the current year on advertising and on research and development as influencing sales in future years. Such recognition was permitted earlier. Instead, the current disclosure rules are designed to prevent managerial abuses in the form of a basic desire to increase reported profits by treating expenditures as assets rather than as expenses for as long as accountants will permit. Accountants were not satisfied with

available techniques used to estimate these assets. From Elliott's viewpoint, even if managers made no sales-generating expenditures in a given year there would still be sales because of some carry over influences from having made sales-generating expenditures in prior periods. While his study with only 9 firms does not establish the importance of prior years' expenditures for a large proportion of major American firms, it does suggest that the specification of sales equations needs to start with an examination of the number of prior years having possible influences on the current year's sales. The sales of a firm are not the result solely of actions of the firm's management. Elliott considered the possibility that the effectiveness of sales-generating expenditures varies by industry. For this purpose, Elliott (1972a) used a price index (i.e., industry prices relative to general prices) and a physical output index (i.e., industry output relative to aggregate output) to explain real sales. Real sales are the accountant's net sales divided by the GNP implicit price deflator. Elliott and Uphoff (1972) used market share, instead, to represent the impact of industry membership on the effectiveness of sales-generating expenditures. The hypothesis tested was that market share gains in prior periods can reward a firm by the necessity for smaller sales-generating expenditures in the current period than are necessary for smaller market share firms desiring to increase sales relative to rivals. Scherer (1980) reviewed the extensive use of market share in industrial organization theory models of the economic performance of firms. He concluded that little can be expected from research using only 4-digit industrial codes of the primary industry. What researchers

need are the more detailed line of business data not released to the public by the Federal Trade Commission. Even though the purpose of Elliott and Uphoff (1972) was to explain and to forecast accounting income statement variables, the researchers treated market share as an endogenous variable.

In using time series data, Elliott hoped to link macroeconomic variables directly in models explaining microeconomic behavior. He chose to use money supply and governmental expenditures rather than gross national product as used in the AICPA's example. In this way, Elliott hoped to determine the relative importance of fiscal and of monetary policy on individual firms. The difficulty with this approach is that governmental expenditures in the private sector are strongly concentrated in the defense and aerospace industries while money supply needs to work through other variables. In a cross-sectional study, these macroeconomic variables cannot be used because there is no variability across firms in a given year. Further, it is not possible to adjust the accounting data of COMPUSTAT firms to reflect different fiscal year ends because quarterly data are not available in the same detail as what is being explained by the aggregate model on an annual basis.

Saltzman (1967) studied the quarterly data of a single firm. Many of the determinants do not apply to annual models. Since the firm being studied sold consumer products, the researcher included personal disposable income as a determinant of sales. To his surprise, the estimated coefficient was negative. He removed the determinant from the final version of his equation.

At this stage of the development of the aggregate model, earlier research with a small number of firms suggests the following initial specification for a sales equation:

$$\text{Sales--Net} = f(\underset{+}{\text{Market Share}};\ \underset{+}{\text{Selling, General, and Administrative Expenses}})$$

The + signs above the determinants indicate the expected sign of the coefficients of the determinants. Elliott's terminology would express the second determinant as the stock of selling, general, and administrative expenses. This would indicate that expenditures during the current period plus those of perhaps the last two or three years influence the sales of a firm. Theory does not predict either the duration or the shape of the lagged impact of these expenditures on sales. This must be estimated empirically. The operationalization of industry-level variables varies considerably among researchers. Elliott and Uphoff (1972), in a study of one single product firm, measured market share as the firm's unit sales/the industry's unit sales. A more usual measure, especially for the study of multiproduct firms, would be the firm's dollar sales/the industry's dollar sales. It is not obvious at this stage of the specification of the model whether one or more years of market share values influence the sales of a firm in the current year.

Even though market share is calculated using the dollar sales variable of the accountant's income statement, it has not been traditionally an accounting variable. Different accounting firms may audit the financial statements of different firms in the same industry. If market share is a major determinant in one or more of the equations in the models of the income statement, and if market share needs to be treated as an endogenous variable to explain adequately the economic behavior of a firm, such findings would have important implications for the disclosure of both historical financial statements and of pro forma financial statements.

While selling, general, and administrative expenses will be discussed at length later as an endogenous variable in the aggregate model, one additional consideration is important at this stage. This variable is a loosely-defined collection of other accounting variables. As such, a small part of the expenditures may be considered closer to being cost-reducing expenditures rather than sales-generating expenditures. This imperfection has not caused great concern to researchers because of the overwhelming importance of sales as a determinant of cost of goods sold in earlier research studies. In this study, an attempt will be made to determine the importance of selling, general, and administrative expenditures to the corporate objectives of generating sales and of reducing costs.

The sales equation will have two versions: (1) the no distributed lag version; (2) the distributed lag version. Elliott found in his time series studies that multicollinearity was more severe for some firms than it was for others. This meant that he was able to use distributed lags for some firms and was compelled to use the current values only for other firms. This option is not available in a cross-sectional study. Instead, it is necessary to have the two versions of any equation for which distributed lags have been claimed to be important. All firms in the study will be used to estimate sales equations with and without distributed lags.

Another departure from some of the earlier studies will be use of net sales for the prior period instead of market share. The difficulties of using 4-digit industry classification codes for the primary industry have been noted earlier. While this specification of the sales equation means that industrial membership issues cannot be examined, it does mean that it will be possible to examine the forecasting issue of forecasting levels directly or via changes.

The equations in this study will differ from earlier studies also in the use of balance sheet variables as determinants. While several of the earlier researchers explained line by line abbreviated income statements, they did not explain the exclusion of balance sheet variables as either determinants or as endogenous variables in their models.

In the sales equation, both receivables and inventory are determinants of sales. An accountant calculates sales by multiplying the number of units sold times the unit selling price. Sales may be lost to competitors if a firm is out of stock. However, if a firm's supply is excessive relative to demand, the unit price will fall. This means that it is not possible to predict the sign of the coefficient for inventory in the sales equation. Managers create and replenish inventory levels both to generate sales and to reduce costs. For many firms, unit costs may be reduced by holding production level throughout the year even though demand is not level throughout the year. The poor choice of a production level will affect dollar sales. For multi-product firms, there may be the additional complication of the existence of excessive inventory levels for some products and order backlogs for other products.

The relationship between accounts receivable and sales is complicated, too. Managers select and change the balance sheet levels of receivables for a number of reasons. The primary purpose of creating receivables on the balance sheet is to support credit sales. The sales variable in the aggregate and disaggregate model consists of both cash and credit sales. Accountants do not usually provide a breakdown in income statements of these components. The practice of providing credit sales is an attempt by managements to obtain incremental sales revenues. However, there are costs for maintaining levels of assets on balance sheets. If credit and collection costs necessitate an increase in the unit selling price, the loss of units demanded at the new unit selling

price may offset the incremental revenues. So, while the purpose of maintaining a receivables level is to generate a higher sales level, the sign of the coefficient could be negative.

In both cases, the sign of the coefficient does not establish whether receivables and inventory are determinants of sales. They are determinants of sales. The empirical question is the relative importance of these determinants in explaining and in forecasting sales.

The specification of the aggregate sales equation, then, is:

Net Sales = f(Net Sales(-1), Accounts Receivable(-1), Inventory(-1), Order Backlog(-1), Selling Assets). The (-1) notation indicates a variable with a lag of 1 year. A firm accumulates sales throughout a year. The value of net sales represents the total accumulation of sales at the end of an accounting period. The determinants with (-1) represent the values of variables at the beginning of the same accounting period. The selling assets variable consists only of the selling, general, and administrative expenses in the year of the net sales, in the view of current accounting practice, or also the lagged values of selling, general, and administrative expenses.

3.5.2 DETERMINANTS OF COST OF GOODS SOLD.

For manufacturing firms, cost of goods sold includes all costs allocated by management directly to production (e.g., material, labor, and overhead). For non-manufacturing firms on the COMPUSTAT tapes, cost of goods sold reflects total operating expenses. This means that it is not possible usually to obtain selling, general, and administrative expenses as a separate line item for non-manufacturing firms. This difference in disclosure practices implies that managers of non-manufacturing firms do not regard gross margin as a variable important to the understanding of the economic behavior of their firms by the public. There has been considerable use of gross margin in studies concerning advertising and research and development expenditures. The appearance of both cost of goods sold and of selling, general, and administrative expenses in the aggregate model means that some non-manufacturing firms in the Annual Industrial COMPUSTAT population will be excluded from the study for not disclosing selling, general, and administrative expenses as a separate line item.

Cost of goods sold, even for manufacturing firms, is a highly aggregate accounting variable. Some of the accounting variables included in cost of goods sold are: taxes other than income taxes; employee benefits; maintenance and repairs; direct labor; heat, light, and power; operating expenses; salary expenses; transportation; warehouse expense; supplies; amortization of deferred costs; freight-in; improvements in leased property; insurance and safety; licenses; rent and royalty expense; and special amortizations in certain industries.

The AICPA's sample disclosure of forecast assumptions for cost of goods sold was (p. 51):

> COST OF SALES Materials: materials used by the Company are expected to be readily available, and the Company has generally used producer associations' estimates of prices in the forecast period to forecast material costs. A significant exception is copper, a major raw material, the market of which has been disrupted by political events in certain principal producer countries. The Company expects to be able to assure sufficient supplies, and estimates that the cost of copper will increase by 22% over 19X2. However, due to the uncertainties noted above, industry estimates as to the price of copper in the forecast period range from percentages of 15 to 30% over 19X2 prices. A variation of five percentage points of the actual increase above or below the assumed increase would affect forecasted net earnings by approximately $485,000. Labor: The Company's labor union contract, which covers substantially all manufacturing personnel, was negotiated in 19X2 for a three-year period. Labor costs are forecasted based upon the terms of that contract.

The availability of raw materials is one example in the proposed guidelines reflecting information managerial decision makers use but do not necessarily disclose. Even if an outside researcher were to use producer association estimates on prices, there is no assurance that a given firm could obtain the units of raw materials needed at those prices. Accounting disclosures are measured predominantly in dollars, not in units. The example does tie variability in one income statement variable to a profit measure. This example shows a preference for both point forecasts and a statement of a reasonable range of dispersion around the point forecasts. This simple example does not include a discussion of many of the concerns of industrial organization theorists: changes in product quality; unit cost position of this firm relative to the unit costs in the industry; economies of scale; typical plant

capacities; costs of building a competitive plant for a new market entrant. The objectives of proponents of the public disclosure of forecasts are narrower currently than are the objectives of industrial organization theorists. Forecast advocates seek ways to buttress the public disclosure of forecasts in order to be able to identify forecasts which are out of the ballpark (i.e., potentially misleading). This is not to say that managers of firms would be prohibited from making forecasts different from the consensus forecasts of financial analysts, for example. Rather, it does mean that benchmarks are needed in the disclosure of forecasts. Managers would be disclosing that their forecasts are more optimistic or pessimistic than a user would expect using only historical data. The reasons cited by management for the difference in expectations would be available for the evaluation of users of financial statements. Users would be free to include other variables in their models, to the extent that other data are available or suitable proxy variables can be found, and compare their forecasts with those of established benchmarks. At issue, then, is what constitutes major determinants of accounting income statement variables to be included in benchmark models. Over time, it might be necessary to develop revised versions of benchmark models made possible by more disaggregated accounting disclosures or by advances in economic theory.

The AICPA's sample disclosure of assumptions for forecasts of cost of goods sold suggests the need to be able to analyze the effect of strikes on the prospects for a firm. This is not usually done in research studies. Elliott and Uphoff (1972) inserted a strike dummy variable in the sales equation of the single firm they were studying

because there was a strike at one of the firm's plants. The use of a strike dummy variable, after the fact of a strike, does not provide an explanation of the possibility of strikes as a determinant of the future profitability of a firm. The industrial organization theory literature reviewed was silent on this topic. If some industries are more strike-prone than others, as measured by man-hours lost during work stoppages (if such data are available on an industry-by-industry basis), one would expect the managers in strike-prone industries to make many decisions differently than their counterparts do in strike-free industries. Neither the aggregate nor the disaggregate model will include strike variables of any type.

Saltzman (1967), in a single-firm study, treated cost of goods sold as a simple function of dollar sales. The coefficent of the single determinant was positive and highly significant.

Elliott and Uphoff (1972), in another single-firm study, selected as determinants of cost of goods sold: net sales dollars; materials price index; package price index; labor cost dummy variable. The net sales variable served as a measure of the volume of operations. A dummy variable was used for labor costs because a new contract was being negotiated. Management expected higher labor costs over the remaining period of their study. The major determinant of cost of goods sold was net sales. However, both the package cost index and the labor cost dummy variable were significant, also. The researchers eliminated the material cost index from the final equation because this variable was highly correlated with the package cost index.

In a 9-firm study with COMPUSTAT data, Elliott (1972a) divided operating expense by real sales in an attempt to explain unit costs. The use of the operating expense variable instead of cost of goods sold permits researchers to use more firms from the COMPUSTAT tapes. As noted earlier, the cost of goods sold variable is not available as a separate line item for many non-manufacturing firms. However, as a variable more aggregate than the already highly aggregate cost of goods sold variable, its use does not permit a close study of the importance of gross margin in managerial decision making. The determinants of Elliott's production cost per dollar of real sales variable were: stock of research and development expenditures; stock of plant and equipment assets; a residual general and administrative expense variable.

The absence of an inventory variable from this specification was the result of Elliott's simplifying assumption that unit costs calculated using sales are the same as unit costs based upon total production for the period.

Elliott attempted in this specification to approximate the average cost curve in microeconomic theories of production costs. He predicted a negative coefficient for the residual general and administrative expense determinant because the purpose of expenditures on management is the lowering of costs at a given level of output.

The stock of plant and equipment asset variable represented Elliott's attempt to overcome what he regarded as unnecessary variability in the accountant's net plant variable, especially in the year of retirement of a major asset. His procedure was to start with the value reported by accountants in the oldest year of the study for net plant. For each year thereafter, capital expenditures (data item 30) were added to net plant (data item 8) and depreciation expense was subtracted (presumably data item 8, plant--gross, minus data item 7, plant--net). Elliott did not explain which COMPUSTAT variables were used.

Elliott noted that microeconomic theory predicts that real sales will be a determinant of average costs, except when the average cost curve is horizontal.

Elliott concluded that more work needs to be done to improve the specification of this variable because it was necessary for him to include an index of time in his equation.

In more recent literature, little has been done to improve upon the specification of cost of goods sold equations. There are many possible reasons for this lack of interest. The inclusion of sales as the sole determinant in a cost of goods sold equation will explain most of the variability observed in cost of goods sold. While some research and development expenditures are devoted to process innovations, Scherer (1980) reviewed a number of studies indicating that 80% or more of research and development expenditures go to product innovations. In the absence of accounting disclosures of the components of research and

development expenditures, the overall research and development variable may prove a poor determinant in cost of goods sold equations. Likewise, the loosely-defined residual or miscellaneous account called general and administrative expenses is unlikely to add much to the explanation provided by sales. This does not mean that microeconomic theories of average cost curves are wrong. Rather, the high level of aggregation of accounting variables disclosed in financial statements by multinational, multiproduct firms limits the extent to which economic theories of the firm can be used to buttress the disclosures.

The specification of the aggregate cost of goods sold equation in this study is: Cost of Goods Sold = f(Cost of Goods Sold(-1), Net Sales, Inventory(-1), Plant and Equipment(-1), Selling Assets). This specification is similar to Elliott (1972a). Elliott, an economist, was aware of the existence of balance sheets. There has been a surprising lack of balance sheet variables in the research of the other studies reviewed. Unlike Elliott's model, the models of this study do not involve an adjustment of the plant and equipment variable reported on the balance sheets of COMPUSTAT firms. In this study, balance sheet variables have been treated as predetermined variables. Earlier researchers made no attempt to explain both income statements and balance sheets. If plant and equipment were to become an endogenous variable in a study of this type, it might be necessary to change the specification of the cost of goods sold equation to reflect in some way changes in plant and equipment during the accounting period. In this study, the assumption is being made that only the level of plant and equipment at the beginning of an accounting period affects the unit

costs for the accounting period.

Another departure from the Elliott study is the inclusion of inventory as a determinant rather than the use of the simplifying assumption. Inventory management is vital to many firms. Managers choose to maintain levels of inventory of raw materials to protect the firm from strikes or other disruptions of supplies coming from their suppliers. Managers choose to have work in process inventories partly to protect the firm from increased labor costs. While many COMPUSTAT firms disclose these components of inventory as separate line items on the balance sheet, the aggregate and disaggregate models of this study are used to explain only the effects of disaggregation of a single income statement variable: selling, general, and administrative expense. Future researchers who attempt to explain and to forecast both the balance sheet and the income statement may find it useful to disaggregate the balance sheet variables used as determinants in this study.

All behavioral equations in the models in the study have as a determinant the lagged endogenous variable of the endogenous variable being explained. As noted for the sales equation, forecasting is the major motivation for such an inclusion.

Selling assets, defined by Elliott as the sum of the coefficients of current and of lagged SGA determinants, are shown as a determinant. Actually, Elliott used selling, general, and administrative expense as a determinant of cost of goods sold. He offered no discussion of why distributed lag effects do not apply for selling, general, and administrative expenditures other than for the advertising and research

and development components. Even though selling, general, and administrative expenditures are a collection of many different expenditures, it is possible that there remain other components with distributed lag characteristics.

3.5.3 GROSS MARGIN.

The equation for gross margin, unlike the equations for sales and for cost of goods sold, is an identity:

Gross Margin = Sales - Cost of Goods Sold

It will be necessary to estimate the coefficients of the behavioral equations. In the gross margin equation, the coefficient for sales is +1 and the coefficient for cost of goods sold is -1, a priori. The accounting variable gross margin may appear elsewhere in systems of equations as a determinant for other accounting variables. Identities are included in the counting rules for variables and for equations concerning the identifiability of a set of equations (Dutta, 1975, p. 270; and the section later in this chapter on the identification of the aggregate model).

The objective of this study is to explain and to forecast line by line a partial income statement, including an examination of the possible importance of simultaneous relationships. The two profit variables in this study, gross margin and operating income before depreciation, are both identities. This means that any explanations and forecasts of these variables are indirect. The forecast accuracy of gross margin and of operating income forecasts depends upon the forecast

accuracy of the behavioral equations in the models. Typically, sales and cost of goods sold are large relative to gross margin. Likewise, operating income may be much smaller than selling, general, and administrative expenses. This means that reasonably accurate forecasts of the behavioral equations could be found along with much less accurate forecasts of gross margin and of operating income before depreciation. Earlier researchers who used multiple equation models did not compare their profit forecasts with single equation behavioral models of gross margin and of operating income, if such studies exist.

3.5.4 DETERMINANTS OF SELLING, GENERAL, AND ADMINISTRATIVE EXPENSES.

The guidelines offered by the AICPA for selling, general, and administrative expenses illustrate the diverse nature of this highly aggregate variable (p. 52):

> SELLING, GENERAL AND ADMINISTRATIVE EXPENSES
>
> The principal types of expense within this category are salaries, transportation costs, and sales promotion. Salaries are forecasted on an individual-by-individual basis, using expected salary rates in the forecast period. Pension cost is planned to be funded and is forecasted based upon its direct relationship to payroll cost. Transportation costs comprise principally the use of contract carriers; volume is forecasted based upon the sales and inventory forecasts (including forecasts by sales outlet), and rates are forecasted to rise by 16% over 19X2, based upon trucking industry forecasts. Sales promotion costs are expected to increase in line with the Consumer Price Index (assumed to rise 9%, based on the mean of five widely-used estimates), and, except for a special campaign budgeted at $750,000, are expected to remain at a level similar to 19X2. The level of other expenses is expected to remain the same as in 19X2, adjusted for the assumed inflation rate of 9%.

This accounting variable poses major problems when attempts are made to compare research results because it is treated as a residual figure. If a researcher is particularly interested in research and development, for example, this residual variable becomes everything in the broad category of selling, general, and administrative expenses except research and development. In this study, this variable appears in the aggregate model as a gross figure and again in the disaggregate model net of advertising and research and development expenditures.

Other than advertising and research and development expenditures, there are many other accounting variables remaining in selling, general, and administrative expenses. Bad debt expense is a function of the level of accounts receivable a firm accepts to make sales. Accounts receivable is a balance sheet variable showing the level of unpaid credit sale obligations as of the end of an accounting period. Credit sales, if disclosed separately from cash sales, would be an income statement flow variable showing the total flow of credit sales during a single accounting period. Management may advertise and conduct research to increase sales. However, part of the demand is likely to represent demand for the firm's products only if the firm can offer better credit terms than those of rivals or of financial institutions. If managements decide to accept credit sales, then accounts receivable will increase on the balance sheet. Over the life of the credit agreement, which could include several years, it may be necessary for accountants to make provisions for doubtful accounts. Hence, the sales of the current and of past accounting periods could determine the amount shown in selling,

general, and administrative expenses.

The definition of this variable, used by COMPUSTAT, is that any expense of operation incurred to secure operating income must be included here. This means that selling, general, and administrative expenses will consist of a variety of accounting variables which increase sales, reduce cost of goods sold, or which do both in varying proportions. Some of the other accounting variables included in selling, general, and administrative expenses are: director's fees, engineering expense, freight-out expense, lease expense, parent company charges for administrative services, and strike expense. The complete list used by COMPUSTAT appears in the data definitions section of the industrial COMPUSTAT manual.

A detailed study of all of these components of selling, general, and administrative expenses is not possible using only data available to the public. Saltzman (1967), using a single firm's private data, was able to study separately: selling expense, product engineering expense, manufacturing expense, and administrative expense. In each of these equations, the researcher used as a determinant the endogenous variable with a lag of one accounting period. This practice continues in this study.

Instead of having only research and development expense data, Saltzman was able to use the two major components: product engineering expense and manufacturing engineering expense. Managements make product engineering expenditures to increase sales by way of new products to market. Managements make manufacturing engineering expenditures to improve productivity. Other than product engineering expenses of lag 1,

the determinants of product engineering expenses used were: dollar sales, market share, shift variables for those accounting periods in which there were no expenditures, and operating profit. Only the lagged product engineering expense and dollar sales variables were significant. The researcher had removed the operating profit variable for having an unexpected sign. Other than using manufacturing engineering expenses from the prior accounting period, Saltzman used as determinants of manufacturing engineering expense: dollar sales and operating profit. In the manufacturing engineering expense equation, all three determinants were significant.

The problem a researcher encounters in making a commitment to explain each line of an income statement is that certain accounting variables have been more interesting to single-equation researchers than have others. Elliott and Uphoff (1972), in a study of a single firm, found that the firm had on its chart of accounts two variables representing only 3% of sales: general and administrative expense; industrial relations expense. Their response was to combine these two variables into a single variable called general and administrative plus industrial relations expense. They noticed an upward trend in the data over time. Their response was to include an index of time as a determinant. They used gross margin to measure available funds for these expenditures. Finally, they included the endogenous variable with a lag of one accounting period as a determinant because they observed a high degree of continuity in this account. To their surprise, neither gross margin nor the lagged dependent variable were significant. The variability in the general administrative and industrial relations

expense could be accounted for only by the index of time. This equation showed the poorest fit with the data of any equation in their system of equations. However, overall forecasts with the system of equations were good, possibly because of the relative smallness of this accounting variable in the income statement.

Elliott (1972a), in his 9-firm study, used as determinants of a general and administrative expense (net of marketing and of research and development components) variable: "one- and two-year lagged moving average net profits after taxes"; index of time. Elliott hoped this specification would capture a profit trend. He appealed to Williamson (1963) for a theoretical explanation of discretionary managerial behavior. According to this theory, managers reward themselves by increasing administrative expenditures after the profits of the firm attain a minimum acceptable level. Elliott found that this equation's fit with the data for 9 firms ranged from very high to almost zero.

In sum, there is a weak base for the specification of an equation for selling, general, and administrative expenses. The task becomes more difficult as major components are removed from the variable, as will be the case in the disaggregate model with the removal of advertising and of research and development expenditures. With advertising and research and development expenditures included in the variable, one would expect some evidence of distributed lag effects of this variable on sales. With the removal of advertising and research and development expenditures from selling, general, and administrative expenses, the impact of these expenditures might be limited only to sales in the current period. The smaller the residual value of this

variable, the less likely one can make statements about its significance.

For the selling, general, and administrative expense variable including advertising and research and development expenditures, the amount of expenditure could be a function of the degree to which earlier expenditures on the advertising and research and development expenditures remain assets over time. If there is a difference between the aggregate and disaggregate models in terms of a user's ability to use more or less disaggregated variables in explaining and in forecasting corporate profitability, then there are disclosure policy implications relative to the aggregation versus disaggregation controversy in accounting. The other major category of a potential determinant of the amount spent on selling, general, and administrative items is some measure of profit. Earlier researchers have been unable to show the importance of different profit measures. One view would be that managers make expenditures throughout an accounting period in response to observed sales. Advertising expenditures can be shifted faster than product quality changes or changes in research and development. The accountant's income statement, by the disclosure of a gross margin variable, suggests that managers make decisions on research and development, advertising, and on other selling, general, and administrative expenditures from gross margin. After-tax profits, used by Elliott in a different study, provide a competing determinant if managers make decisions simultaneously on all accounting variables appearing below gross margin on the income statement. Gross margin, operating income before depreciation, and after-tax profits are all

accrual accounting artifacts. They combine both cash and non-cash components in defining profits. Another possible competing hypothesis would be that managers make these decisions using cash flow generated from operations. A final possibility is that any expenditure with investment characteristics (i.e., likely to affect more than one accounting period in the form of an asset) woud not be constrained by either cash flows or by any measure of profit. Consistent with current separation theories in financial economics, managers would make the decision to pursue any good investments and make a separate decision as how to finance the new investment. These competing hypotheses have not been tested in the same study in any research cited in this study.

The specification of the selling, general, and administrative expense equation in this study is: Selling, general, and administrative expense = f(Selling Assets; Receivables(-1); Inventory(-1); Order Backlog(-1); Invested Capital(-1); Gross Margin).

In this view, managers look first to the extent to which expenditures in the prior periods have carryover effects. These carryover effects may not exist or may last for several years. If carryover effects do exist, then it means that new rivals in the market or those who made smaller expenditures on sales-generating activities will now need to spend more to maintain the same sales or gross margin level. The choice of gross margin, rather than sales or cash flow or total funds, implies that short-term decisions during a given accounting period will be made to the extent that sales-generating activities are not achieving objectives as expected from the analysis of the SGA assets. Until the reasons for deviations from historical relationships

can be determined, it is difficult to specify the sign of changes in selling, general, and administrative expenditures. For example, managers may or may not choose to increase sales-generating expenditures during an accounting period in response to lower than expected sales or gross margins depending upon the reasons perceived for the poorer results. The reasons for the poorer results may be variables not appearing in the models used to date. If results are far better than historical experience would suggest, then it is not obvious that managers will increase sales-generating expenditures in the same accounting period. They may lack the inventories or the productive capacity to respond quickly. Response times may vary considerably across industries. The existence of order backlogs could affect managerial decisions with respect to selling, general, and administrative expenses and with respect to investments in new plant facilities. The difficulty with pursuing each possible relationship in a system of equations is that model misspecification can carry through the system. The absence of line-by-line explanations of the accountant's income statement has been particularly acute with respect to specifications of selling, general, and administrative expense equations.

3.5.5 OPERATING INCOME BEFORE DEPRECIATION.

As with the gross margin equation, operating income before depreciation is an identity:

Operating Income = Gross Margin - SGA Expenses

Operating income and gross margin, as profit variables, are residual figures. The difference is that operating income depends upon another profit variable, gross margin.

3.5.6 IDENTIFICATION OF THE AGGREGATE MODEL.

The current form of the aggregate model is a system of 5 equations:

Sales = f(Sales(-1); Receivables(-1); Inventory(-1); Order Backlog(-1); Selling, General, and Administrative Expense)

Cost of Goods Sold = f(Cost of Goods Sold(-1); Sales; Plant and Equipment(-1); Inventory(-1); Selling, General, and Administrative Expense)

Gross Margin = Sales - Cost of Goods Sold

Selling, General, and Administrative Expenses = f(Selling, General, and Administrative Expenses(-1); Receivables(-1); Inventory(-1); Order Backlog(-1); Invested Capital(-1); Gross Margin)

Operating Income = Gross Margin - Selling, General, and Administrative Expenses

As a prelude to the discussion in Chapter 4 of the choice of estimation techniques, it is necessary to consider the identification of the aggregate model. Even if the literature review had revealed complete agreement on the specification of the equations in the aggregate model,

it would be necessary to examine the possibility of estimating the parameters of the model. According to Schmidt (1976, p. 128):

> A parameter of a model is IDENTIFIED (or identifiable) if and only if its value can be deduced from knowledge of the likelihood function of the model. If a parameter is not identified, it is UNDERIDENTIFIED.

While rules representing necessary conditions will be used to evaluate the identifiability of the aggregate model, Schmidt's book of proofs covers the development also of rules representing necessary and sufficient conditions for identifiability. A discussion of these rules necessitates a classification of the variables used in the aggregate model.

In the sales equation, sales appears as an endogenous variable. Endogenous variables are determined within the system of equations. Inventory is an exogenous variable. An exogenous variable is determined completely outside the aggregate model. Selling, general, and administrative expense is an endogenous variable because it appears as a separate equation in the aggregate model. In order to explain sales, we must know selling, general, and administrative expenses. In order to explain selling, general, and administrative expenses, we must know gross margin, which depends upon a knowledge of sales. Hence, there are simultaneous relationships at work in an explanation of the income statement. The sales variable from the prior period is an example of a lagged endogenous variable. For identification purposes, a distinction must be made between endogenous variables and predetermined variables. A lagged endogenous variable is classified as a predetermined variable for identification purposes, assuming there is no serial correlation

associated with the error term in the equation containing the lagged endogenous variable (Pindyck and Rubinfeld, 1981, p. 181).

For the current form of the aggregate model, there are 5 endogenous and 8 predetermined variables:

(a) Endogenous. Sales; Cost of Goods Sold; Gross Margin; Selling, General, and Administrative Expenses; Operating Income.

(b) Predetermined. Sales(-1); Receivables(-1); Inventory(-1); Order Backlog(-1); Cost of Goods Sold(-1); Plant and Equipment(-1); Selling, General, and Administrative Expenses(-1); Invested Capital(-1).

It is necessary to use counting rules to determine if it is possible to explain 5 endogenous variables with these 8 predetermined variables.

Pindyck and Rubinfeld (1981, p. 326) stated that the most useful rule for identification is the order condition. Two of its forms are:

(1) "...the number of predetermined variables excluded from the equation must be greater than or equal to the number of included endogenous variables minus 1." In counting endogenous variables in an equation, it is necessary to count endogenous variables on both sides of the equal sign.

(2) "...the number of all variables excluded from the equation be greater than or equal to the number of endogenous variables in the model system minus 1."

The sales equation includes 2 endogenous variables: sales; selling, general, and administrative expenses. Hence, the number of endogenous variables included in the sales equation minus one is 1. The sales equation includes 4 predetermined variables: sales(-1); receivables(-1); inventory(-1); order backlog(-1). This means that 4 predetermined variables have been excluded from the sales equation: cost of goods sold(-1); plant and equipment(-1); selling, general, and administrative expenses(-1); invested capital(-1). Since 4 is greater than 1, the sales equation is overidentified. The presence of overidentified equations in a model affects the choice of estimation techniques, a topic to be pursued in detail in Chapter 4. Using the second test of identification, there are 6 variables in the sales equation. This means that 7 variables in the current form of the aggregate model have been excluded from the sales equation. The number of endogenous variables in the model system minus one is 4. Since 7 is greater than 4, the sales equation is overidentified.

The literature review showed a variety of suggestions of which variables to include in the sales equation. An additional concern for accountants will be finding support for the exclusion of variables from each behavioral equation in an income statement. The existing body of economic theory at a specific time may be silent on the relationships or lack of relationships between income statement variables and determinants selected by managements.

The cost of goods sold equation includes 3 endogenous variables: cost of goods sold; sales; selling, general, and administrative expenses. Hence, the number of endogenous variables included in the cost of goods sold equation minus one is 2. This equation includes also 3 predetermined variables: inventory(-1); cost of goods sold(-1); plant and equipment(-1). So, 5 predetermined variables have been excluded from the cost of goods sold equation: sales(-1); receivables(-1); order backlog(-1); selling, general, and administrative expenses(-1); invested capital(-1). Since 5 is greater than 2, the cost of goods sold equation is overidentified. Using the second test, the number of endogenous variables in the aggregate model is 5. Hence, the number of endogenous variables minus one is 4. The cost of goods sold equation includes 6 variables. This means that 7 variables in the aggregate model have been excluded from the cost of goods sold equation. Since 7 is greater than 4, the cost of goods sold equation is overidentified.

There is no need to apply identification counting rules to the gross margin identity. By accounting definition, the coefficient for sales must be +1 and the coefficient for cost of goods sold must be -1.

The selling, general, and administrative expenses equation includes 2 endogenous variables: selling, general, and administrative expenses; gross margin. Hence, the number of endogenous variables included in this equation minus one is 1. There are 5 predetermined variables included in this equation: receivables(-1); inventory(-1); order backlog(-1); selling, general, and administrative expenses(-1); invested capital(-1). This means that 3 predetermined variables were excluded

from the selling, general, and administrative expenses equation: sales(-1); cost of goods sold(-1); plant and equipment(-1). Since 3 is greater than 1, the selling, general, and administrative expenses equation is overidentified. Using the second test, the number of endogenous variables in the aggregate model minus one is 4. This equation includes 7 variables. This means that 6 variables were excluded from the equation. Since 6 is greater than 4, the selling, general, and administrative expenses equation is overidentified.

There is no need to apply the identification counting rules to the operating income before depreciation identity. By accounting definition, the coefficient for gross margin is +1 and the coefficient for selling, general, and administrative expenses is -1.

Elliott (1972a) reported that Almon lags, based upon the current and 3 most recent accounting periods, existed for advertising and for research and development expenditures for some of the 9 firms in his time series data study. For the remaining firms, multicollinearity was so severe that only the advertising and research and development expenditures for the current accounting period were used. Since, both of these accounting variables are components of selling, general, and administrative expenses, there is the possibility that selling assets exist based upon the selling, general, and administrative expenses of the current and 3 prior accounting periods. While multicollinearity may prevent the study of such distributed lags, the first concern is whether the distributed lag form of the aggregate model contains identifiable equations.

Selling assets, if they exist or if they can be detected in spite of multicollinearity, might affect all three behavioral equations in the aggregate model. Advertising and research and development stock variables appeared in Elliott's sales equation. The research and development stock variable appeared also in his cost of goods sold equation. The advertising and research and development stock variables appeared also in their respective current expenditure equations.

The distributed lag form of the aggregate model would be (using SGA as an abbreviation for selling, general, and administrative expenses):

Sales= f(Sales(-1); Receivables(-1); Inventory(-1); Order Backlog(-1); SGA; SGA(-1); SGA(-2); SGA(-3))

Cost of Goods Sold= f(Inventory(-1); Sales; Cost of Goods Sold(-1); Plant and Equipment(-1); SGA; SGA(-1); SGA(-2); SGA(-3))

Gross Margin = Sales - Cost of Goods Sold

Selling, General, and Administrative Expenses = f(Receivables(-1); Inventory(-1); Order Backlog(-1); Invested Capital(-1); Gross Margin; SGA(-1); SGA(-2); SGA(-3))

Operating Income before Depreciation = Gross Margin - SGA

The distributed lag form of the aggregate sales equation still contains 2 endogenous variables: sales and SGA. Hence, the number of endogenous variables included in the sales equation minus one is 1. This sales equation includes 7 predetermined variables: sales(-1); receivables(-1); inventory(-1); order backlog(-1); SGA(-1); SGA(-2); SGA(-3). This means that 3 predetermined variables were excluded from

the sales equation: cost of goods sold(-1); plant and equipment(-1); invested capital(-1). Since 3 is greater than 1, the distributed lag form of the aggregate sales equation is overidentified. Using the second test, the number of endogenous variables in this aggregate model system minus one remains unchanged at 4. The new form of the aggregate model contains 15 variables instead of 13. With 9 variables in the new sales equation, 6 variables have been excluded. Since 6 is greater than 4, the new sales equation is overidentified.

The same 3 endogenous variables remain in the cost of goods sold equation: cost of goods sold; sales; SGA. Hence, the number of endogenous variables included in this equation minus one is 2. The number of predetermined variables included in this equation has increased from 3 to 6: inventory(-1); cost of goods sold(-1); plant and equipment(-1); SGA(-1); SGA(-2); SGA(-3). The number of predetermined variables excluded from the cost of goods sold equation decreases from 5 to 4: sales(-1); receivables(-1); order backlog(-1); invested capital(-1). Since 4 is greater than 2, the distributed lag form of the aggregate cost of goods sold equation remains overidentified. Using the second identification counting rule, the number of endogenous variables in the aggregate model minus one is 4. There are now 9 variables in the cost of goods sold equation. That leaves 6 variables excluded from the equation. Since 6 is greater than 4, the distributed lag form of the aggregate model is overidentified.

There are still 2 endogenous variables in the distributed lag form of the aggregate model: SGA; Gross Margin. Hence, the number of endogenous variables included in this equation minus one is 1. The number of predetermined variables included in this equation has increased from 5 to 7: Receivables(-1); Inventory(-1); Order Backlog(-1); Invested Capital(-1); SGA(-1); SGA(-2); SGA(-3). This leaves the same 3 predetermined variables excluded from this equation: sales(-1); cost of goods sold(-1); plant and equipment(-1). Since 3 is greater than 1, the distributed lag form of the aggregate selling, general, and expenses equation is overidentified.

The identifiability of the equations of the aggregate model are unaffected by distributed lag considerations. However, unless managers of firms vary considerably from year to year their patterns of selling, general, and administrative expenditures, it will not be possible to obtain reasonable estimates of the distributed lag patterns.

3.6 A DISAGGREGATE MODEL FOR PRO FORMA INCOME STATEMENTS.

The aggregate model provides an opportunity to investigate the relationships between highly aggregated accounting variables for a large proportion of COMPUSTAT firms. However, the focus of attention of earlier researchers using a small number of firms was on strategic decisions, namely advertising and research and development. These variables are not available for as many firms as the aggregate model variables were. The following comparison of data availability on the annual industrial COMPUSTAT tapes for 1962 and for 1980 shows the problem of loss of firms for selected accounting variables:

Item	Accounting Variable	1962	1980
12	Net Sales	1332	2433
13	Operating Income	1267	2237
41	Cost of Goods Sold	1091	2084
45	Advertising Expense	0	1791
46	Research and Development Expense	134	1232

This table shows that there has been a considerable increase in detailed disclosures in income statements during the period covered by recent COMPUSTAT tapes. American managers did not discover research and development and advertising within the last few years. Instead, they chose, and accountants permitted, the non-disclosure of these accounting variables as separate line items. In terms of the aggregate and disaggregate models, the number of firms available will be smaller than indicated in the data availability table above because a much smaller number of managements disclosed all of these accounting variables. The

lack of data posed even greater problems for earlier researchers who wanted to use time series data. No COMPUSTAT firms disclosed advertising as a separate line item in 1962.

The purpose of the disaggregate model is to build upon earlier research which emphasized explanations and forecasts using advertising and research and development expenditures. While the number of firms used to estimate the disaggregate model will be smaller than the number used to estimate the aggregate model, it is possible to reestimate the aggregate model using only the firms with data available for the disaggregate model. This will provide evidence of the sensitivity of the empirical results to the number of firms used in estimating the models. The comparison of aggregate with disaggregate results may show the importance of the additional disclosures firms have been making. Finally, the comparison of the aggregate and disaggregate models will reveal the specific nature of multicollinearity problems.

The disaggregate model was prepared by adjusting the aggregate model's chart of accounts for the income statement. Selling, General, and Administrative Expenses were replaced by: Advertising Expense; Research and Development Expense; Selling, General, and Administrative Expenses (Net). This change necessitated a complete review of the specifications of each equation in the aggregate model plus specifications for the new variables in the chart of accounts.

3.6.1 DETERMINANTS OF NET SALES.

In the aggregate model, it was possible to investigate the importance of selling, general, and administrative expenses, past and present, as determinants of net sales. The disclosure of advertising expense and of research and development expense as separate line items means that it is now possible to evaluate the relative importance of these variables as determinants of net sales, subject to multicollinearity constraints.

The specification of the current form of the disaggregate sales equation is: Sales = f(Sales(-1); Receivables(-1); Inventory(-1); Order Backlog(-1); Advertising Expense; Research and Development Expense; Selling, General, and Administrative Expenses (Net)). The only change in the specification of this disaggregate sales equation from the specification of the current form of the aggregate sales equation is a disaggregation of selling, general, and administrative expenses into three major components: advertising expense; research and development expense; selling, general, and administrative expenses (net). The purposes of this decomposition are to determine if there are enough differences between patterns of strategic expenditures to warrant separate disclosure of each component and to aid in forecasting. This specification differs from Elliott (1972a) by the inclusion of selling, general, and administrative expenses (net) in the sales equation. Elliott excluded selling, general, and administrative expenses (net) from the sales equation and included it in the cost of goods sold equation. This treatment was consistent with his view that advertising and research and development represent sales-generating expenditures and

that general and administrative expenses may be considered cost-reducing expenditures. His specification may be correct for some components, such as engineering expense. However, bad debt expenses and freight-out expenses do not have the purpose of reducing production costs at a given level of output. Both the aggregate and the disaggregate models are based upon highly aggregate accounting variables. As a result, the same accounting variable may appear as a determinant for different reasons in different equations. Elliott's approach was not consistent. He included the stock of research and development in both the sales and the cost of goods sold equations. His rationale was that managers fund research to create new products and to develop new production processes. In his treatment of general and administrative expenditures, however, he excluded them from the sales equation even though he acknowledged that cost reduction is only one of the important functions of management.

Elliott (1972a), using time series data, encountered considerable multicollinearity problems using both advertising and research and development as determinants in the same equations and in using current with lagged variables. His response was to select the best fitting combinations for each firm. He excluded advertising or research and development and excluded current or lagged values as necessary. This is not possible using cross-sectional data. In this study, the comparison will be between the current versus distributed lag forms of the aggregate and disaggregate models.

The distributed lag form of the disaggregate sales equation is (using AD, RD, and SN as abbreviations for advertising expense, research and development expense, and for selling, general and administrative expenses (net), respectively):

Sales = f(Sales(-1); Receivables(-1); Inventory(-1); Order Backlog(-1); AD; AD(-1); AD(-2); AD(-3); RD; RD(-1); RD(-2); RD(-3); SN; SN(-1); SN(-2); SN(-3))

The only difference between this distributed lag form and the current form is the addition to the equation of lagged advertising, research and development, and selling, general, and administrative expenses (net) determinants. Such a specification of a sales equation is consistent with studies in industrial organization theory showing long lives for strategic expenditures. The Financial Accounting Standards Board (FASB) issued in October 1974 its Statement of Financial Accounting Standards No. 2 (Accounting for Research and Development Costs). The FASB's literature review was limited mainly to Newman (1968) and to Johnson (1967). These studies could not find correlations between lagged values of research and development and sales or earnings. These studies serve as the basis for the current accounting position that all research and development expenditures must be expensed in the year of the expenditure. The use of two forms of the disaggregate model in this study provides a way of evaluating the different accounting treatments of strategic expenditures. Elliott's studies, and the studies of others, have shown that strategic assets can be found for some firms. The use of two forms of the disaggregate model provides an empirical

basis for evaluating the effect of recognizing distributed lags on forecast accuracy.

The specification of the distributed lag form of the disaggregate sales equation is consistent with Elliott's use of the current period plus the 3 prior periods for strategic expenditures. If such lags are considerably longer, as suggested in industrial organization studies, then Elliott's use of only 4 years may not have been enough to find major variation in strategies over time. The specification in this study includes 4 years of selling, general, and administrative expenses (net); Elliott excluded the current and lagged values of this determinant from his sales equation.

3.6.2 DETERMINANTS OF COST OF GOODS SOLD.

The primary purpose of research and development expenditures is product innovation, not process innovation. Saltzman (1967), using the private data of a single firm, showed what can be accomplished in terms of model specification with data more disaggregated than is being used in this disaggregate model. For example, with both product engineering and manufacturing engineering expenditures available, Saltzman was able to differentiate their uses as determinants and to compare their elasticities with respect to sales.

The specification of the current form of the disaggregate cost of goods sold model is:

Cost of Goods Sold = f(Inventory(-1); Sales; Cost of Goods Sold(-1);
Plant and Equipment(-1); RD; SN)

A major difference between this specification and that of Elliott (1972a) is Elliott's use also of three years of lagged values of research and development expenditures. He used the current year's value of SN, as is done here. Another difference is the use in this study of the original Plant and Equipment values rather than a smoothed value.

The distributed lag form of the disaggregate cost of goods sold equation is:

Cost of Goods Sold = f(Inventory(-1); Sales; Cost of Goods Sold(-1);
Plant and Equipment(-1); RD; RD(-1); RD(-2); RD(-3); SN; SN(-1);
SN(-2); SN(-3))

If Elliott's theory is correct, the coefficients for the lagged SN variables in this disaggregate model should be insignificant.

3.6.3 GROSS MARGIN.

This accounting identity remains unchanged:

Gross Margin = Sales - Cost of Goods Sold

3.6.4 DETERMINANTS OF ADVERTISING EXPENSE.

The current practice of accountants is to expense all expenditures for advertising and for research and development in the year incurred. This represents a change from the earlier practice of permitting managers who wished to do so to record a portion of the expenditures as an asset. While the current accounting disclosure rules have the advantages of all firms using the same procedure and of avoiding the development of methods for capitalizing and for amortizing these items, industrial organization theorists have criticized accountants for this practice. Brozen (1974) cited studies showing that for many firms advertising expenditures have a life of 10 years. If this is correct, the current conservative accounting practice could lead to highly biased financial statements. Scherer (1980, p. 273) reported that industrial organization theorists despair at the sight of accounting data. These researchers claim that no meaningful research can be done using accounting data unless one can devise methods to detect and to correct systematic biases. Typical examples cited in industrial organization theory writings are the accountant's treatment of advertising and of research and development expenditures.

The difficulty with attempting to buttress the income statement with economic theory is that economists are not usually attempting to explain the current expenditures on advertising. As a result, the specifications of the advertising expense and of the research and development expense equations may be considerably more complex than those for other income statement equations. The COMPUSTAT data base may not be rich enough in detail to provide answers to all of the questions

industrial organization theorists pose. In fact, industrial organization theorists are likely to claim that no answers can be forthcoming.

By starting with the earlier researchers, it is possible to trace the development of specifications of advertising equations. Mueller (1967) used 1957 to 1960 data for 67 firms to make 4 separate cross-sectional estimates of advertising expense equations. His determinants were: gross capital investment; cash dividend payments; ten-year change in sales; ratio of industry advertising to industry sales; sales. Mueller did not attempt to explain the income statement line by line. Instead, he attempted to show only that these managerial decisions are interrelated: research and development; gross capital investment; advertising; cash dividend payments. He deflated these variables by sales to avoid the problem of heteroskedasticity in cross-sectional estimates.

Elliott (1972a) based the specification of his advertising equation on a model of optimal advertising (Dorfman and Steiner, 1954). He used as determinants: advertising assets; discretionary cash flow; the ratio of marginal costs to price.

The specification of the current form of the disaggregate advertising equation in this study is:

Advertising Expense = f(Order Backlog(-1); Invested Capital(-1); Gross Margin; Advertising Expense(-1))

This specification replaces Elliott's marginal rate of per unit profits with gross margin. Managers must decide what portions of gross margin will go to advertising, research and development, selling, general, and

administrative expenses (net), and to operating income before depreciation. In a cross-sectional study, it is possible to examine the competing uses of gross margin for a large number of firms.

Another modification of Elliott's specification is the use of invested capital instead of discretionary cash flow. The aggregate and disaggregate models represent an attempt to explain and to forecast operating strategies. An attempt has been made to separate operating and financing decisions, following the example of current models in financial economics. In future research, balance sheet variables will need to be made endogenous and financing decisions will need to be incorporated into the models. By using gross margin and invested capital in this study, an attempt to treat strategic expenditures as investments is being introduced into the model. If strategic expenditures are assets, then they must be part of the total financing decisions of managers along with receivables, inventory, plant and equipment, and all other assets. The aggregate and disaggregate models, lacking balance sheet variables as endogenous variables, cannot explain how financing decisions are made. The use of both gross margin and of invested capital as determinants in the equations of the components of selling, general, and administrative expenses is necessary to explain that managers can decide to make strategic expenditures in excess of gross margin or of cash flow from operations. This is the case for new enterprises and for major new product introductions. Elliott's view of the firm was that each firm possesses a finite amount of cash. Managers must decide among competing uses for the finite cash of the firm. The current literature of financial economics, using restrictive

assumptions, views the firm differently. The view of financial economics is that ample funds can be found to finance good investments. These conflicting views of the firm cannot be tested without the introduction of the major categories of balance sheet variables.

As order backlogs grow, managers can be expected to lower expenditures on advertising in favor of other expenditures to increase supplies of heavily demanded product lines. For multi-product firms, it would be possible to have excessive inventory levels of some products and large order backlogs for other products.

The distributed lag form of the disaggregate advertising expense equation is:

Advertising Expense = f(Order Backlog(-1); Invested Capital(-1); Gross Margin; AD(-1); AD(-2); AD(-3))

The distributed lag form of this equation includes two additional lagged values of advertising expenditures.

3.6.5 DETERMINANTS OF RESEARCH AND DEVELOPMENT EXPENSE.

Hamberg (1966) specified as determinants of research and development: (1) sales; (2) profits; (3) liquidity variables (depreciation); (4) Federal Government research and development contracts; (5) gross investment in plant and equipment; (6) past scale of research and development. The research and development expense variable available on the COMPUSTAT tapes excludes, when corporate disclosures permit, customer or government-sponsored research and development and product engineering expenses. This reduces, but does

not eliminate, the importance of Federal Government research and development contracts as a determinant. If two firms make identical expenditures on research and development in a given year, the effectiveness of those expenditures could differ if one firm had been doing less research in the past or if only one of the firm had worked with research contracts funded by others. The use of one or more years of past expenditures on research and development may reduce the problems of explaining and of forecasting company funded research activities. Invested capital and gross margin replace sales and profits in the disaggregate model of this study. Hamberg's use of plant and equipment as a determinant of research and development poses a problem in terms of the disaggregate system of equations. Each of the strategic expenditures are being studied for differences in responses to gross margin and to invested capital. Invested capital and plant and equipment appear on opposite sides of the balance sheet. For most firms, a large percentage of invested capital will be invested in plant and equipment. The inclusion of both plant and equipment and invested capital in the same equation is likely to produce coefficients with opposite signs because of multicollinearity. Elliott (1972a) did not explain why he excluded plant and equipment from his research and development expense equation, even though plant and equipment was a variable in his system of equations.

Mueller (1967) specified as the determinants of research and development: (1) gross capital investment; (2) advertising; (3) cash dividend payments; (4) ratio of industry research and development to industry sales; (5) ten-year change in sales; (6) profits of the previous period; (7) depreciation plus depletion of the previous period; (8) sales. His approach represents the finite capital view of the firm. In this view, managers must decide simultaneously how to expend a finite amount of dollars on a variety of activities, including dividend payments. This approach is not being used in this study. A major assumption of this study is that it is possible to separate operating and financing decisions.

Elliott (1972a) used one- and two-year lagged moving averages of net profits after taxes and of discretionary cash flows as determinants of research and development expenditures in addition to the research and development expenditures for the three previous years.

The current form of the disaggregate research and development expense equation is:

Research and development expense = f(Invested Capital(-1); Gross Margin; RD(-1))

The distributed lag form of the disaggregate research and development expense equation is:

Research and development expense = f(Invested Capital(-1); Gross Margin; RD(-1); RD(-2); RD(-3))

The only difference between the two forms of the equations is the number of years of prior research and development expenditures regarded as

determinants.

3.6.6 DETERMINANTS OF SELLING, GENERAL, AND ADMINISTRATIVE EXPENSES (NET).

Saltzman (1967) specified as determinants of administrative expenses: the prior period's administrative expenses; sales. The coefficient on sales was not significant.

Elliott (1972a) used as determinants of general, administrative, and other expenses: one- and two-year lagged moving average of net profits after taxes; index of time.

The current form of the disaggregate selling, general, and administrative expenses (net) equation is (using SN to denote selling, general, and administrative expenses (net)):

Selling, General, and Administrative Expenses (Net) = f(Receivables(-1); Inventory(-1); Invested Capital(-1); Gross Margin; SN(-1))

The disaggregate form of this equation is:

Selling, General, and Administrative Expenses (Net) = f(Receivables(-1); Inventory(-1); Invested Capital(-1); Gross Margin; SN(-1); SN(-2); SN(-3))

The use of receivables as a determinant is based upon the inclusion of bad debt expense as a component of selling, general, and administrative expenses (net). Further, some managerial attention must be devoted to the credit and collection process. The receivables variable used in this study is net of the allowance for doubtful accounts. The COMPUSTAT tapes contain a related variable, receivables

(estimated doubtful), available for a smaller number of firms. Between 1962 and 1980, data availability of the receivables variable increased from 1129 to 2055. During the same period, the availability of receivables (estimated doubtful) increased from 0 to 1620. It may not be possible to detect any statistical significance for receivables as a determinant of selling, general, and administrative expenses (net) because there are many components other than bad debt expense in this variable. Comparison of the coefficients with those of the aggregate model may provide some evidence of the effect of more disaggregate, but incomplete, disclosures.

The use of inventory as a determinant is similar to the use of receivables. Kieso and Weygandt (1980, pp. 339, 382) provided examples of the difficulties accountants have in dealing with selling, general, and administrative expenses. Accountants regard these expenses as period expenses. By period expenses, they mean that there is no direct relationship between the expenditures and the production or acquisition of goods. Kieso and Weygandt argue that such costs might be more closely related to cost of goods sold than to unsold inventory. The inclusion of both gross margin and of receivables in this equation represents an attempt to detect the weak relationships. Selling, general, and administrative expenses (net) might include related inventory management expenditures and losses due to market declines of inventory. As was the case with receivables, there are many other expenditures grouped among period expenses.

3.6.7 OPERATING INCOME BEFORE DEPRECIATION.

This identity changes with the disaggregation of selling, general, and administrative expenses:

Operating Income = Gross Margin - Advertising Expense - Research and Development Expense - Selling, General, and Administrative Expenses (Net)

3.6.8 IDENTIFICATION OF THE DISAGGREGATE MODEL.

The application of identification counting rules to the disaggregate model shows that the equations of both the aggregate and of the disaggregate models are overidentified. The disaggregate model includes 7 endogenous variables versus 5 endogenous variables in the aggregate model. While this change appears to be small, it means that the model builder must find support for including or excluding a much larger number of variables from each behavioral equation in the system.

The current form of the disaggregate sales equation contains 4 endogenous variables: sales; advertising expense; research and development expense; selling, general, and administrative expenses (net). Hence, the number of endogenous variables included in this equation minus one is 3. This equation includes 4 predetermined variables: sales(-1); receivables(-1); inventory(-1); order backlog(-1). This means that 6 predetermined variables were excluded: cost of goods sold(-1); plant and equipment(-1); invested capital(-1); advertising expense(-1); research and development expense(-1); selling, general, and administrative expenses (net)(-1). Since 6 is greater than

3, this equation is overidentified. Using the second test, the number of endogenous variables in the disaggregate model minus one is 6. There are 17 variables in the disaggregate model. With 8 variables in this equation, 9 variables have been excluded. Since 9 is greater than 6, this equation is overidentified.

The current form of the disaggregate cost of goods sold equation includes 4 endogenous variables: cost of goods sold; sales; research and development expense; selling, general, and administrative expenses. Hence, the number of endogenous variables included minus one is 3. There are 3 predetermined variables included in this equation: inventory(-1); cost of goods sold(-1); plant and equipment(-1). This means that 7 predetermined variables have been excluded from the equation: sales(-1); receivables(-1); order backlog(-1); invested capital(-1); advertising expense(-1); research and development expense(-1); selling, general, and administrative expenses(-1). Since 7 is greater than 3, this equation is overidentified. Using the second test, the number of endogenous variables in the disaggregate model minus one is 6. This equation includes 7 variables and excludes 10 variables. Since 10 is greater than 6, this equation is overidentified.

The gross margin equation is an identity. This means that the sales variable has a coefficient of +1 and the cost of goods sold variable has a coefficient of -1.

The current form of the disaggregate advertising expense equation includes 2 endogenous variables: advertising expense and gross margin. Hence, the number of endogenous variables included minus one is 1. There are 3 predetermined variables included in this equation: order backlog(-1); invested capital(-1); advertising expense(-1). This leaves 7 predetermined variables excluded from the equation: sales(-1); receivables(-1); inventory(-1); cost of goods sold(-1); plant and equipment(-1); research and development expense(-1); selling, general, and administrative expenses (net)(-1). Since 7 is greater than 1, this equation is overidentified. Using the second test, the number of endogenous variables in the disaggregate model minus one is 6. With 5 variables included in this equation, 12 variables have been excluded. Since 12 is greater than 6, this equation is overidentified.

The current form of the disaggregate research and development expense equation contains 2 endogenous variables: research and development expense; gross margin. Hence, the number of endogenous variables included in this equation minus one is 1. There are 2 predetermined variables included in this equation: invested capital(-1); research and development expense(-1). This leaves 8 predetermined variables excluded from the equation: sales(-1); receivables(-1); inventory(-1); order backlog(-1); cost of goods sold(-1); plant and equipment(-1); advertising expense(-1); selling, general, and administrative expenses (net)(-1). Since 8 is greater than 1, this equation is overidentified. Using the second test, the number of endogenous variables in the disaggregate model minus one is 6. With 4

variables included in this equation, 13 variables have been excluded. Since 13 is greater than 6, this equation is overidentified.

The current form of the disaggregate selling, general, and administrative expenses (net) equation contains 2 endogenous variables: selling, general, and administrative expenses; gross margin. Hence, the number of endogenous variables included minus one is 1. There are 4 predetermined variables included in this equation: receivables(-1); inventory(-1); invested capital(-1); selling, general, and administrative expenses (net)(-1). This leaves 6 predetermined variables excluded from the equation: sales(-1); order backlog(-1); cost of goods sold(-1); plant and equipment(-1); advertising expense(- 1); research and development expense(-1). Since 6 is greater than 1, this equation is overidentified. Using the second test, the number of endogenous variables in the disaggregate model minus one is 6. With 6 variables included in this equation, 11 variables have been excluded. Since 11 is greater than 6, this equation is overidentified.

The operating income before depreciation equation is an identity. Gross margin has a coefficient of +1. Advertising expense, research and development expense, and selling, general, and administrative expenses (net) each have coefficients of -1 by accounting definition.

The distributed lag form of the disaggregate model includes the same 7 endogenous variables and 10 predetermined variables. The difference is the inclusion of 6 additional predetermined variables: AD(-2); AD(-3); RD(-2); RD(-3); SN(-2); SN(-3). The total number of variables in the disaggregate model increases from 17 to 23. The change in form affects only the behavioral equations.

The distributed lag form of the disaggregate sales equation contains 17 variables with the inclusion of the 9 lagged advertising, research and development, and selling, general, and administrative expenses (net) variables. With 23 variables in this form of the disaggregate model, 6 variables have been excluded from this equation. The number of endogenous variables in the disaggregate model minus one is 6. Since 6 equals 6, this equation is now exactly identified.

The distributed lag form of the disaggregate cost of goods sold equation includes 13 variables with the addition of the 6 lagged research and development expense and selling, general, and administrative expense (net) variables. With 23 variables included in this form of the disaggregate model, 10 variables have been excluded from this equation. The number of endogenous variables in the disaggregate model minus one remains unchanged at 6. Since 10 is greater than 6, this equation remains overidentified.

The number of variables included in the distributed lag form of the disaggregate advertising expense equation is 7 with the addition of 2 more lagged advertising expense variables. With 23 variables in this form of the disaggregate model, 16 variables have been excluded from this equation. The number of endogenous variables in the disaggregate model minus one remains unchanged at 6. Since 16 is greater than 6, this equation remains overidentified.

The distributed lag form of the disaggregate research and development expense equation includes 6 variables with the addition of 2 more lagged research and development expense variables. With 23 variables in this form of the disaggregate model, 17 variables have been excluded from this equation. The number of endogenous variables in this form of the disaggregate model minus one remains unchanged at 6. Since 17 is greater than 6, this equation remains overidentified.

The distributed lag form of the disaggregate selling, general, and administrative expenses (net) equation includes 8 variables with the addition of 2 more lagged selling, general, and administrative expenses (net) variables. With 23 variables in this form of the disaggregate model, 15 variables have been excluded from this equation. The number of endogenous variables minus one in this form of the disaggregate model remains unchanged at 6. Since 15 is greater than 6, this equation is overidentified.

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CHAPTER 4

ESTIMATION AND TEST METHODS; DATA SOURCES

PREVIEW OF CHAPTER 4.

Estimates and forecasts of the 6 models of this study are based upon these estimators: (1) ordinary least squares (OLS); (2) two stage least squares (2SLS); (3) OLS unrestricted reduced form; (4) 2SLS derived reduced form. The use of more than one estimator provides empirical evidence as to the direction and importance of simultaneous relationships. Reduced form estimators, in earlier studies, have provided better forecasts of income statement variables in many cases than have structural forms of models.

All data in this study came from the annual industrial COMPUSTAT tapes. The base year for estimation of models was 1978. Distributed lag versions of the models used also data from 1975, 1976, and 1977. The 6 models were used to generate forecasts of income statements for 1979.

4.1 CLASSIFICATION OF THE AGGREGATE AND DISAGGREGATE MODELS.

A closer examination of the structures of the aggregate and disaggregate models of Chapter 3 will reveal considerations in the selection of an estimation technique.

Equation 1 of the aggregate model shows that the sales of a firm are a function of several variables, one of which is selling, general and administrative expense. Equation 4 of the aggregate model shows gross margin as one of the determinants of selling, general and administrative expenses. If managers increase selling, general, and administrative expenditures, they can expect some increase in sales. An increase in profitable sales, however, means also the need to increase selling, general, and administrative expenditures. There is a simultaneous nature to managerial decisionmaking assumed in most of the studies reviewed in chapter 2. The use of ordinary least squares as an estimation technique for simultaneous-equation systems will usually yield biased and inconsistent parameter estimates. If the simultaneous nature of managerial decisions is significant, then those research studies using single equation models to explain sales or any other accounting variable have produced misleading conclusions relating to the relative importance of determinants.

The disaggregate model involves the same considerations. Forms of both models include lagged endogenous variables and distributed lag structures.

4.2 ESTIMATION METHODS.

Elliott (1973, 89-92) explained the popularity of two stage least squares as the estimation method used by researchers whose works were reviewed in Chapter 2. Ordinary least squares estimators are both biased and inconsistent when the OLS method is used to estimate the coefficients in simultaneous equation systems. These estimation methods are biased but consistent: (1) two stage least squares; (2) full information, maximum likelihood (FIML); (3) limited-information, maximum likelihood (LIML). As the sample size used in a study increases, the implication is that OLS should not be used to estimate simultaneous equation systems because other methods will produce better estimates by virtue of the property of consistency.

Much important research using simultaneous equation systems, according to Elliott, has involved relatively small samples. Knowledge of the small sample properties of estimators has come from simulation studies using known true parameter values, such as Summers (1965). Using a sample size of 20, Summers found that FIML and LIML produced less biased estimates of structural coefficients than 2SLS and OLS, if there are no specification errors present in the model. However, if a model contains both specification errors and significant multicollinearity between some of the variables, then 2SLS and OLS are better estimators than LIML and FIML. The earlier research into the problem of disclosing pro forma financial statements involved very small sample sizes. There was considerable disagreement between researchers as to model specification. Two stage least squares was the popular choice for the estimation method in these circumstances.

This study involves a large increase in sample size. The risk of specification error remains a major concern, as it was for earlier studies. Two stage least squares, then, would appear to be the appropriate choice of the estimation method for the aggregate and disaggregate models, unless recent research in econometrics disputes the findings of Summers (1965).

Maddala (1977, 231-233) advocated the reporting of the estimates of the structural equations from more than one estimation method. He would include OLS estimates, though inconsistent, in order to be able to make statements about the direction of the asymptotic bias of the OLS estimators. Further, he argued that the OLS method might be more robust with respect to specification errors and might produce better predictions than many simultaneous equation estimation methods.

Intriligator (1978, 416-420) claimed 2SLS is the most widely used estimation technique for simultaneous equations systems. OLS might be appropriate if the model is nearly recursive. He supported 2SLS by referencing the three major approaches for studying the small sample properties of estimators:

(1) Monte Carlo studies (Cragg, 1967; Smith, 1973)

(2) studies determining the exact finite sample distribution of estimators (Basmann, 1961, 1963, 1974).

(3) studies of approximations of estimators for finite samples (Nagar, 1959, 1962; Kadane, 1971; Sargan and Mikhail, 1971; Anderson and Sawa, 1973).

Judge et. al. (1980) discussed estimation considerations when distributed lags are used in a model, as is the case for one form of the models used in this study. In practice, they claim that, for most economic time series, coefficients will stop being significant after 3 or 4 lagged variables. They suggest that researchers attempt to gain efficiency by testing whether the OLS estimator is inconsistent using the test statistic proposed by Liviatan (1963). If OLS is not found to be inconsistent, then OLS could be used instead of 2SLS.

Pindyck and Rubinfeld (1981, 338 and 377) stressed the importance of the choice of an estimator on the dynamic properties of the estimated model. They cited Fair (1973) for his comparison of OLS, 2SLS, and of FIML under these circumstances: (a) no autoregressive correction; (b) first-order autoregressive correction; (c) second-order autoregressive correction.

The more recent literature in econometrics, then, continues to support the use of 2SLS for simultaneous-equations model estimation, as was used by Elliott and other researchers. Any departures from 2SLS would need to be supported by evidence that OLS estimators did not seem to be inconsistent, that autoregressive corrections were necessary for dynamic simulations, or that multicollinearity posed major problems.

4.3 TEST METHODS.

The controversy over the public disclosure of forecasts has been based upon two general tests: (1) forecast accuracy; (2) support for the forecasting procedure in terms of fundamental economic assumptions.

The aggregate and disaggregate models of this study are being tested:

(a) goodness-of-fit of the models with cross-sectional data for a single year;

(b) prediction-beyond-the data tests.

4.3.1 GOODNESS-OF-FIT TESTS.

In a time series study of 9 firms, Elliott (1972a) used COMPUSTAT data for the years 1948 to 1968. His use of an overidentified simultaneous model meant that he would encounter degrees of freedom problems. The first-stage instruments were found by use of the Structurally Ordered Instrumental Variables approach of Fisher (1965). Elliott tested for and found serious multicollinearity. His treatment of multicollinearity was to drop one of the variables from the equation. Elliott deleted variables also if their signs were found to be inconsistent with theory. He tested also for autocorrelation. If he found autocorrelation problems to be severe, he corrected the equation by including an index of time. Finally, all firms were involved in mergers or acquisitions. Elliott's approach was to introduce dummy variables in equations. For two of the firms, the dummy variables remained in the equations because they were found to be significant.

Elliott's use of only 9 firms in a feasibility study avoided some of the problems of trying to extend his research to all firms on the COMPUSTAT tapes. There was no reference to firms changing fiscal years or making accounting changes. In order to use his model, each firm must have disclosed each variable every year for 20 years. Only a small minority of firms have disclosed research and development or advertising expenditures as separate line items for long periods of time.

Elliott's use of a time series approach for building models of firms resulted in different models, not the same model, being tested. Fisher's Structurally Ordered Instrumental Variables approach is used to reduce multicollinearity and to overcome degrees of freedom problems of overidentified systems by choosing first-stage instruments from exogenous variables before turning to lagged endogenous or lagged exogenous variables. This procedure left Elliott with different first-stage instruments for each firm. The model for each firm differed also in terms of the presence or absence of certain variables: (a) the possible dropping of a determinant because of multicollinearity or because of incorrect sign; (b) an index of time; (c) a dummy variable for mergers and acquisitions. Goodness of fit, then, does not refer in the Elliott study to the same model being fit to the data for 9 firms. While the same determinant might have been significant for more than one firm, Elliott noted that the values of the measured coefficients varied considerably. This did not concern Elliott because he argued that firms with widely varying levels of the same variable should mean the measured coefficients would vary widely, too.

Elliott used R-squared as an indicator of goodness of fit in 3 ways:

(1) the fit of the first-stage equations (i.e., by regressing each endogenous variable on the first-stage instruments);

(2) the fit of the structural equations;

(3) the fit of the values of the endogenous variables in simulations using only exogenous variables from the second-stage structure.

Elliott cautioned that the use of R-squared and of the Durbin-Watson statistic is not appropriate for the last two cases (Basmann, 1962; Durbin, 1957). For several variables, there was little difference in R-squared values. Elliott claimed this was evidence of an absence of serious specification errors for those equations.

The COMPUSTAT tapes contain 20 years of data for nearly 2500 industrial firms. While all firms do not disclose the same variables, there are usually 200 or more firms reporting the variables of interest to Elliott in some years. Elliott (1973, 279-282) reviewed a related study by Mueller (1967) using cross-sectional data for 67 firms. On page 311, Elliott (1973) cited Eisner (1967) as evidence that profits can be an important explanatory variable in investment models using time-series data but less important with cross-sectional data. Elliott provided no guidelines for deciding when to consider cross-sectional or panel data approaches to building models of firms.

Intriligator (1978, 63) has argued that one should expect to see different estimates of a model depending upon the use of time-series or of cross-sectional data. The choice between the two depends upon one's interest in studying long-run elasticities (hence, the choice of cross-sectional data) or in short-run forecasting (for which time-series data would be chosen). If pooled data are available, it is possible to estimate certain parameters using cross-sectional data and to estimate others using time-series data. A special case of pooled data is the use of panel (or longitudinal) data, in which the same firms would be used in the study each year. Panel data studies are particularly useful when microdata are available because certain aggregation problems are avoided (Meyer and Kuh, 1957; Kuznets, 1966; Orcutt et al., 1961; Orcutt, 1962).

Cassidy (1981, 80) developed further the importance of the decision to use cross-sectional, time-series, or panel data. He provided an example of how, given an annual time-series model, it might be necessary to change the structure of the model, definitions of some of the variables, and even to change some variables in order to make the model a cross-sectional model. One major difference between cross-sectional and time-series models, cited by Cassidy, was the use of lagged dependent variables. The use of lagged dependent variables in estimating dynamic relationships does not add to behavioral explanations. Instead, lagged dependent variables serve as scale factors in many models (i.e., they are useful only for predicting the relative size of the dependent variable). Cassidy would include dynamics into a pooled-data model to the extent that the average

variation in dependent and independent variables for the same firm over time was greater than the average variation of the variables for all firms in a given year.

Dutta (1975, 108) expressed concern for the choice between time-series analysis and cross-sectional analysis in terms of violations of assumptions about disturbance terms. In time-series analysis, one assumes that each time period's disturbance term is statistically independent of the disturbance terms for other time periods. In cross-sectional analysis, one assumes that the disturbance term for one firm is statistically independent of the disturbance terms for all other firms. If serial correlation is present, OLS estimators become less efficient. Elliott (1972a, 1515) attributed his high R-squared values in large part to common serial trends in the dependent variable and in some of the explanatory variables in some of his equations.

The Elliott studies, using time-series data, encountered severe degrees of freedom problems. Using the COMPUSTAT tapes, there will usually be far more than 20 firms available for most research studies. There are only 20 years of annual data available. Pindyck and Rubinfeld (1981, 252) suggested that researchers consider the pooling of cross-sectional and of time-series data if there are insufficient observations for time-series or for cross-sectional analyses. They offered an example of the determinants of profits of firms in a single industry based upon Kuh (1963, 116). However, pooling is appropriate only if cross-sectional parameters remain constant over time. The lack of shifting of cross-sectional parameters over time provides the basis for the combining of data to obtain more efficient parameter estimates. The

structure of the disturbance term could be complex because the disturbance term could consist of time-series disturbances, cross-sectional disturbances, and a combination of them. Next, the researcher must select a pooling approach from the following:

(1) COVARIANCE MODEL. Model specification errors, in the form of omitted variables, could mean we need to introduce into the analysis dummy variables to allow for changing cross-sectional and time-series intercepts.

(2) ERROR-COMPONENTS MODEL. Instead of combining all cross-sectional and time-series data for estimation by OLS, one can use a two-stage estimation process: (a) estimate for the pooled sample using OLS; (b) use the residuals to estimate cross-sectional, time-series, and combined error components.

(3) TIME-SERIES AUTOCORRELATION MODEL. The error-components model cannot be used if an equation contains lagged dependent variables or if an equation is part of a simultaneous-equations model. A time-series autocorrelation model involves writing the model in difference form and correcting for heteroskedasticity.

The use of time-series analyses in some of the studies of corporate profitability reviewed in Chapter 2 would require justification today. If pooling were considered, some guidelines are available:

(a) Judge et al. (1980, 358). These authors suggested that researchers answer several questions a priori. The first question is whether slope coefficients are likely to vary over firms. Elliott (1972a) provided evidence that this is to be expected. If so, then one considers whether it is reasonable to capture differences between firms

through the intercept or through the disturbance term. Few firms were used in earlier studies and the question was not addressed. If one assumes differences between firms depend upon the explanatory variables of the firms, then a dummy variable model would be preferable to an error components model or a random coefficients model. In order to model changes over time, one must make some assumptions as to whether disturbances follow an autoregressive or a moving average process. Finally, there is a difference between the models in terms of the number of observations needed. Until the number of firms for this study has been determined in Chapter 5, it is not possible to consider further the finite sample reliability of variance estimates. However, the use of cross-sectional data does avoid the severe degrees of freedom problems encountered by Elliott.

(b) Maddala (1977, 332). Maddala suggested the use of empirical testing in making decisions about possible pooling. The first step is to estimate each equation individually using OLS. This will provide an opportunity to test for the presence of any systematic behavior in the slope and intercept coefficients. A systematic pattern in the residuals should be investigated.

Elliott's solution to the problem of multicollinearity, of dropping a variable, needs to be reviewed to determine if that solution is still used and if there are adequate tests for multicollinearity. While multicollinearity, the linear relationship among the observed values of regressors, would concern Elliott in doing time series analyses, it can appear in cross-sectional studies as well (Goldberger, 1964, 193).

Multicollinearity is a concern in studies of corporate profitability and of the disclosure of forecasts because some authors have suggested that multicollinearity can be good for forecasting (Intriligator, 1978, 155; Kelejian and Oates, 1981, 200). Others object that such claims are based on the assumption that the collinearity observed in a given sample will continue to exist in the future (Gujarati, 1978, 183; Malinvaud, 1970, 220).

Rules of thumb for detecting severe multicollinearity appear frequently in the econometrics literature. If there are only two independent variables in an equation, a popular rule of thumb suggests that multicollinearity is severe if the simple correlation between the two independent variables is larger than the correlation of either or both variables with the dependent variable (Pindyck and Rubinfeld, 1981, 89). The rule of thumb is not useful for more than two independent variables because there can be complicated linear relationships between independent variables. The authors suggested that researchers drop one or more variables with high standard errors from the equation. If the remaining variables show lower standard errors, multicollinearity may have caused the problem.

Farrar and Glauber (1967) proposed a test for the severity of multicollinearity. Haitovsky (1969) proposed a modification to improve the test. Maddala (1977, 186) concluded that these tests are not meaningful because multicollinearity is a problem with samples, not with populations.

Maddala (1977) criticized also the 6 major proposals of solutions to multicollinearity:

(1) DROPPING VARIABLES. The problem with this approach is that it introduces bias if the omitted variable had strong theoretical support. He suggested that researchers report the original OLS estimates and the associated covariance matrix prior to dropping variables.

(2) USING EXTRANEOUS ESTIMATES. He rejected these as truly extraneous (Meyer and Kuh, 1957).

(3) RIDGE REGRESSION. He rejected this as a purely statistical solution.

(4) USING RATIOS OR FIRST DIFFERENCES. The price the researcher must pay for these data transformations is in the form of adverse effects on the properties of the resulting residuals: (a) ratios introduce heteroskedasticity; (b) first differences introduce autocorrelation.

(5) PRINCIPAL COMPONENTS. The linear combinations have no economic interpretation.

(6) GATHERING MORE DATA. The informational content of the data is lacking, not the quantity. If a researcher starts with annual data and tries to gather quarterly data or to pool cross-sectional and time-series data, the problem of weak data might not be solved. Instead, one could encounter new sources of variation: seasonality, cross-sectional variation, or interpolated data series.

Judge et al. (1980, 487-497) discussed solutions based upon the work of Stein (1956). Stein-like estimators combine sample information with uncertain non-sample information. Without sampling distributions for these estimators, only point estimates are possible. The authors suggested that multicollinear data may not be a serious problem if researchers can use precise estimates of linear combinations of parameters.

Elliott's practice of using a time trend variable to improve the fit of his models has been challenged by some econometricians. Gujarati (1978, 124-126) regarded the use of time as a trend variable as common in these time series analyses: (a) if the researcher's objective is to learn how, but not why, the dependent variable behaves over time; (b) if the researcher believes that a variable affecting a trend in the dependent variable is either difficult to obtain or is not directly observable (such as the variable technology in production theory). Rao and Miller (1971, 99-104) provided the example that one might conclude that profits are a determinant of capital investment expenditures because both variables move in the same direction. It is possible, they claimed, that both move in the same direction because both depend upon increases in sales. It is inappropriate to use time as an explicit variable if a researcher's purpose is to explain trends in variables. The proper use of a time trend variable, according to Rao and Miller, is to capture the trend component from all variables in the model not already corrected (such as raw variables and deseasonalized variables in the same model). The coefficient on the time trend variable need not be

interpreted. Cassidy (1981, 42) claimed there is no theoretical justification for including a time variable because the variable adds nothing to the explanatory power of the model in a causal sense.

Elliott's practice of omitting variables whose coefficients displayed the wrong signs is not a universal practice. Cassidy (1981, 23) suggested that researchers show + and - signs above their functional statements of relationships, where theory suggests an unambiguous sign. Otherwise, a ? should be used. The studies reviewed in Chapter 2 do not provide evidence of strong theoretical support for the specification of determinants of each line of the income statement.

In sum, the procedures used in some earlier studies ensured a good fit of models and data. While these procedures may or may not have helped forecast accuracy, the procedures lack theoretical justification in that they do not contribute to our understanding of the behavior of income statement variables. In this study, the same models are tested against all COMPUSTAT firms reporting the relevant accounting variables.

4.3.2 PREDICTION-BEYOND-THE-DATA TESTS.

Elliott and Uphoff (1972), while expending considerable efforts to attain goodness of fit for their model, argued that there is no necessary implication that the best fitting models will produce also the best forecasts. In order to test the stability of relationships over time, the authors used the approach of ex post forecasting suggested by Stekler (1968): use the actual values, not forecasts, of exogenous variables over the forecast horizon. By using actual values, a forecaster can isolate forecast errors associated with a model's structure. The use of forecast values would confound errors associated with forecasts of exogenous variables with errors associated with a model's structure. While a regulatory group might be concerned about forecast accuracy under the realistic conditions of having only forecasts of exogenous variables, the concern of forecasters at this stage of development of models of the accountant's income statement is with the structure of models. It is possible to satisfy both concerns by comparing forecasts prepared using actual values with those using representative (say, median published forecasts) forecasts, if available.

The measure of forecast accuracy used by Elliott and Uphoff was the absolute percentage error. The authors revealed that managers of the firm for which the model was prepared told the authors only that an absolute average percent forecasting error of 5 percent or less for sales would be considerably better than management had been able to do. The model of these researchers produced average percent forecasting errors for 1 to 3 months of less than 5 percent for these variables: net

sales; market share; and operating profit. Forecasts of marketing and of merchandising were worse than 15%.

The absence of published forecasts by managements does not preclude the comparison of econometric models with the best available forecasting techniques. Many forecasting techniques involve using only the historical accounting variable series for forecasting future values in the series. There is no attempt to explain forecasts using other variables. Elliott and Uphoff (1972) cited one study of the time series behavior of earnings (Beaver, 1970) to show that the underlying process generating annual income data appears to be mean-reverting. They concluded that a good moving average model should forecast well. The popularity in business at the time of their research of exponential smoothing led them to use exponential smoothing as a benchmark against which to judge the forecast accuracy of econometric models. These authors chose constant, linear, and quadratic versions of time series models for comparison. All models suffered to some extent from systematic overestimation.

Eliott (1972a) illustrates the lack of agreement in evaluating forecast accuracy. The same author, in a different study published the same year, compared forecasts:

(a) compared the actual values of each accounting variable with forecasts generated by the structural model, the first stage of the model, and by the naive models of no change and of the same change from the previous period:

(b) calculated Theil's inequality coefficient.

Elliott (1973, 125) interpreted Theil's inequality coefficient:

(1) if I = 0, then a model's forecasts were perfect;

(2) if I = 1, then the model did as well as the naive forecast of no change;

(3) if I is greater than 1, then the econometric model produced forecasts poorer than the naive model of no change forecasts;

(4) if I is less than 1, then the econometric model produces forecasts better than the naive model forecasting no changes.

4.4 FORECAST ACCURACY MEASURES.

While the current forecasting literature would support the use of ex post forecasts and of reporting more than one measure of forecast accuracy, the choice of measures of forecast accuracy is different from the choice made by Elliott and other researchers of corporate profitability. This section contains a summary of the major proposed measures of forecast accuracy. The first 10 forecast accuracy measures follow the notation and assumptions of Armstrong (1978, 320):

A denotes the actual result

F denotes the forecast

t denotes: the element to be forecast, if cross-sectional data

: the time interval, if time-series data

h denotes: the number of elements, if cross-sectional data

: the number of periods in the forecast horizon, if time-series data

Assumptions:

(1) A and F must be nonnegative, unless otherwise noted;

(2) Data must be ratio scaled (i.e., true zero point).

4.4.1 MEAN ERROR (ME).

The mean error of a forecast is computed by summing from t=1 to t=h the differences between actual and forecast (A(t)-F(t)) and dividing the sum by h.

Assumptions relaxed:

(1) A and F may be negative;

(2) Interval-scaled data may be used.

Measures: systematic error (bias)

Does not measure: error variance

Cost of errors assumption: symmetrical

Unit free? No.

Loss function symmetrical? Yes.

Assesses both levels and changes? No.

Interpretation: ME = 0 is possible with large, offsetting errors.

Recommendation: Armstrong (1978) suggested that this measure never be reported by itself because of the lack of a measure of error variance.

4.4.2 MEAN ABSOLUTE DEVIATION (MAD) OR MEAN ABSOLUTE ERROR (MAE).

Mean absolute deviation (or mean absolute error) differs from mean error in the use of the absolute difference between actual and forecast rather than the use of the difference.

Assumptions relaxed:

(1) A and F may be negative;

(2) Interval-scaled data may be used.

Measures: the typical error

Does not distinguish: variance and bias

Cost of errors assumption: linear

Unit free? No.

Loss function symmetrical? Yes.

Assesses both levels and changes? Yes.

4.4.3 ROOT MEAN SQUARE ERROR (RMSE).

Root mean square error differs from mean error by squaring the differences between actual and forecast. The square root of the sum of the squared differences divided by h becomes root mean square error.

Assumptions relaxed:

(1) A and F may be negative;

(2) Interval-scaled data may be used.

Cost of errors assumption: quadratic

Unit free? No.

Loss function symmetrical? Yes.

Assesses both levels and changes? Yes.

Recommendation: Armstrong suggested avoiding RMSE when there are outliers (large measurement errors) because of the effect of squaring differences. RMSE is appropriate if the quadratic loss function applies. It is easier to calculate MAD. Further, RMSE may be approximated from MAD (Brown, 1963): RMSE = 0.8 MAD. Pindyk and Rubinfeld (1981, 363) called this measure root-mean square simulation error. They wrote that it is the most used method for evaluating the fit of simulation models. The magnitude of the error should be compared with the average size of the variable.

4.4.4 MEAN ABSOLUTE PERCENTAGE ERROR (MAPE).

The mean absolute percentage error (MAPE) differs from mean absolute deviation (MAD) or mean absolute error (MAE) by dividing the absolute differences between A(t) and F(t) by A(t) and by multiplying this result by 100.

Cost of errors assumption: percentage errors, not unit errors

Unit free? Yes.

Loss function symmetrical? No.

Assesses both levels and changes? Yes.

Interpretation: As A(t) becomes smaller, interpretation becomes more difficult. Further, there is bias in favor of forecasts smaller than actual values. If F(t) = 0, the worst inaccuracy is 100%. As F(t) becomes larger relative to A(t), there is no limit on the possible percentage errors of the forecast.

Recommendation: Armstrong preferred MAPE over MAD in most situations because MAPE is dimensionless. This property permits forecasters to compare forecasts from different situations and even using different measures. The procedure is: (a) calculate MAPE; (b) then, average the MAPE calculations across each situation.

Makridakis and Wheelwright (1978, 570) advocated the use of MAPE comparisons between a proposed forecasting model, naive forecasting models, and a measure of the optimal forecast. They regarded MAPE superior to mean squared error (MSE) because they assume users need percentage accuracy measures. With MSE, it would then be necessary to compare the value calculated for MSE with the average value of the variable. However, the authors rejected the reporting of MAPE by itself

because the MAPE of a proposed forecasting method per se would not indicate the gains in forecast accuracy possible by selecting the forecasting model.

If both unadjusted and seasonally adjusted data series are available for the same variable, Makridakis and Wheelwright make two naive forecasts, one with unadjusted data and the other with seasonally adjusted data. For a time horizon of one period, the MAPE of the naive forecast is computed by summing from t=2 to t=h the absolute differences of $(A(t)-A(t-1)/A(t-1))$. This sum is divided by h-1 and multiplied by 100. These forecasters calculate this measure twice, one for actual unadjusted data and once for seasonally adjusted data. There is no forecast for the first data period. Hence, the calculation of MAPE begins with period 2. These forecasters compare the MAPE measures for the two naive forecasts to determine the improvement in forecast accuracy, if any, achieved by using seasonally adjusted data. The better of the two naive forecast measures provides a benchmark of any gains resulting from a proposed forecasting model.

While MAPE for naive forecasts provides a floor for evaluating the forecast accuracy of proposed forecasting models, MAPE for the optimal forecast (MAPEOF) serves the purpose of providing a ceiling. The first step with any data is to determine the random component. Makridakis and Wheelwright calculate the MAPE for the optimal forecast using R(t), the random component of A(t), the actual value. The numerator of the MAPE computation becomes the sum of the absolute values of $(R(t)-R(t-1)/R(t))$. If the difference between MAPEOF and MAPENF2 is regarded as small by Makridakis and Wheelwright, then these researchers go no

further in the development of a formal forecasting model for that forecasting problem. They use the naive model for forecasting.

4.4.5 ADJUSTED MEAN ABSOLUTE PERCENTAGE ERROR (Adjusted MAPE).

Instead of dividing the absolute differences between actual and forecast by A(t), the computation of adjusted MAPE uses (A(t)+F(t))/2. The purpose of the adjustment is to provide a symmetrical loss function, a property lacked by MAPE. There is no longer a bias in favor of low estimates. The interpretation of MAPE is: 0 for a perfect forecast; 200 for an infinitely bad forecast. Additionally, adjusted MAPE is less sensitive than MAPE to measurement errors in data series. In spite of these advantages, Armstrong prefers in most situations the use of MAPE because it is easier to understand and easier to relate to decision making.

4.4.6 THEIL's MEASURE OF INEQUALITY (U).

There are two versions of Theil's measure, the original and the adjusted versions. Some forecasters use U and others use I to represent the measure. The numerator of the original version is root mean square error (RMSE). The denominator of the original version is the sum of two components: (1) the sum from t=1 to t=h of A(t) squared divided by h; (2) the sum from t=1 to t=h of F(t) squared divided by h. For reasons discussed below, an adjusted version is available for measuring errors in forecasts of changes but not of levels. The adjusted version uses in the numerator changes in F(t) and in A(t) and only a change in A(t) component in the denominator.

Assumptions relaxed: Interval-scaled data may be used.

Unit free? Yes.

Loss function symmetrical? Yes.

Assesses both levels and changes? No.

Interpretation: U1 (Theil, 1958) is bounded between 0 for a perfect forecast and 1 for a no-change forecast. Bliemel (1973) noted that U1 should not be used as a measure of forecast accuracy because no forecasting model can do worse than the naive model of no change, if change data are used. U2 (Theil, 1966) corrected the bounds: 0 still represented a perfect forecast; 1 still represented a no-change forecast model; but, there is no upper limit beyond 1. The price paid for this improvement of U2 over U1 was that U2 can measure only errors in changes, not in levels.

Recommendation: Armstrong concluded that Theil's measure of inequality is not needed as a measure of forecasting accuracy because other measures can do a better job and are simpler.

Maddala (1977, 346), citing the example of Granger and Newbold (1973), argued that it is important to determine what a forecast accuracy statistic tends to in the limit. This tendency can be compared with the optimal value of a coefficient for a predictor. In the case of U1, the Granger and Newbold example had demonstrated that the forecast accuracy measure suffered the defect of having U1 squared minimized for the wrong (i.e., non-optimal) value. U2 corrected the defect.

Several authors stressed the importance of studying the decompositions of the mean-square error term in the numerator of Theil's statistics. Maddala regarded the decomposition of mean-square error into bias, regression, and residual proportions as being more important than the alternative of reporting a decomposition into bias, variance, and covariance proportions.

Intriligator (1978, 525) explained that an advantage of using Theil's inequality coefficient is that the decomposition shows the different causes of inaccuracy. Unlike Maddala, Intriligator stressed these decompositions:

(average A - average F) squared is the measure of bias. It shows the extent to which actual and forecasted percentage changes have unequal central tendencies. Bias is calculated by squaring the difference between the means.

(s(actual) - s(forecast)) squared, the measure of unequal variation, is calculated by squaring the difference between the standard deviations of the actual and forecasted percentage changes.

2(1-r)*s(actual)*s(forecast), the measure of imperfect covariation, is calculated using r, the correlation coefficient between A and F. Unlike the first two components, the covariance component represents unavoidable nonsystematic random error.

Pindyck and Rubinfeld (1981, 365) termed the three components as proportions of inequality. The values of the systematic proportions, bias and variance, should be close to zero. These researchers would attempt to revise their models until the value of the bias proportion fell below 0.2. Ideally, the average values of the simulated and actual series will be the same. Likewise, these researchers want the variance component to be as close to zero as possible. A large value of the variance proportion would mean either the actual series fluctuated considerably while the simulated series did not or the simulated series fluctuated considerably while the actual series did not. For any positive value of Theil's inequality coefficient, the ideal distribution of the components would be a value of 1 for the covariance proportion and a value of zero for the bias and variance proportions. These researchers suggested that more research will be needed to provide guidelines on making tradeoffs between criteria. They offered as an example the possibility that Theil's inequality coefficient could be very small but the bias component could be very large.

Makridakis and Wheelwright (1978, 573) noted that the numerator of Theil's inequality coefficient is similar to the MAPE of a given forecasting method while the denominator is similar to the MAPE of naive forecasts. The only term missing from Theil's U-statistic is the MAPE of the optimal forecast (OF). An alternative way of reporting Theil's inequality coefficient is McLaughlin's batting average, found: 100(4-U). The range in values is 200 to 400, with 300 having the same interpretation as 1 does for Theil's U (McLaughlin, 1975).

Elliott (1972a) neither reported nor indicated any use of components of Theil's inequality coefficient. Instead, he compared the inequality coefficients for: (1) reduced-form model; (2) structural equations model; (3) no-change naive forecast; (4) same-change naive forecast. In comparing forecasts with the actual sales, Elliott found that the structural sales prediction was closer to actual in 10 to 15 predictions. The no-change and same-change sales forecasts followed in that order. However, Theil's inequality coefficient ranked the reduced form forecasts slightly better than the structural equation forecasts: (1) reduced form, 0.14; (2) structural equations, 0.32; (3) no change, 1.00; (4) same change, 1.44. Elliott concluded that the evidence is inconclusive as to whether reduced-form or structural equations produce superior forecasts.

The profits equation in the Elliott study showed different forecast accuracy results. For the profits equation, both the absolute value of the prediction error and Theil's inequality coefficent produced the same rankings: (1) reduced form, 0.97; (2) no change, 1.00; (3) same change, 2.76; (4) structural equations, 7.99. While the reduced-form model remained the best, in terms of Theil's inequality coefficient, in the profits equation there was little difference between the reduced-form model and the naive forecast of no change. The structural equation was a disaster, doing worse than both naive forecasts.

Elliott's interpretation of this result was that his production cost variable must have been poorly specified, given the excellent results with the sales equation. He offered no explanation for the extreme difference in results between the reduced-form and the structural equations, other than a small number of very bad forecasts can affect the value of Theil's inequality coefficient.

In summary, Elliott's usage of Theil's inequality coefficient is not consistent with the current forecasting practices. Forecasters either do not use Theil's inequality coefficient because other easier measures are available (such as MAPE) or they use Theil's inequality coefficient in order to report the sources of forecast inaccuracy provided by decomposition of this forecast accuracy measure. A more detailed example appears in section 4.4.11.

4.4.7 COEFFICIENT OF VARIATION (CV).

The coefficient of variation (CV) has root mean square error (rmse) as its numerator. The denominator is the mean of the actual data.

Unit free? Yes.

Loss function symmetrical? Yes.

Assesses both levels and changes? Yes.

Recommendation: Armstrong (1978) preferred MAPE over CV only because he regarded MAPE as being easier to interpret. Unlike RMSE, CV is unit free because RMSE has been related to the average value of the actual data.

4.4.8 COEFFICIENT OF DETERMINATION (r-squared).

The numerator of r-squared is the square of the sum of the products of the forecast and actual deviations from their respective means. The denominator of r-squared is the sum of the squared forecast deviations from the mean forecast times the sum of the squared actual deviations from the mean of the actual data.

Assumptions relaxed: Scaling requirements vary.

Unit free? Yes.

Loss function symmetrical? Yes.

Assesses both levels and changes? No.

Interpretation: r-squared is usually interpreted as the proportion of variance explained. However, Armstrong argued that an r-squared of 1 cannot be interpreted as a perfect forecast because that value is possible if the forecasts are always wrong by the same percentage. The steepness of the regression line affects r-squared. As changes become greater, r-squared increases (Barrett, 1974). R-squared = 0 cannot be interpreted as a completely bad forecast. Another way to increase r-squared is to add a large number of independent variables to a model. Armstrong (1970b) showed how it is possible to obtain an r-squared of 0.85 with random data. Ames and Reiter (1961) showed that r-squared in excess of 0.5 is possible in regressing one economic time series against as few as 2 to 6 other economic time series selected at random.

Recommendation: Armstrong (1978) urged researchers to use MAPE rather than r-squared. Some problems could be overcome by using adjusted r-squared. He offered three formulas:

(1) Adjusted r-squared = 1 - (1 - R-squared) (h-1/h-v)

Wherry (1931)

(2) Adjusted r-squared = 1 - (1 - R-squared) (h-1/h-v-1)

McNemar (1962)

(3) Adjusted r-squared = 1 - (1 - R-squared) (h+v-1/h-v-1)

Lord (1950)

where: h denotes the number of observations

v denotes the number of independent variables

Armstrong praised Lord's formula, citing Uhl and Eisenberg (1970) for support.

Finally, Armstrong cited Montgomery and Morrison (1973) to show the extent of risk a researcher faces in using r-squared. If the true r-squared = 0, your expectation of the calculated r-squared for a sample can be appoximated by: approximate r-squared = v/h.

4.4.9 ACCURACY RATIO.

The accuracy ratio, denoted by Armstrong as Q-bar, is the mean of the actual to forecast and of the forecast to actual ratios, Q:

where: $Q = A(t)/F(t)$, if $A(t) > F(t)$

$Q = F(t)/A(t)$, if $F(t) > A(t)$

Cost of errors assumption: symmetrical, in percentage terms

Unit free? Yes.

Loss function symmetrical? Yes.

Assesses both levels and changes? Yes.

Recommendation: Armstrong (1978) preferred the accuracy ratio over MAPE if large errors are present. Unlike MAPE, the accuracy ratio is not bounded on both sides. The accuracy ratio can range from 1 to infinity.

4.4.10 TURNING POINT ERRORS (TP).

Assumptions relaxed: Nominal-scaled data is used.

Unit free? Yes.

Loss function symmetrical? No.

Assesses both levels and changes? No.

Recommendation: Intriligator (1978, 522) cited studies showing that there is systematic underestimation of change in most forecasts, probably because of the simplifying assumption of model builders that all other relevant variables will not change or will be represented by the stochastic disturbance term (Theil, 1961, 1966; Mincer and Zarnowitz, 1969).

Makridakis and Wheelwright (1978, 436) suggested that a forecast contains two predictions: (1) for the continuation of existing conditions; (2) of turning points. This involves the study of cyclical patterns.

Pindyck and Rubinfeld (1981, 364) regarded the ability of a simulation model to duplicate turning points to be more important than fitting data closely during the rest of the simulation period. All forecasting methods do well during long periods of changes in the same direction. These authors suggested that only models really explaining the underlying process could predict turning points.

Wheelwright and Makridakis (1980, 40) suggested that the same forecasting methodology may not be useful for both continuation and turning point predictions (McLaughlin and Boyle, 1968; McLaughlin, 1975; Trigg, 1964).

Elliott (1972a) attributed the failure of the structural model for profits to its failure to change when the economy moves into a recession.

Armstrong (1978, 326) concluded that there is seldom a need to consider turning point errors because there are no special costs associated with missing the direction of change. He suggested that turning point errors be supplemented by other accuracy measures because the count of turning point errors ignores the magnitude of those errors. He conceded that there has been interest in turning point errors in economics (Smyth, 1966; Platt, 1971; Fels and Hinshaw, 1968, 1974). A more general measure is "hits or misses," appropriate for forecasting

whether an event will occur or not. In the context of corporate profitability studies, this might be useful for extraordinary items. Joy and Tollefson (1975) outlined the application of hits and misses to financial problems.

Nelson (1973, 211) disputed the need to analyze turning-point errors. He rejected the claim that cycles and trends are systematic. Instead, Nelson claimed that his ARIMA analysis of GNP data show that cycles "may be merely artifacts of random shocks working their way through the economy as Eugen Slutzky and Ragnar Frisch suggested some time ago." A forecaster's goal should be, he argued, to anticipate any large disturbance, not just those associated with turning points. Nelson recommended:

(1) Specify the loss associated with errors.

(2) State the conditions for optimal predictions.

After this, according to statistical decision theory, turning-point errors per se are of no special interest.

4.4.11 MEAN SQUARE ERROR (MSE).

Armstrong's list of 10 measures of forecast accuracy from which to select did not include mean square error (MSE), though it did include root mean square error (RMSE). Other authors explained why MSE need not be on the list.

Makridakis and Wheelwright (1978, 569) defined MSE: the sum of the squared differences between actual and forecast values divided by h. The use of a mean square error measure poses problems because some form of mean square error would be used in both measuring forecast accuracy and in fitting models.

In the fitting stage, it is possible to achieve MSE = 0 by using high order polynomials or Fourier transformations. These forecasters regarded overfitting of models (i.e., including randomness in the generating process) as being as bad as failing to identify the nonrandom pattern in data. They claimed there is no necessary relationship between MSE in the fitting phase and forecast accuracy in later use. The extensive use of MSE in the fitting phase creates problems for the use of MSE in the forecasting phase:

> different methods use different procedures in the fitting phase. These differences make comparison on a single criterion measure often incomplete. For example, smoothing methods are highly dependent upon initial forecasting estimates, decomposition methods include the trend-cycle in the fitting phase as though it were known; regression methods minimize MSE by giving equal weight to all observations; generalized adaptive filtering minimizes an evolutionary MSE value, since the weights change with time; and Box-Jenkins minimizes the MSE of a nonlinear optimization procedure. Thus, comparison of such methods that utilize MSE in their fitting procedure in very different ways is of limited value.

As an absolute measure, MSE represents a poor way to compare across different time series or for different time intervals. The squaring of a range of values means there will be no intuitive interpretation.

Maddala (1977, 344) defined MSE using actual relative changes and forecasted relative changes: $(A(t)-A(t-1))/A(t-1)$ and $(F(t)-A(t-1))/A(t-1)$. This definition of MSE can be rewritten in other forms for comparison with other forecasting accuracy measures and for decomposition purposes. Maddala called the square of the difference between the means of the two relative changes the bias component. The remaining component is the variance of the prediction errors.

Theil (1966) developed two sets of decompositions of MSE using also the correlation between the actual and the forecasted relative changes. The two sets of decompositions of MSE serve as the basis for two sets of statistics on some computer packages, such as TSP: (1) bias, variance, and covariance proportions; (2) bias, regression, and disturbance proportions. The bias component of the decomposition is common to both statistics. Maddala recommended reporting only the bias, regression, and disturbance proportions because Granger and Newbold (1973) have shown that the variance and covariance proportions do not tend to zero for the optimal predictor.

4.4.12 EFFICIENT PREDICTOR.

Mincer and Zarnowitz (1969) suggested regressing actual values on forecasted values. An efficient predictor, according to them, is one whose constant term is not significantly different from zero and whose slope is not significantly different from 1. Maddala offered these objections to this procedure:

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(1) cross-spectral analysis is more appropriate for studying the relationship between forecasted and actual values (Dhrymes et al., 1972);

(2) the distributional and time-series properties of the forecast error series are more important than the properties of forecasted and actual series (Granger and Newbold, 1973).

4.4.13 INDEX OF PREDICTIVE EFFICIENCY (IPE).

Armstrong (1978, 327) recommended that forecasters select all appropriate forecasting accuracy measures. Then, forecasters can compare competing forecasting models on the basis of all appropriate forecast accuracy measures. A forecaster can have confidence in a forecasting model shown to be most accurate by all appropriate measures of accuracy.

Ohlin and Duncan (1949) proposed a measure of the relative efficiency of forecasting models: IPE = (M(1)-M(2))/M(1)

where:

M(1) denotes the error measure for the current model

M(2) denotes the error measure for the proposed model Armstrong suggested that a preferable presentation would be to translate error scores into economic terms.

4.5 DATA SOURCES.

Accounting variables are available from annual reports, 10-K forms, and from Standard & Poor's Industrial COMPUSTAT tapes. The initial use of the COMPUSTAT tapes permits rapid testing by computer of a large population of firms. Further, Standard & Poor's has adjusted data in several ways to be noted in the discussion of each accounting variable.

4.5.1 SALES.

Sales--Net is annual data item 12 of the COMPUSTAT tapes. Standard & Poor's defines the variable:

> Sales consists of gross sales (the amount of actual billings to customers for regular sales completed during the period) reduced by cash discounts, trade discounts, and returned sales and allowances for which credit is given to customers.

Sales--Net includes: (1) any revenue source expected to continue for the life of the company; (2) other operating revenue; (3) installment sales; (4) franchise sales (when corresponding expenses are available). The Industrial COMPUSTAT manual contains in Section 9 (Data Definitions) a list also of special cases of revenue included for certain industries.

This variable excludes non-operating income: (1) interest income; (2) equity in earnings of unconsolidated subsidiaries; (3) other income; (4) rental income; (5) royalty income.

Sales--Net excludes also special items: (1) gain on the sale of securities or fixed assets; (2) discontinued operations.

Standard & Poor's excludes excise taxes from sales and deducts the taxes from cost of goods sold (annual data item 41).

Standard & Poor's provides annual footnote codes to indicate problems with Sales--Net data so that researchers can eliminate companies with those problems or go to the original sources and attempt to correct the data series. These problems include: (1) mergers or acquisitions; (2) accounting changes; (3) exclusion of data because an operation is no longer considered to be continuing; (4) excise taxes known to be included; (5) other income known to be included; (6) sales of leased departments included; (7) fiscal year change.

The use in this study of Sales--Net, annual data item 12, means that the quarterly data item 2 is not being used. The quarterly variable differs in definition from the annual variable because other income and excise taxes are included in the definition of the quarterly variable, for those companies not reporting these items separately in quarterly reports. The use of a quarterly variable would necessitate explanations of seasonal patterns. The following annual COMPUSTAT variables for the models in this study are not available on a quarterly basis: (1) cost of goods sold; (2) advertising expense; (3) research and development expense. Even if quarterly data are available, Standard & Poor's retains only the most recent 10 years on the data tapes; it retains the most recent 20 years of annual variables. As of January 28, 1982, Standard & Poor's showed that 2433 firms on the primary, supplementary, and tertiary industrial files have annual sales data. The availability of the quarterly variable during the four quarters of

1980 was: 2416, 2409, 2403, and 2390 firms.

Also not used in this study is annual data item 117, Sales (Restated). Restatements may be made at any time by a firm but are not done for more than 10 years. Acquisitions or accounting changes, or both, are the usual reasons restatements are made. The restated sales variable may include items excluded from Sales--Net, such as: other income; excise taxes. This variable is not available for utility firms or for life insurance, property, and casualty firms. This variable is not available on a quarterly basis. In 1980, 2151 firms restated sales. This number can change.

4.5.2 COST OF GOODS SOLD.

Cost of Goods Sold is annual data item 41; it is not available on a quarterly basis. The definition of cost of goods sold is all costs allocated directly by the company to production (such as material, labor, and overhead). One form of measurement error for this variable is that many non-manufacturing firms report only total operating costs. In those cases, Standard & Poor's treats total operating costs as cost of goods sold. In specifying the equation for the determinants of cost of goods sold in chapter 3, it was necessary to consider a long list of items included in and excluded from the definition of cost of goods sold. This variable is not available for banks, utilities, life insurance, or property and casualty firms. The COMPUSTAT tapes contain footnotes indicating which firms were affected by an accounting change and which firms needed to have cost of goods sold reduced by the amount of depreciation which should be allocated to Selling, General, and Administrative Expense. Cost of Goods Sold is available for 2084 firms in 1980. This means a loss of 349 firms, or 14% of the firms for which Sales--Net is available.

4.5.3 ADVERTISING EXPENSE.

Advertising Expense, annual data item 45, is not available on a quarterly basis. It includes the cost of advertising media (radio, television, periodicals, etc.) and promotional expenses. Advertising expense is not available for banks, utilities, life insurance, or property and casualty companies. There are no COMPUSTAT footnote disclosures for this variable. In 1980, 1791 firms appeared on the COMPUSTAT tapes with advertising expense as a separate line item. This represents a loss of 642 firms, or 26% of the 2433 firms showing Sales--Net as a separate line item. On a time-series basis, the lack of data availability is more severe. In 1963, advertising expense was not available for any COMPUSTAT firm. It was available for only 26 firms in 1964.

4.5.4 RESEARCH AND DEVELOPMENT EXPENSE.

Research and Development Expense, annual data item 46, is not available on a quarterly basis. This variable includes only the firm's contribution to the development of new products or services. It excludes: (1) customer or government contributions; (2) extractive industry activities; (3) engineering expense; (4) inventor royalties; (5) market research and testing. This variable is not available for banks, utilities, life insurance, or property and casualty firms. COMPUSTAT provides footnote codes if this variable includes either customer and government contributions or engineering expense. In 1980, research and development expense was available for 1232 firms. This represents a loss of 1201 firms, or 49% of the 2433 firms having sales--net available. On a time series basis, the lack of data is more severe. In 1962, for example, this variable was available for only 134 COMPUSTAT firms.

4.5.5 OPERATING INCOME BEFORE DEPRECIATION.

Operating Income before Depreciation, annual data item 13, is available on a quarterly basis as quarterly data item 21. This accounting variable represents sales less cost of goods sold and operating expenses. Strike expense is an example of a component of operating expenses not appearing each year. Operating income before depreciation is not available for banks, life insurance, or property and casualty companies. There are no COMPUSTAT footnote codes for this variable. In 1980, this variable was available for 2237 firms. This represents a loss of 196 firms, or 8% of the 2433 firms for which sales--net was available. The quarterly data availability in 1980 was: 1656; 1629; 1635; 1561.

4.5.6 RECEIVABLES.

Receivables, annual data item 2, are claims against others (after applicable reserves for doubtful items) collectible in money, generally within 12 months. The Industrial COMPUSTAT manual lists typically more than twenty categories included in this highly aggregate variable. For the purposes of this study, only accounts receivable are needed. However, for some firms, the variable will contain other components, such as amounts due from unconsolidated subsidiaries, money due from sales of securities, claims in litigation, and many other items not related to the support of credit sales levels.

This accounting variable is net; it excludes several items including allowance for doubtful accounts. This is unfortunate for this study because bad debt expense is a component of selling, general, and administrative expenses. The allowance for doubtful accounts appears for some firms on the COMPUSTAT tapes as data item 67: Receivables (Estimated Doubtful). It would be possible to construct a gross receivables variable at the cost of the loss of firms in a study. Specifically, the receivables variable is available for 1,129 firms in 1962 and for 2,055 firms in 1980 while the receivables (estimated doubtful) variable is available for 0 firms in 1962 and for 1620 firms in 1980. The receivables variable is not available for banks or utilities. The receivables (estimated doubtful) variable is not available for banks, utilities, life insurance, property and casualty, or Canadian companies.

4.5.7 INVENTORIES.

Inventories, COMPUSTAT annual data item 3, include merchandise bought for resale and supplies purchased for use in the production of revenue. A disaggregation of the inventories variable is available at the cost of loss of firms in a study, as shown by the following number of firms for which the variables were available:

		1962	1980
Raw Materials	Annual data item 76	0	1204
Work in Process	Annual data item 77	0	1063
Finished Goods	Annual data item 78	0	1165
Inventories	Annual data item 3	1129	2081

These variables, measured in millions of dollars, are not available for banks, utilities, life insurance, or property and casualty companies.

The Annual Industrial COMPUSTAT tapes contain also codes showing the inventory valuation method or methods used by firms:

1 First In, First Out (FIFO)

2 Last In, First Out (LIFO)

3 Specific Identification

4 Average Cost

5 Retail Method

6 Standard Cost

7 Current or Replacement Cost

If a firm uses more than one method of inventory valuation, then the code number for each method used appears in order of relative importance. However, firms need not disclose the exact dollar figure of inventory valued by each method. Firms may change methods. This poses

research problems for time series and for panel data studies more than it does for cross sectional studies.

4.5.8 PLANT-NET.

Plant-Net, COMPUSTAT annual data item 8, is Plant-Gross, annual data item 7, less accumulated reserves for depreciation, depletion, and for amortization. Both variables represent tangible fixed property used to manufacture products for sale. These variables exclude plant, property, and equipment of discontinued operations. The choice of plant-net was based upon the absence of depreciation expense from the aggregate and the disaggregate models. If future researchers want to explain and to forecast depreciation expense, the use of plant-gross would be appropriate. These variables are highly aggregate. They include more than land, buildings, and equipment in some industries, including: beverage producers' bottles, kegs, and cases; publishing companies's book plates; timber rights; tools and dies. These variables, measured in millions of dollars, are not available for banks.

4.5.9 INVESTED CAPITAL (TOTAL).

Invested Capital (Total), COMPUSTAT annual data item 37, is the sum of other accounting variables: (1) Long-Term Debt (annual data item 9); (2) Preferred Stock-Carrying Value (annual data item 130); (3) Minority Interest (annual data item 38); (4) Common Equity (As Reported) (annual data item 60). The separate components were not used in this study because the aggregate and disaggregate models explain and forecast only operating decisions. In future research, the aggregate and disaggregate models will need to include the balance sheet and financing decisions.

The invested capital (total) variable used in this study was definition 1. The COMPUSTAT manual shows three additional definitions used by some researchers. Definition 2 excludes minority interest. Definition 3 excludes minority interest and includes deferred taxes and investment tax credits. Definition 4 includes minority interest, deferred taxes, and investment tax credits. The choice of definitions is an important consideration for models incorporating financing decisions. This variable, regardless of definition used, is measured in millions of dollars.

4.5.10 ORDER BACKLOG.

Order Backlog, COMPUSTAT annual data item 98, is a firm-level variable representing the dollar amount of backlog of orders believed to be firm at the end of an accounting period. This variable provides an indication of plant capacity problems. In future studies which use plant and equipment variables as endogenous variables, order backlog would need to be considered as a determinant. Its use in this study was limited to serving as a determinant in the sales and in the sales-generating variables equations.

CHAPTER 5

EMPIRICAL RESULTS

PREVIEW OF CHAPTER 5.

Estimates and forecasts of the aggregate models were possible for 1674 COMPUSTAT firms. Estimates and forecasts of the disaggregate models were possible for 343 firms. Many of the earlier studies used from 1 to 9 firms. Earlier researchers concluded their studies were feasibility studies; they suggested that similar studies be conducted using a much larger number of firms.

While the use of unconstrained estimates of distributed lags meant better fitting models, such distributed lags did not mean more accurate forecasts. The lack of variability in advertising and in research and development expenditure patterns for the COMPUSTAT firms produced mixed signs for coefficients of distributed lag determinants. The use of lags consisting of the current period plus the past three periods, successful for some firms in earlier research, cannot be generalized to the larger

population of COMPUSTAT firms.

Aggregate models generated more accurate forecasts than did the corresponding disaggregate models. Using the models of this study, it is possible to generate more accurate income statement forecasts for the 343 firms reporting advertising and research and development expenditures than it is for the 1674 population of COMPUSTAT firms from which they were drawn. While one of the reduced form estimators generated the best forecasts of operating income before depreciation for all 6 models, OLS and 2SLS generated more accurate forecasts of some of the other income statement variables.

5.1 1674 AGGREGATE MODEL AND 343 DISAGGREGATE MODEL FIRMS

The empirical results of this chapter are based upon firm-level data for 1674 firms appearing on the annual industrial COMPUSTAT tapes. TSP (Time Series Processor), a computer program for econometric analysis, was used to estimate 6 models. Estimators used were: ordinary least squares, OLS unrestricted reduced form, 2SLS derived reduced form, and two stage least squares. The base year for the estimates was 1978. TSP was used also for forecasts of 1979 and for forecast accuracy measures. Standard & Poor's Compustat Services, Inc. and TSP International provide detailed manuals explaining the data and the estimation techniques used in this study.

5.2 MODEL 1: AGGREGATE, 1674 FIRMS, NO DISTRIBUTED LAGS.

The purpose of model 1 is to provide a basis for comparison with models estimated using the data of the smaller number of firms disclosing also advertising and research and development expenditures. This model represents the current accounting view that distributed lag effects of advertising and of research and development expenditures can be ignored. Such a viewpoint may be tested empirically with respect both to estimation of models and forecasts based upon the models.

5.2.1 ESTIMATION OF MODEL 1.

Table 1 summarizes the results of using ordinary least squares to estimate each line of the aggregate model's income statement:

TABLE 1

OLS ESTIMATION OF MODEL 1: AGGREGATE, 1674 FIRMS, NO DISTRIBUTED LAGS

1978 SALES EQUATION

Standard error of the regression	= 221.140
Mean of the dependent variable	= 961.964
Standard deviation	= 3350.81
R-squared	= .995658
Adjusted R-squared	= .995645

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	6.78611	5.77925	1.17422
Net Sales 1977	1.10330	.00592133	186.327
SGA Expense 1978	.130782	.0224884	5.81552
Receivables 1977	- .126720	.0347130	- 3.65051
Inventory 1977	.114213	.0403370	2.83147
Order Backlog 1977	.0273582	.00739499	3.69956

1978 COST OF GOODS SOLD EQUATION

Standard error of the regression	= 90.1739
Mean of the dependent variable	= 699.829
Standard deviation	= 2595.70
R-squared	= .998797
Adjusted r-squared	= .998793

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	13.2029	2.35282	5.61154
COGS 1977	.531235	.00891020	59.6210
Net Sales 1978	.490811	.00709618	69.1656
Plant 1977	-.138809	.00500650	-27.7257
Inventory 1977	.0297424	.0173612	1.71316
SGA Expense 1978	-.608493	.128503	-47.3525

TABLE 1 (CONTINUED)

1978 SELLING, GENERAL, AND ADMINISTRATIVE EXPENSE EQUATION

Standard error of the regression	= 33.7680
Mean of the dependent variable	= 136.156
Standard deviation	= 407.390
R-squared	= .993154
Adjusted r-squared	= .993129

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	3.03187	.890539	3.40454
SGA Expense 1977	1.01706	.00672321	151.276
Total Capital 1977	- .0243223	.00239503	-10.1553
Order Backlog 1977	- .00301030	.00113980	- 2.64109
Gross Margin 1978	.086186	.00433844	18.8129
Inventory 1977	.0154780	.00465160	3.32745
Receivables 1977	.00332011	.00606552	.547373

The mean net sales in 1978 of the 1674 COMPUSTAT firms used in estimating the aggregate model was nearly 962 million dollars. One standard deviation was more than 3 billion dollars. The range of sales reported by these 1674 firms shows the extensive coverage of firms by COMPUSTAT: from 1.488 million dollars to 63.2211 billion dollars. The disclosure rules of the SEC and of the FASB cover a wide range of firms. Tables in this chapter will show to what extent highly aggregate models of the firm can fit and can forecast accounting data for this wide range of firms.

The 1978 net sales equation was estimated with an adjusted r-squared in excess of .99. While the adjusted r-squared indicates an excellent fit of an aggregate model with no distributed lags, the standard error of the regression, 221.14 million dollars, was 23% of the mean 1978 net sales for the 1674 firms. The coefficients of all

determinants of the sales equation were significant. As expected, the lagged endogenous sales variable was highly significant and its coefficient was positive. The mean 1977 net sales of the 1674 firms was 846.649 million dollars. On average, then, sales increased approximately 14% from 1977 to 1978. The positive coefficient of the selling, general, and administrative expenses determinant is consistent with expectations for sales-generating expenditures. However, the negative coefficient of the receivables determinant is contrary to expectations. It is not possible, with the aggregate and the disaggregate models, to examine carefully the reasons for this result. The earlier researchers who attempted to explain each line of the income statement did not attempt to extend the explanations to each line of the balance sheet. This study, too, treats balance sheet variables as exogenous. At the end of 1977 (or beginning of 1978), the mean receivables of the 1674 firms were 109.435 million dollars. During 1978, these firms increased their average level of receivables to 128.839 million dollars, an increase of 18% to support an average sales increase of 14%. At the end of 1977, the receivables levels of these firms ranged from 44 thousand dollars to 6.6714 billion dollars. This receivables determinant is a highly aggregate variable including many components other than amounts used to support credit sales. As long as accounting disclosures remain acceptable at such a high level of aggregation, receivables may remain a poor determinant in sales equations. During 1978, the average inventory levels of the 1674 firms increased from 127.079 to 140.406 million dollars, an increase of 10%. The positive coefficient on the inventory determinant is consistent with

managements' expectations for inventory levels with respect to dollar sales. However, under some circumstances the coefficient could be negative. The inventory variable, along with other balance sheet variables, needs to become an endogenous variable in models of the firm. Order backlogs are a firm-level variable. This determinant could be audited. In model 1, the sign of the coefficient was positive. During 1978, the mean order backlog for the 1674 firms increased from 95.5334 to 111.202 million dollars. This is the only variable in the aggregate and the disaggregate models which had a zero value for some firms. During 1978, the number of firms disclosing order backlogs increased from 572 (34%) to 591 (35%). The sign of the coefficient could be negative, depending upon circumstances. Order backlogs need to be considered in future research. In this study, the only managerial response considered was the reduction of selling, general, and administrative expenditures. In future research involving balance sheet variables as endogenous variables, it may be possible to understand other ways managers respond to order backlogs.

The 1978 cost of goods sold equation shows the sensitivity of the level of cost of goods sold to sales volume. Unlike the sales equation, the lagged endogenous variable's coefficient in the cost of goods sold equation was far from a value of 1. The 1978 mean of cost of goods sold was 699.829 million dollars, an increase of 13% over the 1977 mean cost of goods sold of 619.163 million dollars. For the 1674 firms, the ratio of cost of goods sold to net sales in the years 1977, 1978, and 1979 remained constant at .73. Net sales was a major determinant of cost of goods sold for the 1674 firms. The negative coefficient on the plant,

property, and equipment determinant indicated that managers were rewarded in 1978 for earlier investments in plant in the form of lower unit costs. Managers may decide to hold inventory for a number of reasons. In future research, the inventory variable needs to become endogenous to represent these reasons. Inventory appeared in the sales equation representing the importance of product availability in making a sale. Inventory appears in the cost of goods sold equation because managers maintain inventory levels also to reduce cost of goods sold, especially in times of inflation. However, excessive inventory levels or recessions could result in a positive coefficient on the inventory determinant in a cost of goods sold equation. For the 1674 firms, the coefficient on the inventory determinant in the cost of goods sold equation was positive in 1978. The selling, general, and administrative expenses determinant appeared in both the sales and cost of goods sold equations for different reasons. In a sales equation, SGA represents sales-generating activities; it should have a positive coefficient. In a cost of goods sold equation, SGA represents cost- reducing activities; it should have a negative coefficient. For the 1674 firms in 1978, the coefficient on the SGA determinant was strongly negative, as expected. The adjusted r-squared of the cost of goods sold equation, as was the case with the sales equation, was in excess of .99. The standard error of the regression, 90.1739 million dollars, represented 13% of the mean of cost of goods sold for the 1674 firms. This standard error is an improvement over the 23% of mean observed in the sales equation. This finding is consistent with earlier researchers, some of whom achieved high r-squared results using net sales as the sole determinant of cost

of goods sold.

The mean gross margins in 1978 and in 1979 were 262.136 and 310.929 million dollars respectively. Since the ratio of cost of goods sold to sales was a constant .73 during the period of this study, the ratio of gross margin to sales was a constant .27.

The 1978 selling, general, and administrative expenses equation shared with the other equations in this aggregate model an adjusted r-squared in excess of .99. The mean SGA expenditures were 136.156 million dollars (14% of sales). This relationship with sales remained constant during 1977, 1978, and 1979. The standard error of the OLS regression was 33.7680 million dollars (25% of the mean of SGA), a result worse than the 23% for sales and the 13% for cost of goods sold. This might indicate, as some earlier researchers concluded, poor specification of a poorly-defined accounting variable. The coefficient on the lagged endogenous determinant was positive and nearly 1. The negative coefficient on the order backlog determinant is consistent with the expectation that managers will reduce sales-generating expenditures when faced with order backlogs. The inventory determinant showed a positive coefficient, consistent with accounting debits to components of SGA. The expectation is that the relationship between inventory and SGA will appear stronger as some components are removed, such as advertising and research and development. The coefficient on the receivables determinant was not significant. There is a positive relationship between receivables and bad debt expense. Bad debt expense is a component of SGA. In the disaggregate model, advertising and research and development expense are removed from SGA. As components other than

bad debt expense are disclosed a separate line items leaving a smaller SGA residual, the relationship between receivables and SGA residuals should become positive. The coefficient on the gross margin determinant was positive, consistent with expectations that improvements in gross margins can result in some short-run managerial responses in the form of increased SGA expenditures. The relationship between invested capital and SGA was negative. The role of invested capital cannot be examined beyond that in this study. Its role can be studied by making balance sheet variables endogenous in the models. An assumption of this study was that operating decisions and financing decisions can be separated.

The mean operating income before depreciation was 125.979 million dollars in 1978 and 154.008 million dollars in 1979. The ratio of operating income to sales remained constant at .13 in 1978 and in 1979.

Table 2 summarizes the results of unrestricted reduced form estimates of the aggregate model with no lags for 1674 firms:

TABLE 2

UNRESTRICTED REDUCED FORM ESTIMATION OF MODEL 1:

AGGREGATE, 1674 FIRMS, NO DISTRIBUTED LAGS

1978 SALES EQUATION

Standard error of the regression	= 201.057
Mean of the dependent variable	= 961.964
Standard deviation	= 3350.81
R-squared	= .996417
Adjusted R-squared	= .996400

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	14.7736	5.35570	2.75849
Net Sales 1977	1.57005	.0331355	47.3825
SGA Expense 1977	-.629767	.0473420	-13.3025
Receivables 1977	-.222395	.0384160	-5.78913
Inventory 1977	.00481392	.0466467	.103200
Order Backlog 1977	.0308474	.00682718	4.51832
COGS 1977	-.514840	.0363502	-14.1633
Plant 1977	-.376230	.0328449	-11.4547
Total Capital 1977	.311886	.0360993	8.63967

TABLE 2 (CONTINUED)

1978 COST OF GOODS SOLD EQUATION

Standard error of the regression	= 158.294
Mean of the dependent variable	= 699.829
Standard deviation	= 2595.70
R-squared	= .996299
Adjusted r-squared	= .996281

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	10.3154	4.21659	2.44638
Net Sales 1977	.420028	.0260879	16.1005
SGA Expense 1977	-.549235	.0372728	-14.7355
Receivables 1977	-.176375	.0302453	-5.83149
Inventory 1977	-.0227180	.0367253	-.618591
Order Backlog 1977	.0321444	.00537510	5.98025
COGS 1977	.657863	.0286188	22.9871
Plant 1977	-.284201	.0258591	-10.9904
Total Capital 1977	.202473	.0284213	7.12400

1978 SELLING, GENERAL, AND ADMINISTRATIVE EXPENSE EQUATION

Standard error of the regression	= 36.1964
Mean of the dependent variable	= 136.156
Standard deviation	= 407.390
R-squared	= .992144
Adjusted r-squared	= .992106

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	1.93483	.964189	2.00670
Net Sales 1977	.0514112	.00596541	8.61822
SGA Expense 1977	1.05744	.00852301	124.069
Receivables 1977	.00915665	.00691606	1.32397
Inventory 1977	.0641984	.00839782	7.64465
Order Backlog 1977	-.00327359	.00122910	-2.66340
COGS 1977	-.0603495	.00654414	-9.22191
Plant 1977	.0203816	.00591309	3.44686
Total Capital 1977	-.0253397	.00649897	-3.89903

The standard error of the regression for the sales equation improved by 2% of the mean of sales. However, the standard error of the cost of goods sold equation worsened by 10% and that of the SGA equation by 2%.

While two stage least squares is appropriate for the estimation of systems of simultaneous equations, its conditional expectations are not appropriate for use in forecasting. Two stage least squares derived reduced form, OLS, and OLS unrestricted reduced form are appropriate for forecasting. Two stage least squares forecasts will be included in this chapter to provide an additional basis for comparison with earlier studies. Standard errors and t-statistics will not be included in the tables of this chapter for two stage least squares estimates because such computations require a major computer programming effort with popular statistical computing packages. Goldberger, Nagar, and Odeh (1961) provided the appropriate covariance matrix of reduced form coefficients and a numerical example using Klein's Model I.

Table 3 summarizes the results of two stage least squares derived reduced form estimates of model 1:

TABLE 3

2SLS DERIVED REDUCED FORM ESTIMATION OF MODEL 1:

AGGREGATE, 1674 FIRMS, NO DISTRIBUTED LAGS

1978 SALES EQUATION

Mean of the dependent variable = 961.964
Standard deviation = 3350.81

Right-hand Variables	Estimated Coefficients
Constant	9.1603343
Net Sales 1977	1.1055136
SGA Expense 1977	.077811925
Receivables 1977	-.086500450
Inventory 1977	.12477959
Order Backlog 1977	.027730530
COGS 1977	-.0019320753
Plant 1977	.00024800056
Total Capital 1977	-.00058668670

1978 COST OF GOODS SOLD EQUATION

Mean of the dependent variable = 699.829
Standard deviation = 2595.70

Right-hand Variables	Estimated Coefficients
Constant	12.681553
Net Sales 1977	.33184077
SGA Expense 1977	-.38944884
Receivables 1977	-.025198664
Inventory 1977	.093092685
Order Backlog 1977	.0098057246
COGS 1977	.75163904
Plant 1977	-.096480143
Total Capital 1977	.0029363681

TABLE 3 (CONTINUED)

1978 GROSS MARGIN IDENTITY (SHOWN IN EXPLICIT EQUATION FORM)

Right-hand Variables	Estimated Coefficients
Constant	-3.5212191
Net Sales 1977	.77367285
SGA Expense 1977	.46726077
Receivables 1977	-.061301786
Inventory 1977	.031686900
Order Backlog 1977	.017924805
COGS 1977	-.75357112
Plant 1977	.096728144
Total Capital 1977	-.0035230548

1978 SELLING, GENERAL, AND ADMINISTRATIVE EXPENSE EQUATION

Mean of the dependent variable = 136.156
Standard deviation = 407.390

Right-hand Variables	Estimated Coefficients
Constant	1.5878678
Net Sales 1977	.027823287
SGA Expense 1977	1.0914339
Receivables 1977	-.0041988516
Inventory 1977	.020669343
Order Backlog 1977	-.0032130674
COGS 1977	-.027100377
Plant 1977	.0034785955
Total Capital 1977	-.0082291982

TABLE 3 (CONTINUED)

1978 OPERATING INCOME IDENTITY (SHOWN IN EXPLICIT EQUATION FORM)

Right-hand Variables	Estimated Coefficients
Constant	-5.1090869
Net Sales 1977	.7454956
SGA Expense 1977	-.62417315
Receivables 1977	-.057102934
Inventory 1977	.011017557
Order Backlog 1977	.021137873
COGS 1977	-.72647074
Plant 1977	.093249548
Total Capital 1977	.0047061434

Table 4 summarizes the results of two stage least squares estimates of model 1:

2SLS

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TABLE 4

2SLS ESTIMATION OF MODEL 1: AGGREGATE, 1674 FIRMS, NO DISTRIBUTED LAGS

1978 SALES EQUATION

Standard error of the regression = 221.603
Mean of the dependent variable = 961.964
Standard deviation = 3350.81

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	9.04713	5.79282	1.56178
Net Sales 1977	1.10353	.00593375	185.975
SGA Expense 1978	.0712933	.0227941	3.12771
Receivables 1977	-.0862011	.0348638	-2.47251
Inventory 1977	.123306	.0404249	3.05026
Order Backlog 1977	.0279596	.00741057	3.77294

1978 COST OF GOODS SOLD EQUATION

Standard error of the regression = 106.417
Mean of the dependent variable = 699.829
Standard deviation = 2595.70

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	10.4462	2.77850	3.75967
COGS 1977	.741969	.0126585	58.6143
Net Sales 1978	.309705	.0103305	29.9796
Plant 1977	-.0952389	.00608727	-15.6456
Inventory 1977	.0622795	.0205550	3.02990
SGA Expense 1978	-.378903	.0170816	-22.1820

TABLE 4 (CONTINUED)

1978 SELLING, GENERAL, AND ADMINISTRATIVE EXPENSE EQUATION

Standard error of the regression = 34.8716
Mean of the dependent variable = 136.156
Standard deviation = 407.390

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	1.71450	.921091	1.86138
SGA Expense 1977	1.07463	.00729999	147.209
Total Capital 1977	-.00801025	.00255453	-3.13571
Receivables 1977	-.00199428	.00626722	-.318208
Inventory 1977	.0195298	.00480625	4.06342
Order Backlog 1977	-.00385769	.00117752	-3.27612
Gross Margin 1978	.0359626	.00482407	7.45482

There is little difference between the OLS and the 2SLS estimates of the sales equation and of the cost of goods sold equation. There are relatively greater shifts in the values of the coefficients of the SGA equation, though the significant determinants retain the same signs.

5.2.2 FORECAST ACCURACY OF MODEL 1.

The best-fitting historical models or individual equations within the models in this study might not produce the most accurate forecasts. Table 5 summarizes the forecast accuracy of OLS, unrestricted reduced form, 2SLS derived reduced form, and of 2SLS estimates of model 1:

TABLE 5

FORECAST ACCURACY OF MODEL 1:

AGGREGATE, 1674 FIRMS, NO DISTRIBUTED LAGS

1979 NET SALES FORECASTS

Forecast Accuracy Measures	OLS	OLS Unrestricted Reduced Form	2SLS Derived Reduced Form	2SLS
A	.9912	.9897	.9912	.9913
B	.9825	.9795	.9826	.9827
C	592.2	640.2	591.2	590.1
D	120.0	128.3	120.5	119.8
E	52.82	57.65	53.09	53.11
F	1.068	1.073	1.068	1.068
G	.07327	.07945	.07315	.07303
H	.007955	.008109	.008063	.008099
I	.2370	.2378	.2374	.2391
J	.7551	.7541	.7546	.7528
K	.1823	.1787	.1828	.1845
L	.8097	.8132	.8091	.8074

1979 COST OF GOODS SOLD FORECASTS

Forecast Accuracy Measures	OLS	OLS Unrestricted Reduced Form	2SLS Derived Reduced Form	2SLS
A	.9986	.9920	.9928	.9975
B	.9972	.9842	.9857	.9950
C	182.5	441.7	420.5	254.2
D	49.84	93.09	90.84	59.24
E	19.17	46.68	44.73	28.16
F	1.026	1.070	1.067	1.042
G	.02881	.07134	.06781	.04043
H	.01103	.01117	.01131	.01228
I	.2110	.2622	.2643	.2754
J	.7780	.7266	.7244	.7123
K	.1899	.2082	.2128	.2443
L	.7990	.7807	.7759	.7434

TABLE 5 (CONTINUED)

1979 GROSS MARGIN FORECASTS

Forecast Accuracy Measures	OLS	OLS Unrestricted Reduced Form	2SLS Derived Reduced Form	2SLS
A	.8937	.9778	.9805	.9375
B	.7987	.9562	.9613	.8790
C	482.6	234.8	221.3	382.0
D	96.07	41.81	44.28	73.27
E	33.64	10.97	8.360	24.94
F	1.076	1.077	1.075	1.103
G	.2376	.1109	.1043	.1859
H	.004860	.002182	.001427	.004265
I	.1396	.1732	.1776	.1744
J	.8555	.8246	.8210	.8213
K	.01949	.09975	.1073	.05949
L	.9757	.8981	.8912	.9362

1979 SELLING, GENERAL, AND ADMINISTRATIVE EXPENSES FORECASTS

Forecast Accuracy Measures	OLS	OLS Unrestricted Reduced Form	2SLS Derived Reduced Form	2SLS
A	.9965	.9958	.9956	.9961
B	.9930	.9917	.9912	.9923
C	40.91	43.09	44.29	42.05
D	12.12	12.44	12.28	11.62
E	-1.037	-.4175	-.3184	-.6615
F	.9690	.9761	.9770	.9739
G	.04178	.04417	.04543	.04305
H	.0006424	.00009390	.00005167	.0002474
I	.1005	.04623	.03858	.06163
J	.8988	.9537	.9614	.9381
K	.1268	.06711	.05862	.08435
L	.8725	.9328	.9413	.9154

TABLE 5 (CONTINUED)

1979 OPERATING INCOME BEFORE DEPRECIATION FORECASTS

Forecast Accuracy Measures	OLS	OLS Unrestricted Reduced Form	2SLS Derived Reduced Form	2SLS
A	.6918	.9502	.9610	.8384
B	.4786	.9029	.9235	.7029
C	488.5	227.1	209.1	377.9
D	93.74	35.02	38.35	67.82
E	34.68	11.38	8.678	25.61
F	1.003	1.153	1.169	1.171
G	.4165	.1793	.1653	.3170
H	.005040	.002513	.001722	.004592
I	.1835	.2724	.3308	.2575
J	.8114	.7251	.6674	.7379
K	.000007079	.1398	.2019	.04790
L	.9950	.8577	.7964	.9475

FORECAST ACCURACY MEASURES CODES

A Correlation Coefficient
B Correlation Coefficient Squared
C Root-Mean-Squared Error
D Mean Absolute Error
E Mean Error
F Regression Coefficient of Actual on Predicted
G Theil's Inequality Coefficient
H Fraction of Error Due to Bias
I Fraction of Error Due to Different Variation
J Fraction of Error Due to Different Co-Variation

Alternative Decompositions of the last 2 components of Theil's Inequality Coefficient:

K Fraction of Error Due to Difference of Regression Coefficient from Unity
L Fraction of Error Due to Residual Variance

The OLS forecasting results for model 1 show that the higher the adjusted r-squared for an equation, the better the forecast accuracy (as measured by Theil's inequality coefficient). While the sales, cost of goods sold, and SGA forecast results were excellent, the gross margin and operating income results were not. The opposite relationship held for unrestricted reduced form estimates and forecasts. While the unrestricted reduced form forecasts of sales, cost of goods sold, and of SGA were not as accurate as the OLS forecasts, the gross margin and operating income forecasts were considerably better. The 2SLS sales forecast was the most accurate. Overall, however, the best forecasts were the result of using the 2SLS derived reduced form of model 1.

5.3 MODEL 2: AGGREGATE, 1674 FIRMS, UNCONSTRAINED LAGS.

Model 2 serves as a starting point for the development of distributed lag models, such as the Almon lag used by Elliott. In the Elliott studies, time series data were used to estimate the models. Elliott discovered that multicollinearity was so severe in his unconstrained lag estimates for some firms as to warrant the dropping of lagged determinants for those firms. This procedure is not possible in this cross sectional study. Model 1 provided estimation results if no distributed lags are used. Model 2 provides a comparison by using distributed lags.

5.3.1 ESTIMATION OF MODEL 2.

Table 6 summarizes the results of estimating model 2 by OLS:

TABLE 6

OLS ESTIMATION OF MODEL 2: AGGREGATE, 1674 FIRMS, UNCONSTRAINED LAGS

1978 SALES EQUATION

Standard error of the regression	= 194.504
Mean of the dependent variable	= 961.964
Standard deviation	= 3350.81
R-squared	= .996647
Adjusted R-squared	= .996631

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	8.08645	5.09554	1.58696
Net Sales 1977	1.10313	.00521963	211.343
SGA Expense 1978	2.78447	.137091	20.3110
SGA Expense 1977	-2.44745	.322894	-7.57973
SGA Expense 1976	-.635966	.459518	-1.38399
SGA Expense 1975	-.0593659	.283440	-.209448
Receivables 1977	-.0834558	.0316220	-2.63917
Inventory 1977	.0449448	.0359399	1.25056
Order Backlog 1977	.0431188	.00661804	6.51534

1978 COST OF GOODS SOLD EQUATION

Standard error of the regression	= 88.9375
Mean of the dependent variable	= 699.829
Standard deviation	= 2595.70
R-squared	= .998832
Adjusted r-squared	= .998826

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	13.2886	2.32372	5.71866
COGS 1977	.540896	.00921636	58.6886
Net Sales 1978	.483870	.00737449	65.6140
Plant 1977	-.142785	.00515338	-27.7071
Inventory 1977	.0311054	.017495	1.80327
SGA Expense 1978	-.417246	.0689742	-6.04931
SGA Expense 1977	.255268	.148237	1.72202
SGA Expense 1976	-1.05914	.207266	-5.11006
SGA Expense 1975	.599379	.129049	4.64460

TABLE 6 (CONTINUED)

1978 SELLING, GENERAL, AND ADMINISTRATIVE EXPENSE EQUATION

Standard error of the regression	= 31.5732
Mean of the dependent variable	= 136.156
Standard deviation	= 407.390
R-squared	= .994022
Adjusted r-squared	= .993994

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	2.80202	.833305	3.36254
SGA Expense 1977	1.54598	.0370291	41.7503
SGA Expense 1976	-1.07937	.0701866	-15.3786
SGA Expense 1975	.548620	.0448171	12.2413
Total Capital 1977	-.0225662	.00230951	-9.77099
Order Backlog 1977	-.000233965	.00108085	-.216464
Gross Margin 1978	.0769669	.00415769	18.5119
Inventory 1977	.0245001	.00447479	5.47514
Receivables 1977	-.00953980	.00573806	-1.66255

The introduction of lagged values of selling, general, and administrative expenses in the sales equation reduced the standard error of the regression from 23% of the mean sales value to 20%. However, the sign of the coefficient for SGA 1978 rose from .130782 without lags to 2.78447 with lags. The coefficients for SGA were negative in 1977 and in 1976 and insignificant in 1975. This is the multicollinearity problem Elliott discussed.

The cost of goods sold equation results are nearly the same with or without lagged SGA variables. The SGA determinants suffer from alternating signs for their coefficients. The sum of the coefficients for the 1978, 1977, 1976, and 1975 determinants was -.621739, which is close to the value of -.608493 for the 1978 SGA determinant in model 1. This means that the use of the current SGA variable plus the lagged

values for the previous 3 periods does not provide enough variability in the data to analyze distributed lag effects. Elliott's choice of the current period plus the prior 3 periods for studying distributed lags cannot be generalized for a large population of firms.

The introduction of lagged SGA determinants in the 1978 selling, general, and administrative expenses equation resulted in alternating signs for the SGA determinants. Order backlog, which was negative in Table 1, is insignificant in Table 6 after the introduction of lagged SGA determinants. The receivables determinant was insignificant for model 1 but negative (the wrong sign) for model 2.

Table 7 summarizes the results of unrestricted reduced form estimates of model 2:

TABLE 7

UNRESTRICTED REDUCED FORM ESTIMATION OF MODEL 2:

AGGREGATE, 1674 FIRMS, UNCONSTRAINED LAGS

1978 SALES EQUATION

Standard error of the regression	= 191.316
Mean of the dependent variable	= 961.964
Standard deviation	= 3350.81
R-squared	= .996760
Adjusted R-squared	= .996740

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	14.2128	5.09781	2.78802
Net Sales 1977	1.56056	.0321019	48.6127
SGA Expense 1977	2.25450	.223660	10.0801
SGA Expense 1976	-5.31587	.434895	-12.2233
SGA Expense 1975	2.28919	.278143	8.23027
Receivables 1977	-.311190	.0373320	-8.33574
Inventory 1977	-.0377575	.0446494	-.845644
Order Backlog 1977	.0434079	.00657833	6.59862
COGS 1977	-.500443	.0350396	-14.2822
Plant 1977	-.461758	.0319265	-14.4632
Total Capital 1977	.403951	.0351496	11.4923

TABLE 7 (CONTINUED)

1978 COST OF GOODS SOLD EQUATION

Standard error of the regression	= 153.728
Mean of the dependent variable	= 699.829
Standard deviation	= 2595.70
R-squared	= .996513
Adjusted r-squared	= .996492

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	10.0425	4.09625	2.45164
Net Sales 1977	.410738	.0257949	15.9232
SGA Expense 1977	1.22972	.179718	6.84252
SGA Expense 1976	-3.15213	.349452	-9.02020
SGA Expense 1975	1.27263	.223497	5.69416
Receivables 1977	-.228601	.0299974	-7.62069
Inventory 1977	-.0508576	.0358772	-1.41755
Order Backlog 1977	.0395815	.00528589	7.48813
COGS 1977	.669869	.0281554	23.7918
Plant 1977	-.335940	.0256539	-13.0950
Total Capital 1977	.260348	.0282438	9.21790

1978 SELLING, GENERAL, AND ADMINISTRATIVE EXPENSE EQUATION

Standard error of the regression	= 33.7550
Mean of the dependent variable	= 136.156
Standard deviation	= 407.390
R-squared	= .993176
Adjusted r-squared	= .993135

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	1.78923	.899438	1.98927
Net Sales 1977	.0507947	.00566394	8.96809
SGA Expense 1977	1.65794	.0394616	42.0140
SGA Expense 1976	-1.15673	.0767312	-15.0751
SGA Expense 1975	.531593	.0490745	10.8324
Receivables 1977	-.0103331	.00658671	-1.56879
Inventory 1977	.0560780	.00787776	7.11852
Order Backlog 1977	-.000536136	.0011606	-.461925
COGS 1977	-.0585861	.00618224	-9.47651
Plant 1977	.00217462	.00563299	.386051
Total Capital 1977	-.00660271	.00620166	-1.06467

Unrestricted reduced form estimates of the sales, cost of goods sold, and of the selling, general, and administrative expenses equations resulted in a small reduction in the standard errors of the regression relative to OLS estimates of the same equations.

Table 8 summarizes the results of estimating the 2SLS derived reduced form of model 2:

TABLE 8

2SLS DERIVED REDUCED FORM ESTIMATION OF MODEL 2:

AGGREGATE, 1674 FIRMS, UNCONSTRAINED LAGS

1978 SALES EQUATION

Mean of the dependent variable = 961.964
Standard deviation = 3350.81

Right-hand Variables	Estimated Coefficients
Constant	19.963865
Net Sales 1977	1.4332500
SGA Expense 1977	2.0299882
SGA Expense 1976	-4.2613992
SGA Expense 1975	1.8975774
Receivables 1977	-.25670061
Inventory 1977	.015775272
Order Backlog 1977	.058974787
COGS 1977	-.30250436
Plant 1977	.055237229
Total Capital 1977	-.11920132

1978 COST OF GOODS SOLD EQUATION

Mean of the dependent variable = 699.829
Standard deviation = 2595.70

Right-hand Variables	Estimated Coefficients
Constant	14.554012
Net Sales 1977	.44878714
SGA Expense 1977	.71323137
SGA Expense 1976	-2.0779535
SGA Expense 1975	.65868164
Receivables 1977	.019391896
Inventory 1977	.17714815
Order Backlog 1977	.024589841
COGS 1977	.5963643
Plant 1977	-.10889605
Total Capital 1977	.020861162

TABLE 8 (CONTINUED)

1978 GROSS MARGIN IDENTITY (SHOWN IN EXPLICIT EQUATION FORM)

Right-hand Variables	Estimated Coefficients
Constant	5.4098530
Net Sales 1977	.98446291
SGA Expense 1977	1.3167568
SGA Expense 1976	-2.1834457
SGA Expense 1975	1.2388958
Receivables 1977	-.27609250
Inventory 1977	-.16137288
Order Backlog 1977	.034384947
COGS 1977	-.89886899
Plant 1977	.16413328
Total Capital 1977	-.14006248

1978 SELLING, GENERAL, AND ADMINISTRATIVE EXPENSE EQUATION

Mean of the dependent variable = 136.156
Standard deviation = 407.390

Right-hand Variables	Estimated Coefficients
Constant	1.9789585
Net Sales 1977	.037246563
SGA Expense 1977	1.6915687
SGA Expense 1976	-1.1887094
SGA Expense 1975	.56549288
Receivables 1977	-.024337694
Inventory 1977	.020381254
Order Backlog 1977	.00044833784
COGS 1977	-.034008169
Plant 1977	.0062098840
Total Capital 1977	-.013400860

TABLE 8 (CONTINUED)

1978 OPERATING INCOME IDENTITY (SHOWN IN EXPLICIT EQUATION FORM)

Right-hand Variables	Estimated Coefficients
Constant	3.4308944
Net Sales 1977	.94721634
SGA Expense 1977	-.37481186
SGA Expense 1976	-.99473637
SGA Expense 1975	.67340291
Receivables 1977	-.25175481
Inventory 1977	-.18175414
Order Backlog 1977	.033936609
COGS 1977	-.86486082
Plant 1977	.15792339
Total Capital 1977	-.1266612

Table 9 shows the results of using 2SLS to estimate model 2:

TABLE 9

2SLS ESTIMATION OF MODEL 2: AGGREGATE, 1674 FIRMS, UNCONSTRAINED LAGS

1978 SALES EQUATION

Standard error of the regression = 288.053
Mean of the dependent variable = 961.964
Standard deviation = 3350.81

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	2.36093	7.58466	.311277
Net Sales 1977	1.10194	.00773169	142.523
SGA Expense 1978	8.89505	.838069	10.6137
SGA Expense 1977	-13.0166	1.48545	-8.76269
SGA Expense 1976	6.31223	1.14801	5.49840
SGA Expense 1975	-3.13251	.586024	-5.34537
Receivables 1977	-.0402156	.0471831	-.852331
Inventory 1977	-.165517	.0601436	-2.75203
Order Backlog 1977	.0549868	.00992748	5.53885

1978 COST OF GOODS SOLD EQUATION

Standard error of the regression = 204.756
Mean of the dependent variable = 699.829
Standard deviation = 2595.70

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	16.5489	5.57102	2.97053
COGS 1977	.543424	.0595175	9.13049
Net Sales 1978	.459888	.0453397	10.1432
Plant 1977	-.0992291	.0122062	-8.12937
Inventory 1977	.284995	.0749373	3.80312
SGA Expense 1978	-5.64743	1.51560	-3.72620
SGA Expense 1977	9.33268	2.47392	3.77243
SGA Expense 1976	-6.83134	1.64017	-4.16501
SGA Expense 1975	2.97959	.764283	3.89854

TABLE 9 (CONTINUED)

1978 SELLING, GENERAL, AND ADMINISTRATIVE EXPENSE EQUATION

Standard error of the regression	= 32.4023
Mean of the dependent variable	= 136.156
Standard deviation	= 407.390

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	1.77428	.856256	2.07213
SGA Expense 1977	1.64175	.0382102	42.9663
SGA Expense 1976	-1.10610	.0720381	-15.3543
SGA Expense 1975	.518620	.0460109	11.2717
Receivables 1977	-.0138919	.00589152	-2.35795
Inventory 1977	.0264867	.00459304	5.76671
Order Backlog 1977	-.000852596	.00110953	-.768430
Total Capital 1977	-.00810168	.00244553	-3.31285
Gross Margin 1978	.0378344	.00456760	8.28321

OLS estimates of the sales equation in model 2 (with lags) had resulted in a reduction of the standard error of the regression relative to OLS estimates of the same equation in model 1 (without lags). The opposite is the case with the 2SLS estimator. The standard error of the regression increased from 23% of the mean sales figure to 30%. All sales determinants were significant based upon 2SLS estimates of model 1. The receivables determinant was not significant in the sales equation of model 2. The sign of the inventory determinant was positive in the sales equation of model 1 and reversed in model 2.

The introduction of lagged SGA determinants in the cost of goods sold equation resulted in an increase of the standard error of the regression from 15% of mean COGS (Table 4) to 29%. The coefficients for the SGA determinants alternated signs. The largest SGA coefficient was for 1977, not 1978.

The standard error of regression of the 1978 selling, general, and administrative expenses equation decreased with the introduction of lagged SGA determinants compared with the results of Table 4. The coefficient for the receivables determinant was insignificant in the 2SLS estimation of model 1. For model 2, the negative coefficient for the receivables determinant is incorrect. Order backlogs are not a significant determinant of SGA in model 2, unlike the results of model 1.

5.3.2 FORECASTS OF MODEL 2.

Table 10 contains the forecast accuracy measures for the OLS, unrestricted reduced form, 2SLS derived reduced form, and 2SLS versions of model 2:

TABLE 10

FORECAST ACCURACY OF MODEL 2:

AGGREGATE, 1674 FIRMS, UNCONSTRAINED LAGS

1979 NET SALES FORECASTS

Forecast Accuracy Measures	OLS	OLS Unrestricted Reduced Form	2SLS Derived Reduced Form	2SLS
A	.9929	.9894	.9914	.9909
B	.9858	.9789	.9828	.9818
C	554.1	640.9	574.6	623.4
D	100.6	133.2	125.0	130.0
E	51.90	49.41	46.42	65.72
F	1.073	1.069	1.059	1.081
G	.06865	.07941	.07081	.07761
H	.008775	.005942	.006528	.01112
I	.2928	.2192	.1995	.2907
J	.6985	.7748	.7940	.6981
K	.2393	.1613	.1491	.2306
L	.7519	.8328	.8443	.7582

1979 COST OF GOODS SOLD FORECASTS

Forecast Accuracy Measures	OLS	OLS Unrestricted Reduced Form	2SLS Derived Reduced Form	2SLS
A	.9986	.9918	.9929	.9934
B	.9972	.9837	.9859	.9869
C	184.5	442.3	418.8	355.1
D	49.99	95.21	92.31	99.84
E	18.39	41.49	40.65	7.047
F	1.027	1.067	1.067	1.006
G	.02911	.07133	.06752	.05563
H	.009940	.008800	.009421	.0003939
I	.2125	.2442	.2674	.01202
J	.7775	.7470	.7232	.9876
K	.1912	.1909	.2159	.002743
L	.7989	.8003	.7747	.9969

TABLE 10 (CONTINUED)

1979 GROSS MARGIN FORECASTS

Forecast Accuracy Measures	OLS	OLS Unrestricted Reduced Form	2SLS Derived Reduced Form	2SLS
A	.9150	.9774	.9774	.7434
B	.8372	.9554	.9554	.5526
C	444.5	235.1	229.6	736.8
D	77.64	44.51	54.65	175.8
E	33.51	7.915	5.773	58.67
F	1.131	1.072	1.048	.8096
G	.2211	.1108	.1071	.3485
H	.005685	.001133	.0006322	.006341
I	.2087	.1593	.09816	.01391
J	.7856	.8396	.9012	.9797
K	.06434	.08829	.04362	.06354
L	.9300	.9106	.9558	.9301

1979 SELLING, GENERAL, AND ADMINISTRATIVE EXPENSES FORECASTS

Forecast Accuracy Measures	OLS	OLS Unrestricted Reduced Form	2SLS Derived Reduced Form	2SLS
A	.9953	.9945	.9945	.9950
B	.9906	.9890	.9890	.9900
C	47.17	49.60	49.78	48.01
D	13.11	13.54	13.57	12.78
E	-2.515	-2.091	-2.170	-2.388
F	.9656	.9725	.9718	.9690
G	.04810	.05077	.05093	.04904
H	.002843	.001777	.001899	.002474
I	.08857	.04327	.04606	.06542
J	.9086	.9550	.9520	.9321
K	.1177	.06692	.07037	.09207
L	.8794	.9313	.9277	.9055

TABLE 10 (CONTINUED)

1979 OPERATING INCOME BEFORE DEPRECIATION FORECASTS

Forecast Accuracy Measures	OLS	OLS Unrestricted Reduced Form	2SLS Derived Reduced Form	2SLS
A	.7326	.9501	.9490	.4040
B	.5368	.9027	.9006	.1632
C	462.7	226.3	220.5	779.5
D	82.08	36.5	48.33	187.8
E	36.03	10.01	7.943	61.06
F	1.096	1.148	1.099	.3661
G	.3995	.1784	.1705	.5403
H	.006062	.001955	.001298	.006136
I	.2340	.2636	.1740	.008032
J	.7600	.7344	.8247	.9858
K	.008800	.1330	.06819	.3668
L	.9851	.8651	.9305	.6271

FORECAST ACCURACY MEASURES CODES

A Correlation Coefficient
B Correlation Coefficient Squared
C Root-Mean-Squared Error
D Mean Absolute Error
E Mean Error
F Regression Coefficient of Actual on Predicted
G Theil's Inequality Coefficient
H Fraction of Error Due to Bias
I Fraction of Error Due to Different Variation
J Fraction of Error Due to Different Co-Variation

Alternative Decompositions of the last 2 components of Theil's Inequality Coefficient:

K Fraction of Error Due to Difference of Regression Coefficient from Unity
L Fraction of Error Due to Residual Variance

The use of lagged SGA determinants in model 2 produced similar forecast accuracy results to those of model 1 (Table 5). Again, 2SLS derived reduced form forecasts were the best overall for the model. The OLS forecasts of sales, cost of goods sold, and of SGA were best. This time, however, 2SLS forecasts of gross margin and of operating income were the worst. A comparison of the 2SLS derived reduced form forecasts of models 1 and 2 shows that better forecasts of gross margin and of operating income were achieved with the absence of lagged SGA determinants. Lagged SGA determinants improved the forecast accuracy of 2SLS derived forecasts.

5.4 MODEL 3: AGGREGATE, 343 FIRMS, NO DISTRIBUTED LAGS.

Model 3 serves to show the ways in which the 343 firms out of the 1674 firms of model 1 are different. These 343 disclosed as separate line items both advertising and research and development expenditures. A second major role of model 3 is to serve as a basis for evaluating the results of model 5. The income statements of models 3 and 5 differ only in the aggregation of selling, general, and administrative expenses disclosures. The choices of determinants for both models are similar. The important empirical consideration is whether the disaggregation of selling, general, and administrative expenses improves explanations of the economic behavior of firms and improves the forecast accuracy for users of accounting data.

5.4.1 ESTIMATION OF MODEL 3.

Table 11 shows the results of using OLS to estimate model 3:

TABLE 11

OLS ESTIMATION OF MODEL 3: AGGREGATE, 343 FIRMS, NO DISTRIBUTED LAGS

1978 SALES EQUATION

Standard error of the regression	= 118.057
Mean of the dependent variable	= 1078.09
Standard deviation	= 2057.59
R-squared	= .996756
Adjusted R-squared	= .996708

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	-9.48026	7.41336	- 1.27881
Net Sales 1977	1.05669	.0155394	68.0004
SGA Expense 1978	.371590	.0342737	10.8419
Receivables 1977	.226686	.0719538	3.15044
Inventory 1977	- .102631	.0855941	- 1.19904
Order Backlog 1977	- .0218587	.00756282	- 2.89029

1978 COST OF GOODS SOLD EQUATION

Standard error of the regression	= 61.7858
Mean of the dependent variable	= 716.444
Standard deviation	= 1438.36
R-squared	= .998182
Adjusted r-squared	= .998155

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	-.271765	3.85292	- .0705346
COGS 1977	.571846	.0284472	20.1020
Net Sales 1978	.487498	.0262556	18.5674
Plant 1977	-.155467	.0139436	-11.1497
Inventory 1977	-.0935029	.0397224	- 2.35391
SGA Expense 1978	-.520212	.0451076	-11.5327

TABLE 11 (CONTINUED)

1978 SELLING, GENERAL, AND ADMINISTRATIVE EXPENSE EQUATION

Standard error of the regression	= 47.9824
Mean of the dependent variable	= 212.788
Standard deviation	= 396.998
R-squared	= .985648
Adjusted r-squared	= .985392

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	2.37991	3.01321	.789827
SGA Expense 1977	.657652	.0380275	17.2941
Total Capital 1977	- .118572	.0117790	-10.0665
Order Backlog 1977	- .0161160	.00317547	- 5.07515
Gross Margin 1978	.304416	.0270232	11.2650
Inventory 1977	.191939	.0297454	6.45273
Receivables 1977	.0511887	.0324927	1.57539

The means and standard deviations of each accounting income statement variable are quite different from those of the 1674 firms reviewed to this point. For example, the mean 1978 sales of the 343 firms disclosing advertising and research and development expenditures was 1.07809 billion dollars, 12% higher than the 1674 firms from which the 343 firms were taken. The standard deviation of 1978 sales for the 343 firms was 2.05759 billion dollars, 61% of the standard deviation of the 1674 firms. A comparison of the ranges of 1978 sales for both groups revealed that the largest and the smallest firms did not disclose advertising and research and development expenditures as separate line items in their income statements. The smallest of the 343 firms reported 1978 sales of 6.349 million dollars; the smallest of the 1674 firms reported 1.488 million dollars. The largest of the 343 firms reported 1978 sales of 19.6538 billion dollars; the largest of the 1674

firms reported 63.2211 billion dollars. The use of 6 models in this study provides a basis of controlling some of the differences between the firms disclosing and not disclosing disaggregated SGA components.

The OLS estimates of 1978 sales in model 3 are quite different from the comparable estimates of model 1 (Table 1). While the adjusted r-squared results are nearly identical, the standard errors of the regression decreased from 23% of mean sales for model 1 to 11% for model 3. The estimated constant term was negative for model 3, a reversal from model 1. Sales cannot be negative. There were reversals of signs of sales determinants from the results of Table 1: (a) receivables have a positive sign, consistent with expectations; (b) inventory has a negative sign, possible under some circumstances; (c) order backlog has a negative sign, possible under some circumstances.

The ratio of cost of goods sold to sales is smaller for the 343 firms than it was for the 1674 firms. For the 1674 firms, this ratio remained constant at .73 for the years 1977, 1978, and 1979. For the 343 firms disclosing advertising and research and development expenditures, the ratio of cost of goods sold to sales was: (a) .67 in 1977; (b) .66 in 1978; (c) .67 in 1979.

The standard error of the regression for the OLS estimate of the 1978 cost of goods sold equation decreased from the 13% of mean COGS for model 1 to 9% for model 3. As with the sales equation, the estimated constant term was negative. Cost of goods sold cannot be negative. Further, cost of goods sold includes overhead. Hence, the expectation for a constant term for a cost of goods sold equation is positive. Except for the inventory determinant, the values of the coefficients of

the determinants are close for the 1674 and for the 343 firms. There was a sign reversal for inventory. For the 343 firms, there was an inverse relationship between inventory and cost of goods sold. This result is consistent with one of the purposes for which managers hold inventory.

The ratio of selling, general, and administrative expenses to sales remained a constant .14 for the 1674 firms in 1977, 1978, and in 1979. For the 343 firms, this ratio remained constant at .20.

The adjusted r-squared fell below .99 for the 1978 SGA equation. However, there was a 2% reduction in the standard error of the regression compared with the results for model 1.

The profit averages revealed differences between firms disclosing advertising and research and development expenditures and the larger population of COMPUSTAT firms. For 1978 and 1979, the ratio of operating income to sales was approximately .13 for both groups of firms. By contrast, the ratio of gross margin to sales was .33 for the firms disclosing advertising and research and development versus .27 for the larger population of firms. This means that the coefficient on gross margin in SGA equations should be larger for the 343 firms than for the 1674 firms. A comparison of Table 1 and of Table 11 shows this was the case for OLS estimates of the SGA equation.

Table 12 contains the results of unrestricted reduced form estimation of model 3:

TABLE 12

UNRESTRICTED REDUCED FORM ESTIMATION OF MODEL 3:

AGGREGATE, 343 FIRMS, NO DISTRIBUTED LAGS

1978 SALES EQUATION

Standard error of the regression	= 98.5023
Mean of the dependent variable	= 1078.09
Standard deviation	= 2057.59
R-squared	= .997762
Adjusted R-squared	= .997708

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	-12.0510	6.19841	-1.94421
Net Sales 1977	.951585	.0852285	11.1651
SGA Expense 1977	.163651	.110471	1.48140
Receivables 1977	-.223106	.0722246	-3.08905
Inventory 1977	-.627020	.0797647	-7.86087
Order Backlog 1977	-.0273111	.00714765	-3.82099
COGS 1977	.186594	.0826646	2.25724
Plant 1977	-.824021	.0553573	-14.8855
Total Capital 1977	.818575	.0554488	14.7627

TABLE 12 (CONTINUED)

1978 COST OF GOODS SOLD EQUATION

Standard error of the regression	= 76.4495
Mean of the dependent variable	= 716.444
Standard deviation	= 1438.36
R-squared	= .997241
Adjusted r-squared	= .997175

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	-9.01730	4.81071	-1.87442
Net Sales 1977	-.202784	.0661474	-3.06563
SGA Expense 1977	.362572	.0857384	4.22882
Receivables 1977	-.0308712	.0560549	-.550732
Inventory 1977	-.440281	.0619068	-7.11199
Order Backlog 1977	-.00460215	.00554742	-.829602
COGS 1977	1.29009	.0641575	20.1081
Plant 1977	-.393239	.0429638	-9.15279
Total Capital 1977	.448718	.0430349	10.4269

1978 SELLING, GENERAL, AND ADMINISTRATIVE EXPENSE EQUATION

Standard error of the regression	= 45.7798
Mean of the dependent variable	= 212.788
Standard deviation	= 396.998
R-squared	= .987014
Adjusted r-squared	= .986703

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	-.690781	2.88077	-.239791
Net Sales 1977	-.0689947	.0396107	-1.74182
SGA Expense 1977	1.05869	.0513422	20.6203
Receivables 1977	-.114859	.0335670	-3.42177
Inventory 1977	-.112317	.0370713	-3.02977
Order Backlog 1977	-.192398	.00332193	-5.79176
COGS 1977	.115250	.0384191	2.99982
Plant 1977	-.293592	.0257278	-11.4115
Total Capital 1977	.254164	.0257703	9.86268

Unrestricted reduced form estimates of the sales equation in model 3 reduced the standard error of the regression by 2% relative to OLS estimates. OLS estimates of the COGS equation provided a 2% better fit than unrestricted reduced form estimates, as measured by the standard error of the regression divided by the mean COGS for the 343 firms. For the SGA equation, there was only a 1% improvement in fit provided by the unrestricted reduced form over OLS estimates.

Table 13 contains the 2SLS derived reduced form estimates of model 3:

TABLE 13

2SLS DERIVED REDUCED FORM ESTIMATION OF MODEL 3:

AGGREGATE, 343 FIRMS, NO DISTRIBUTED LAGS

1978 SALES EQUATION

Mean of the dependent variable = 1078.09
Standard deviation = 2057.59

Right-hand Variables	Estimated Coefficients
Constant	-7.5583774
Net Sales 1977	1.0840413
SGA Expense 1977	.31710619
Receivables 1977	.24356109
Inventory 1977	-.043388059
Order Backlog 1977	-.028084943
COGS 1977	-.017749548
Plant 1977	.0011337926
Total Capital 1977	-.016187570

1978 COST OF GOODS SOLD EQUATION

Mean of the dependent variable = 716.444
Standard deviation = 1438.36

Right-hand Variables	Estimated Coefficients
Constant	-6.3524418
Net Sales 1977	.20686763
SGA Expense 1977	.022305489
Receivables 1977	.044715765
Inventory 1977	-.10061823
Order Backlog 1977	-.0047543894
COGS 1977	.87595248
Plant 1977	-.055953448
Total Capital 1977	-.0011386459

TABLE 13 (CONTINUED)

1978 GROSS MARGIN IDENTITY (SHOWN IN EXPLICIT EQUATION FORM)

Right-hand Variables	Estimated Coefficients
Constant	-1.2059356
Net Sales 1977	.87717365
SGA Expense 1977	.29480070
Receivables 1977	.19884532
Inventory 1977	.057230168
Order Backlog 1977	-.023330553
COGS 1977	-.89370203
Plant 1977	.057087241
Total Capital 1977	-.015048924

1978 SELLING, GENERAL, AND ADMINISTRATIVE EXPENSE EQUATION

Mean of the dependent variable = 212.788
Standard deviation = 396.998

Right-hand Variables	Estimated Coefficients
Constant	1.8518820
Net Sales 1977	.054559324
SGA Expense 1977	.99310131
Receivables 1977	.057345980
Inventory 1977	.17202566
Order Backlog 1977	-.016887537
COGS 1977	-.055587373
Plant 1977	.0035507693
Total Capital 1977	-.050695628

TABLE 13 (CONTINUED)

1978 OPERATING INCOME IDENTITY (SHOWN IN EXPLICIT EQUATION FORM)

Right-hand Variables	Estimated Coefficients
Constant	-3.0578176
Net Sales 1977	.82261433
SGA Expense 1977	-.69830061
Receivables 1977	.14149934
Inventory 1977	-.11479549
Order Backlog 1977	-.0064430161
COGS 1977	-.83811466
Plant 1977	.053536471
Total Capital 1977	.035646704

Table 14 shows the results of using 2SLS to estimate model 3:

TABLE 14

2SLS ESTIMATION OF MODEL 3: AGGREGATE, 343 FIRMS, NO DISTRIBUTED LAGS

1978 SALES EQUATION

Standard error of the regression = 118.463
Mean of the dependent variable = 1078.09
Standard deviation = 2057.59

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	-8.14970	7.44214	-1.09507
Net Sales 1977	1.06662	.0156786	68.0304
SGA Expense 1978	.319309	.03554535	9.00640
Receivables 1977	.225250	.0722022	3.11972
Inventory 1977	-.0983174	.0858920	-1.14466
Order Backlog 1977	-.0226926	.00759013	-2.98975

1978 COST OF GOODS SOLD EQUATION

Standard error of the regression = 72.4424
Mean of the dependent variable = 716.444
Standard deviation = 1438.36

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	-4.82279	4.53830	-1.06269
COGS 1977	.877201	.0430898	20.3575
Net Sales 1978	.192798	.0405085	4.75944
Plant 1977	-.0560332	.0186258	-3.00837
Inventory 1977	-.0855266	.0468573	-1.82525
SGA Expense 1978	-.0391017	.0685819	-.570146

TABLE 14 (CONTINUED)

1978 SELLING, GENERAL, AND ADMINISTRATIVE EXPENSE EQUATION

Standard error of the regression	= 53.4117
Mean of the dependent variable	= 212.788
Standard deviation	= 396.998

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	1.92689	3.35443	.574432
SGA Expense 1977	.974765	.0518111	18.8138
Total Capital 1977	-.0497596	.0146269	-3.40192
Receivables 1977	.0449780	.0361740	1.24338
Inventory 1977	.168466	.0331849	5.07659
Order Backlog 1977	-.0154364	.00353536	-4.36628
Gross Margin 1978	.0621990	.0377569	1.64736

A comparison of Table 11 and of Table 14 shows that OLS and 2SLS estimates of sales in model 3 produced similar results. By contrast, a comparison of Table 4 with Table 14 shows very different results when the only change is the number of firms used to estimate models 1 and 3.

5.4.2 FORECAST ACCURACY OF MODEL 3.

Table 15 summarizes the findings of using the 343 advertising and research and development firms in forecasts of the income statement:

TABLE 15

FORECAST ACCURACY OF MODEL 3:

AGGREGATE, 343 FIRMS, NO DISTRIBUTED LAGS

1979 NET SALES FORECASTS

Forecast Accuracy Measures	OLS	OLS Unrestricted Reduced Form	2SLS Derived Reduced Form	2SLS
A	.9950	.9918	.9947	.9952
B	.9900	.9836	.9894	.9904
C	233.9	299.3	241.0	229.9
D	83.80	98.00	84.09	81.55
E	-2.568	5.718	-2.696	-2.315
F	.9908	.9920	.9900	.9911
G	.04422	.05671	.04555	.04346
H	.0001205	.0003651	.0001251	.0001014
I	.001785	.000002502	.002111	.001766
J	.9981	.9996	.9978	.9981
K	.008476	.003909	.0094552	.008278
L	.9914	.9957	.9904	.9916

1979 COST OF GOODS SOLD FORECASTS

Forecast Accuracy Measures	OLS	OLS Unrestricted Reduced Form	2SLS Derived Reduced Form	2SLS
A	.9986	.9921	.9940	.9966
B	.9972	.9843	.9881	.9932
C	88.02	207.8	180.4	137.3
D	33.09	72.90	64.01	49.54
E	4.525	9.505	4.882	5.355
F	1.008	1.010	1.006	1.009
G	.02396	.05680	.04915	.03742
H	.002643	.002092	.0007326	.001522
I	.03142	.01987	.01132	.02316
J	.9659	.9780	.9879	.9753
K	.02288	.006125	.002680	.01234
L	.9745	.9918	.9966	.9861

TABLE 15 (CONTINUED)

1979 GROSS MARGIN FORECASTS

Forecast Accuracy Measures	OLS	OLS Unrestricted Reduced Form	2SLS Derived Reduced Form	2SLS
A	.9772	.9895	.9942	.9904
B	.9548	.9792	.9885	.9809
C	170.1	112.1	84.16	109.5
D	67.28	40.95	32.99	42.52
E	-7.093	-3.787	-7.578	-7.670
F	.9296	.9662	.9727	.9585
G	.09688	.06456	.04847	.06276
H	.001739	.001142	.008107	.004910
I	.05162	.02659	.03952	.05289
J	.9466	.9723	.9524	.9422
K	.1080	.05453	.06286	.08765
L	.8903	.9443	.9290	.9074

1979 SELLING, GENERAL, AND ADMINISTRATIVE EXPENSES FORECASTS

Forecast Accuracy Measures	OLS	OLS Unrestricted Reduced Form	2SLS Derived Reduced Form	2SLS
A	.9968	.9835	.9932	.9943
B	.9936	.9672	.9865	.9887
C	35.57	80.78	51.68	47.21
D	16.83	28.22	20.38	18.92
E	-.3853	1.807	-1.204	-.7325
F	1.001	.9805	.9894	.9942
G	.03519	.07979	.05096	.04663
H	.0001174	.0005007	.0005425	.0002407
I	.002298	.0002822	.001129	.000001509
J	.9976	.9992	.9983	.9998
K	.00006002	.01157	.008388	.002967
L	.9998	.9879	.9911	.9968

TABLE 15 (CONTINUED)

1979 OPERATING INCOME BEFORE DEPRECIATION FORECASTS

Forecast Accuracy Measures	OLS	OLS Unrestricted Reduced Form	2SLS Derived Reduced Form	2SLS
A	.8854	.9922	.9914	.9749
B	.7840	.9844	.9830	.9503
C	170.3	48.47	46.95	79.68
D	72.72	20.27	21.76	35.84
E	-6.708	-5.595	-6.374	-6.937
F	.8325	.9385	.9626	.9372
G	.2177	.06218	.06084	.1028
H	.001552	.01332	.01844	.007580
I	.01627	.1623	.04755	.02967
J	.9822	.8244	.9340	.9627
K	.1278	.2099	.07859	.07848
L	.8706	.7768	.9030	.9139

FORECAST ACCURACY MEASURES CODES

A Correlation Coefficient
B Correlation Coefficient Squared
C Root-Mean-Squared Error
D Mean Absolute Error
E Mean Error
F Regression Coefficient of Actual on Predicted
G Theil's Inequality Coefficient
H Fraction of Error Due to Bias
I Fraction of Error Due to Different Variation
J Fraction of Error Due to Different Co-Variation

Alternative Decompositions of the last 2 components of Theil's Inequality Coefficient:

K Fraction of Error Due to Difference of Regression Coefficient from Unity
L Fraction of Error Due to Residual Variance

The use of 343 firms, instead of 1674 firms, in developing forecasts of the income statement produced an identical pattern of best forecasts. As was the case with model 1, OLS provided the best forecasts of cost of goods sold and of SGA, 2SLS provided the best forecast of sales, and 2SLS derived reduced form produced the best forecasts of gross margin and of operating income. The forecasts of model 3 were superior to the forecasts of model 1.

5.5 MODEL 4: AGGREGATE, 343 FIRMS, UNCONSTRAINED LAGS.

Model 4 contains unconstrained lags of selling, general, and expenses determinants for the current accounting period plus as many as three prior periods. Comparisons with model 2 will show differences between a general population of COMPUSTAT firms and those firms disclosing advertising and research and development expenditures as separate line items. Comparisons with model 3 will show the potential usefulness of adding distributed lags in specifying models of the income statement. Later comparisons with model 6 will show the effects of disaggregating selling, general, and administrative expenses into major components.

5.5.1 ESTIMATION OF MODEL 4.

Table 16 shows the results of OLS estimates of model 4:

TABLE 16

OLS ESTIMATION OF MODEL 4: AGGREGATE, 343 FIRMS, UNCONSTRAINED LAGS

1978 SALES EQUATION

Standard error of the regression	= 71.4634
Mean of the dependent variable	= 1078.09
Standard deviation	= 2057.59
R-squared	= .998822
Adjusted R-squared	= .998794

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	-2.94752	4.51332	-.653071
Net Sales 1977	1.07404	.00977048	109.928
SGA Expense 1978	1.00859	.0783151	12.8786
SGA Expense 1977	1.98417	.243731	8.14083
SGA Expense 1976	-2.81861	.383279	-7.35393
SGA Expense 1975	-.451579	.280127	-1.61205
Receivables 1977	.100392	.0449517	2.23334
Inventory 1977	.0496317	.0563204	.881239
Order Backlog 1977	-.00864491	.00508230	-1.70098

1978 COST OF GOODS SOLD EQUATION

Standard error of the regression	= 55.4001
Mean of the dependent variable	= 716.444
Standard deviation	= 1438.36
R-squared	= .998551
Adjusted r-squared	= .998517

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	1.28836	3.46525	.371794
COGS 1977	.710348	.0310502	22.8786
Net Sales 1978	.361701	.0287054	12.6005
Plant 1977	-.124037	.0133923	-9.26182
Inventory 1977	-.0264694	.0393536	-.672603
SGA Expense 1978	-.456190	.0672048	-6.78805
SGA Expense 1977	1.62993	.224918	7.24679
SGA Expense 1976	-1.94651	.299734	-6.49412
SGA Expense 1975	.233355	.203585	1.14623

TABLE 16 (CONTINUED)

1978 SELLING, GENERAL, AND ADMINISTRATIVE EXPENSE EQUATION

Standard error of the regression	= 43.0645
Mean of the dependent variable	= 212.788
Standard deviation	= 396.998
R-squared	= .988508
Adjusted r-squared	= .988233

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	3.59513	2.71361	1.32485
SGA Expense 1977	1.58898	.123297	12.8874
SGA Expense 1976	-.661386	.220530	-2.99908
SGA Expense 1975	-.358232	.163355	-2.19296
Total Capital 1977	-.109327	.0106426	-10.2726
Order Backlog 1977	-.0168655	.00317805	-5.30688
Gross Margin 1978	.238513	.0253161	9.42142
Inventory 1977	.270818	.0281691	9.61400
Receivables 1977	.0206754	.0294027	.703180

The introduction of lagged SGA determinants to the sales equation decreased the standard error of the regression from 11% of average sales (Table 11) to 7%. The constant term improved with lags present because the sign of the constant term is now insignificant. The coefficients for the lagged determinants exhibited mixed signs. Without lags, the sign of the inventory determinant had been negative. With lags, the inventory coefficient became insignificant.

The pattern was similar for the cost of goods sold and SGA equations. The introduction of lagged SGA determinants lowered the standard error of the regression but showed mixed signs for the lagged determinants.

Table 17 provides unrestricted reduced form estimates of model 4 for comparison:

TABLE 17

UNRESTRICTED REDUCED FORM ESTIMATION OF MODEL 4:

AGGREGATE, 343 FIRMS, UNCONSTRAINED LAGS

1978 SALES EQUATION

Standard error of the regression	= 76.5969
Mean of the dependent variable	= 1078.09
Standard deviation	= 2057.59
R-squared	= .998655
Adjusted R-squared	= .998614

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	-4.27692	4.85516	-.880901
Net Sales 1977	1.00941	.0664055	15.2007
SGA Expense 1977	3.18593	.235397	13.5343
SGA Expense 1976	-3.05809	.414041	-7.38596
SGA Expense 1975	-.435871	.300752	-1.44927
Receivables 1977	-.135924	.0565671	-2.40289
Inventory 1977	-.160319	.0713061	-2.24832
Order Backlog 1977	-.0255758	.00594404	-4.30276
COGS 1977	.117692	.0644678	1.82560
Plant 1977	-.460314	.0495520	-9.28951
Total Capital 1977	.426990	.0505597	8.44526

TABLE 17 (CONTINUED)

1978 COST OF GOODS SOLD EQUATION

Standard error of the regression	= 64.8613
Mean of the dependent variable	= 716.444
Standard deviation	= 1438.36
R-squared	= .998026
Adjusted r-squared	= .997967

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	-3.85822	4.11129	-.938445
Net Sales 1977	-.164525	.0562313	-2.92586
SGA Expense 1977	2.36343	.199331	11.8568
SGA Expense 1976	-2.09529	.350604	-5.97621
SGA Expense 1975	-.209179	.254673	-.821366
Receivables 1977	.0253997	.0479003	.530263
Inventory 1977	-.138532	.0603810	-2.29429
Order Backlog 1977	-.00292828	.00503333	-.581778
COGS 1977	1.24534	.0545904	22.8125
Plant 1977	-.155309	.0419600	-3.70137
Total Capital 1977	.192444	.0428133	4.49495

1978 SELLING, GENERAL, AND ADMINISTRATIVE EXPENSE EQUATION

Standard error of the regression	= 43.1381
Mean of the dependent variable	= 212.788
Standard deviation	= 396.998
R-squared	= .988538
Adjusted r-squared	= .988193

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	1.27421	2.73435	.466002
Net Sales 1977	-.0543880	.0373985	-1.45428
SGA Expense 1977	1.82224	.132572	13.7453
SGA Expense 1976	-.778040	.233181	-3.33663
SGA Expense 1975	-.104005	.169379	-.614040
Receivables 1977	-.0929446	.0318577	-2.91750
Inventory 1977	.00503335	.0401584	.125337
Order Backlog 1977	-.0187610	.00334759	-5.60433
COGS 1977	.0979103	.0363072	2.69672
Plant 1977	-.201925	.0279069	-7.23569
Total Capital 1977	.155463	.0284744	5.45975

The unrestricted reduced form estimates did not fit the data as well as OLS estimates for the sales and for the cost of goods sold equations. Unrestricted reduced form estimates of the SGA equation were only slightly better than OLS estimates (Table 16).

Table 18 summarizes the 2SLS derived reduced form estimates of model 4:

TABLE 18

2SLS DERIVED REDUCED FORM ESTIMATION OF MODEL 4:

AGGREGATE, 343 FIRMS, UNCONSTRAINED LAGS

1978 SALES EQUATION

Mean of the dependent variable = 1078.09
Standard deviation = 2057.59

Right-hand Variables	Estimated Coefficients
Constant	.34959220
Net Sales 1977	1.0415168
SGA Expense 1977	4.2066620
SGA Expense 1976	-3.6607902
SGA Expense 1975	-.95812936
Receivables 1977	.14539033
Inventory 1977	.36936630
Order Backlog 1977	-.026874513
COGS 1977	.027035290
Plant 1977	.00052424451
Total Capital 1977	-.058248851

1978 COST OF GOODS SOLD EQUATION

Mean of the dependent variable = 716.444
Standard deviation = 1438.36

Right-hand Variables	Estimated Coefficients
Constant	-2.9309505
Net Sales 1977	-.0040265931
SGA Expense 1977	2.6687783
SGA Expense 1976	-2.2905788
SGA Expense 1977	-.55824899
Receivables 1977	.0018122675
Inventory 1977	.14351091
Order Backlog 1977	-.0082657633
COGS 1977	1.0718846
Plant 1977	.020785042
Total Capital 1977	-.020348933

TABLE 18 (CONTINUED)

1978 GROSS MARGIN IDENTITY (SHOWN IN EXPLICIT EQUATION FORM)

Right-hand Variables	Estimated Coefficients
Constant	3.2805427
Net Sales 1977	1.0455433
SGA Expense 1977	1.5378837
SGA Expense 1976	-1.3702114
SGA Expense 1975	-.39988037
Receivables 1977	.14357806
Inventory 1977	.22585539
Order Backlog 1977	-.018608750
COGS 1977	-1.0448493
Plant 1977	-.020260798
Total Capital 1977	-.037899918

1978 SELLING, GENERAL, AND ADMINISTRATIVE EXPENSE EQUATION

Mean of the dependent variable = 212.788
Standard deviation = 396.998

Right-hand Variables	Estimated Coefficients
Constant	3.5304406
Net Sales 1977	-.018054756
SGA Expense 1977	2.1800134
SGA Expense 1976	-.90094778
SGA Expense 1975	-.42360075
Receivables 1977	.0020824410
Inventory 1977	.26849386
Order Backlog 1977	-.015759059
COGS 1977	.018042772
Plant 1977	.00034986953
Total Capital 1977	-.038874033

TABLE 18 (CONTINUED)

1978 OPERATING INCOME IDENTITY (SHOWN IN EXPLICIT EQUATION FORM)

Right-hand Variables	Estimated Coefficients
Constant	-.24989786
Net Sales 1977	1.0635981
SGA Expense 1977	-.64212962
SGA Expense 1976	-.46926361
SGA Expense 1975	.023720375
Receivables 1977	.14149562
Inventory 1977	-.042638467
Order Backlog 1977	-.0028496914
COGS 1977	-1.0628921
Plant 1977	-.020610667
Total Capital 1977	.00097411477

Table 19 provides the 2SLS estimates of model 4:

TABLE 19

2SLS ESTIMATION OF MODEL 4: AGGREGATE, 343 FIRMS, UNCONSTRAINED LAGS

1978 SALES EQUATION

Standard error of the regression = 75.5323
Mean of the dependent variable = 1078.09
Standard deviation = 2057.59

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	-4.94042	4.30435	-1.02832
Net Sales 1977	1.06857	.0104454	102.300
SGA Expense 1978	1.49840	.162951	9.19537
SGA Expense 1977	.940130	.394810	2.38122
SGA Expense 1976	-2.31081	.430444	-5.36844
SGA Expense 1975	-.323406	.298346	-1.08400
Receivables 1977	.142270	.0490032	2.90327
Inventory 1977	-.0329449	.0640581	-.514298
Order Backlog 1977	-.00326114	.00558883	-.583511

1978 COST OF GOODS SOLD EQUATION

Standard error of the regression = 74.5540
Mean of the dependent variable = 716.444
Standard deviation = 1438.36

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	-4.75391	4.78130	-.994271
COGS 1977	1.06244	.0537784	19.7560
Net Sales 1978	.00507624	.0501504	.101220
Plant 1977	.0206019	.0224360	.918250
Inventory 1977	.00313282	.0574376	.0545431
SGA Expense 1978	.515852	.191966	2.68721
SGA Expense 1977	1.52286	.501863	3.03441
SGA Expense 1976	-1.80724	.498732	-3.62368
SGA Expense 1975	-.334870	.280243	-1.19493

TABLE 19 (CONTINUED)

1978 SELLING, GENERAL, AND ADMINISTRATIVE EXPENSE EQUATION

Standard error of the regression = 49.2073
Mean of the dependent variable = 212.788
Standard deviation = 396.998

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	3.58709	3.10068	1.15687
SGA Expense 1977	2.20657	.149715	14.7384
SGA Expense 1976	-.924609	.252910	-3.65588
SGA Expense 1975	-.430506	.186751	-2.30524
Receivables 1977	.00456179	.0336228	.135675
Inventory 1977	.272394	.0321875	8.46275
Order Backlog 1977	-.0160804	.00363195	-4.42747
Total Capital 1977	-.0395285	.0134411	-2.94088
Gross Margin 1978	-.0172683	.0357349	-.483233

The 2SLS estimates of the sales equation differed from the OLS estimates (Table 16): (a) the constant term gain a negative sign with 2SLS; (b) the order backlog determinant became insignificant.

There were major differences between 2SLS and OLS estimates of the cost of goods sold equation of model 4. Net sales and plant were insignificant determinants of COGS by 2SLS estimates. While both estimators showed all SGA determinants as being significant, the patterns of the mixed signs differed.

In the SGA equation of model 4, the OLS estimates for each proposed determinant were significant except for receivables. The 2SLS estimates added gross margin to the list of insignificant determinants of COGS.

5.5.2 FORECAST ACCURACY OF MODEL 4.

Table 20 shows the results of forecasting with a model based upon the 343 firms and the use of unconstrained lags of SGA expenditures:

TABLE 20

FORECAST ACCURACY OF MODEL 4:

AGGREGATE, 343 FIRMS, UNCONSTRAINED LAGS

1979 NET SALES FORECASTS

Forecast Accuracy Measures	OLS	Unrestricted Reduced Form	Restricted Reduced Form	2SLS
A	.9916	.9862	.9848	.9937
B	.9833	.9727	.9698	.9875
C	305.8	391.1	414.3	263.4
D	92.37	105.7	115.2	86.48
E	-19.03	-16.60	-27.62	-15.76
F	.9811	.9740	.9667	.9861
G	.05758	.07359	.07771	.04967
H	.003873	.001801	.004445	.003578
I	.006642	.005625	.01110	.004760
J	.9895	.9926	.9845	.9917
K	.02121	.02469	.03654	.01551
L	.9749	.9735	.9590	.9809

1979 COST OF GOODS SOLD FORECASTS

Forecast Accuracy Measures	OLS	OLS Unrestricted Reduced Form	2SLS Derived Reduced Form	2SLS
A	.9956	.9877	.9868	.9912
B	.9913	.9756	.9738	.9825
C	154.2	258.0	268.5	218.4
D	45.94	75.91	79.67	71.29
E	-4.484	-5.189	-9.810	-5.588
F	.9989	.9909	.9855	.9967
G	.04184	.06997	.07266	.05930
H	.0008453	.0004047	.001335	.0006546
I	.001193	.0004067	.00006633	.001748
J	.9980	.9992	.9986	.9976
K	.0001500	.003386	.007973	.0006044
L	.9990	.9962	.9907	.9987

TABLE 20 (CONTINUED)

1979 GROSS MARGIN FORECASTS

Forecast Accuracy Measures	OLS	OLS Unrestricted Reduced Form	2SLS Derived Reduced Form	2SLS
A	.9792	.9818	.9789	.9972
B	.9587	.9639	.9583	.9944
C	161.2	148.5	160.6	61.06
D	54.37	42.43	46.30	23.69
E	-14.55	-11.41	-17.82	-10.17
F	.9398	.9526	.9469	.9724
G	.09195	.08517	.09185	.03510
H	.008147	.005899	.01230	.02773
I	.03853	.02423	.02521	.09966
J	.9533	.9699	.9625	.8726
K	.08641	.06162	.06647	.1226
L	.9054	.9325	.9212	.8497

1979 SELLING, GENERAL, AND ADMINISTRATIVE EXPENSES FORECASTS

Forecast Accuracy Measures	OLS	OLS Unrestricted Reduced Form	2SLS Derived Reduced Form	2SLS
A	.9838	.9702	.9673	.9659
B	.9679	.9414	.9356	.9329
C	80.46	109.5	115.9	118.6
D	24.99	28.69	29.47	30.17
E	-6.037	-3.824	-7.917	-8.224
F	.9739	.9529	.9407	.9373
G	.07896	.1072	.1129	.1154
H	.005629	.001220	.004662	.004807
I	.003172	.005399	.01164	.01300
J	.9912	.9934	.9837	.9822
K	.02114	.03763	.05431	.05834
L	.9732	.9612	.9410	.9368

TABLE 20 (CONTINUED)

1979 OPERATING INCOME BEFORE DEPRECIATION FORECASTS

Forecast Accuracy Measures	OLS	OLS Unrestricted Reduced Form	2SLS Derived Reduced Form	2SLS
A	.9426	.9899	.9874	.9748
B	.8886	.9800	.9749	.9502
C	118.3	54.03	58.04	87.15
D	51.38	20.85	23.04	28.69
E	-8.511	-7.584	-9.898	-1.944
F	.9149	.9367	.9486	.8878
G	.1531	.06923	.07475	.1102
H	.005177	.01971	.02908	.0004978
I	.007703	.1295	.05793	.1475
J	.9871	.8508	.9130	.8520
K	.06428	.1793	.09932	.2333
L	.9305	.8009	.8716	.7662

FORECAST ACCURACY MEASURES CODES

A Correlation Coefficient
B Correlation Coefficient Squared
C Root-Mean-Squared Error
D Mean Absolute Error
E Mean Error
F Regression Coefficient of Actual on Predicted
G Theil's Inequality Coefficient
H Fraction of Error Due to Bias
I Fraction of Error Due to Different Variation
J Fraction of Error Due to Different Co-Variation

Alternative Decompositions of the last 2 components of Theil's Inequality Coefficient:

K Fraction of Error Due to Difference of Regression Coefficient from Unity
L Fraction of Error Due to Residual Variance

The use of lagged SGA determinants in making forecasts for the 343 firms produced a pattern of forecast accuracy unlike that for models 1, 2, and 3. OLS produced the best cost of goods sold and SGA forecasts. The best sales and gross margin forecasts came from 2SLS. Unrestricted reduced form provided the best operating income forecasts. Both models

3 and 4 produced the unusual result of having the unrestricted reduced form generate more accurate forecasts of operating income than of gross margin. The forecast accuracy of model 3 was better than that of model 4. Hence, the introduction of SGA lags meant poorer forecasts. The same result appeared with the forecasts of models 1 and 2.

5.6 MODEL 5: DISAGGREGATE, 343 FIRMS, NO DISTRIBUTED LAGS.

Model 5 serves to show if there are any advantages to model builders in having accountants disclose as components of SGA: (1) advertising expense; (2) research and development expense; (3) a residual SGA component. The results for model 3 showed a constant 20% of sales revenues going to selling, general, and administrative expenses for the 343 firms in the years 1977, 1978, and 1979. The disaggregation of SGA expenditures for the same firms in the same years showed a constant 3% of sales going to advertising, 2% to research and development, and 15% of sales going to a wide variety of other selling, general, and administrative expenses. These are relationships between the mean values for the 343 firms. If most individual firms show the same spending patterns each year, then models 5 and 6 of this study might not offer explanatory advantages over the aggregate models.

5.6.1 ESTIMATION OF MODEL 5.

Table 21 shows the results of OLS estimates of model 5:

TABLE 21

OLS ESTIMATION OF MODEL 5: DISAGGREGATE, 343 FIRMS, NO DISTRIBUTED LAGS

1978 SALES EQUATION

Standard error of the regression	= 105.151
Mean of the dependent variable	= 1078.09
Standard deviation	= 2057.59
R-squared	= .997442
Adjusted r-squared	= .997388

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	-3.54097	6.67393	-.530568
Net Sales 1977	1.07381	.0139650	76.8932
Advertising 1978	- .692725	.130933	- 5.29067
R & D 1978	1.24183	.209372	5.93123
Receivables 1977	- .0408195	.0736938	- .553907
Inventory 1977	- .0349063	.0766533	- .455379
Order Backlog 1977	- .0282231	.00681654	- 4.14038
SGA Net 1978	.469005	.0446629	10.5010

1978 COST OF GOODS SOLD EQUATION

Standard error of the regression	= 70.4567
Mean of the dependent variable	= 716.444
Standard deviation	= 1438.36
R-squared	= .997643
Adjusted r-squared	= .997601

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	-6.63473	4.43124	-1.49726
COGS 1977	.663683	.424370	15.6393
Net Sales 1978	.391425	.0385087	10.1646
Plant 1977	-.0970973	.0159138	- 6.10145
Inventory 1977	-.120180	.0455562	- 2.63807
R & D 1978	-.745967	.192770	- 3.86973
SGA Net 1978	-.323788	.0675943	- 4.79017

TABLE 21 (CONTINUED)

1978 ADVERTISING EXPENSE EQUATION

Standard error of the regression	= 5.36274
Mean of the dependent variable	= 29.6407
Standard deviation	= 64.1591
R-squared	= .993095
Adjusted r-squared	= .993014

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	-.165040	.333838	-.494373
Advertising 1977	1.09024	.00767827	141.990
Total Capital 1977	-.00446082	.000774593	-5.75892
Order Backlog 1977	-.00161277	.000313156	-5.15005
Gross Margin 1978	.0125844	.00133486	9.42754

1978 RESEARCH AND DEVELOPMENT EXPENSE EQUATION

Standard error of the regression	= 6.18592
Mean of the dependent variable	= 24.6685
Standard deviation	= 61.3523
R-squared	= .989923
Adjusted r-squared	= .989834

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	-.360574	.386687	-.932470
R & D 1977	1.10228	.0161783	68.1329
Total Capital 1977	-.00248970	.000865865	-2.87539
Gross Margin 1978	.00762632	.00149450	5.10292

TABLE 21 (CONTINUED)

1978 SELLING, GENERAL, AND ADMINISTRATIVE EXPENSE (NET) EQUATION

Standard error of the regression	= 44.8074
Mean of the dependent variable	= 158.479
Standard deviation	= 298.237
R-squared	= .977758
Adjusted r-squared	= .977428

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	4.42943	2.78164	1.59238
SGA Net 1977	.733218	.0302297	24.2549
Total Capital 1977	-.0708872	.00959827	-7.38542
Gross Margin 1978	.176079	.0180734	9.74244

The OLS estimates of the sales equation of model 3 (Table 11) indicated all suggested determinants were significant. While the OLS estimates of model 5 resulted in a lower standard error of the regression, there were differences with respect to the significance of determinants. The lack of significance of the constant term, with the introduction of the disaggregated components of SGA expenditures, represents an improvement in the sales equation over the negative sign for OLS estimates of model 3. While OLS estimates of model 3 indicated the expected positive sign for an SGA determinant in a sales equation, the advertising determinant showed a negative sign in OLS estimates of model 5. A negative sign for advertising in a sales equation is contrary to expectations. The negative sign might have resulted from an increase in multicollinearity brought about by the disaggregation of the SGA determinant, from poor matching of revenues and expenses for firms paying for advertising prior to its distribution, or from problems of model misspecification. Both the receivables and the inventory

determinants became insignificant with the disaggregation of SGA expenditures in the sales equation.

OLS estimates of the COGS equation for model 5 resulted in a larger standard error of the regression than was the case with the use of the aggregate SGA determinant in model 3. Further, contrary to expectations, the constant term became negative with the disaggregation of SGA expenditures. The signs of the research and development and SGA (net) components of SGA were consistent with expectations.

The advertising equation of model 5 displayed coefficients consistent with expectations. In particular, there was evidence that managers respond to order backlogs by decreasing advertising expenditures and that increases in gross margin will mean short term increases in advertising expenditures.

The research and development expense equation, in spite of its simplicity, had a standard error of the regression which was 25% of the mean of the dependent variable. The coefficient for the gross margin determinant indicated there are short run adjustments in research and development budgets in response to changes in gross margin.

The residual SGA (net) component of SGA, in spite of its poor definition, showed a standard error of the regression of 28% of the mean of SGA (net). Disaggregation of SGA hurt the sign of the receivables determinant. OLS estimates of the SGA equation in model 3 (Table 11) indicated a positive sign, as expected, for the receivables determinant. Disaggregation of SGA indicated a lack of significance for a receivables determinant in the SGA (net) equation.

Table 22 summarizes the results of estimating the unrestricted reduced form of model 5:

TABLE 22

UNRESTRICTED REDUCED FORM ESTIMATION OF MODEL 5:

DISAGGREGATE, 343 FIRMS, NO DISTRIBUTED LAGS

1978 SALES EQUATION

Standard error of the regression	= 90.3150
Mean of the dependent variable	= 1078.09
Standard deviation	= 2057.59
R-squared	= .998130
Adjusted r-squared	= .998073

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	-5.62357	5.75399	-.977334
Net Sales 1977	.748843	.0917187	8.16456
Advertising 1977	-.342958	.174257	-1.96811
R & D 1977	1.98057	.349192	5.67186
Receivables 1977	-.330485	.0678501	-4.87081
Inventory 1977	-.498655	.0748411	-6.66285
Order Backlog 1977	-.0392030	.00677855	-5.78338
SGA Net 1977	.486102	.112339	4.32711
COGS 1977	.420934	.0909499	4.62820
Plant 1977	-.698849	.0544539	-12.8338
Total Capital 1977	.674151	.0540983	12.4616

TABLE 22 (CONTINUED)

1978 COST OF GOODS SOLD EQUATION

Standard error of the regression	= 66.5374
Mean of the dependent variable	= 716.444
Standard deviation	= 1438.36
R-squared	= .997923
Adjusted r-squared	= .997860

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Net Sales 1977	-.136896	.0675717	-2.02593
Advertising 1977	-.648440	.128380	-5.05093
R & D 1977	.385249	.257259	1.49751
Receivables 1977	-.0739463	.0499870	-1.47931
Inventory 1977	-.347134	.0551374	-6.29580
Order Backlog 1977	-.0177189	.00499394	-3.54808
SGA Net 1977	.449365	.0827629	5.42954
COGS 1977	1.24600	.0670052	18.5955
Plant 1977	-.366978	.0401176	-9.14754
Total Capital 1977	.370542	.0398556	9.29711

1978 ADVERTISING EXPENSE EQUATION

Standard error of the regression	= 5.28335
Mean of the dependent variable	= 29.6407
Standard deviation	= 64.1591
R-squared	= .993417
Adjusted r-squared	= .993219

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	-.122867	.336604	-.365021
Net Sales 1977	-.00934387	.00536547	-1.74148
Advertising 1977	1.11804	.0101939	109.677
R & D 1977	.0767863	.0204274	3.75898
Receivables 1977	-.00841655	.00396918	-2.12048
Inventory 1977	-.0164938	.00437814	-3.76730
Order Backlog 1977	-.00209596	.000396540	-5.28563
SGA Net 1977	.0210857	.00657172	3.20855
COGS 1977	.0135701	.00532049	2.55054
Plant 1977	-.00937065	.00318551	-2.94165
Total Capital 1977	.00769373	.00316470	2.43110

TABLE 22 (CONTINUED)

1978 RESEARCH AND DEVELOPMENT EXPENSE EQUATION

Standard error of the regression	= 4.80099
Mean of the dependent variable	= 24.6685
Standard deviation	= 61.3523
R-squared	= .994056
Adjusted r-squared	= .993876

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	-.599165	.305872	-1.95887
Net Sales 1977	-.0293536	.00487561	-6.02050
Advertising 1977	.00305001	.00926323	.329260
R & D 1977	1.18256	.0185625	63.7071
Receivables 1977	-.00305582	.00360680	-.847239
Inventory 1977	-.0195261	.00397843	-4.90800
Order Backlog 1977	-.00177011	.000360336	-4.91238
SGA Net 1977	.0433008	.00597174	7.25095
COGS 1977	.0317012	.00483474	6.55696
Plant 1977	-.0216156	.00289468	-7.46736
Total Capital 1977	.0229196	.00287577	7.96988

1978 SELLING, GENERAL, AND ADMINISTRATIVE EXPENSE (NET) EQUATION

Standard error of the regression	= 38.1189
Mean of the dependent variable	= 158.479
Standard deviation	= 298.237
R-squared	= .984141
Adjusted r-squared	= .983664

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	2.18804	2.42857	.900960
Net Sales 1977	-.206074	.0387114	-5.32334
Advertising 1977	.391762	.0735482	5.32660
R & D 1977	.908672	.147382	6.16541
Receivables 1977	-.137233	.0286373	-4.79210
Inventory 1977	-.067489	.0315879	-2.13656
Order Backlog 1977	-.0127796	.00286100	-4.46685
SGA Net 1977	1.12828	.0474144	23.7962
COGS 1977	.248782	.0383869	6.48091
Plant 1977	-.204950	.0229831	-8.91742
Total Capital 1977	.193409	.0228331	8.47057

The unrestricted reduced form estimates of each equation in model 5 improved upon the OLS estimates in Table 21.

Table 23 shows 2SLS derived reduced form estimates of model 5:

TABLE 23

2SLS DERIVED REDUCED FORM ESTIMATION OF MODEL 5:

DISAGGREGATE, 343 FIRMS, NO DISTRIBUTED LAGS

1978 SALES EQUATION

Mean of the dependent variable = 1078.09
Standard deviation = 2057.59

Right-hand Variables	Estimated Coefficients
Constant	-.51993293
Net Sales 1977	1.1226713
Advertising 1977	-.74594828
R & D 1977	1.4103297
Receivables 1977	-.053157620
Inventory 1977	.040637716
Order Backlog 1977	-.030321988
SGA Net 1977	.34334022
COGS 1977	-.040080235
Plant 1977	-.00017359163
Total Capital 1977	-.017677749

1978 COST OF GOODS SOLD EQUATION

Mean of the dependent variable = 716.444
Standard deviation = 1438.36

Right-hand Variables	Estimated Coefficients
Constant	-3.8071771
Net Sales 1977	-.0081945346
Advertising 1977	.0054447806
R & D 1977	.79574266
Receivables 1977	-.0095016442
Inventory 1977	-.060370481
Order Backlog 1977	.00022132442
SGA Net 1977	.32700403
COGS 1977	1.0901913
Plant 1977	.0047217306
Total Capital 1977	-.018157387

TABLE 23 (CONTINUED)

1978 GROSS MARGIN IDENTITY (SHOWN IN EXPLICIT EQUATION FORM)

Right-hand Variables	Estimated Coefficients
Constant	3.2872442
Net Sales 1977	1.1308658
Advertising 1977	-.75139306
R & D 1977	.61458700
Receivables 1977	-.043655976
Inventory 1977	.10100820
Order Backlog 1977	-.030543312
SGA Net 1977	.016336192
COGS 1977	-1.1302715
Plant 1977	-.0048953223
Total Capital 1977	.00047963743

1978 ADVERTISING EXPENSE EQUATION

Mean of the dependent variable = 29.6407
Standard deviation = 64.1591

Right-hand Variables	Estimated Coefficients
Constant	-.10242260
Net Sales 1977	.012266728
Advertising 1977	1.0880995
R & D 1977	.0066665481
Receivables 1977	-.00047354510
Inventory 1977	.0010956561
Order Backlog 1977	.0011671306
SGA Net 1977	.00017720194
COGS 1977	-.012260281
Plant 1977	-.000053100540
Total Capital 1977	-.0035729973

TABLE 23 (CONTINUED)

1978 RESEARCH AND DEVELOPMENT EXPENSE EQUATION

Mean of the dependent variable = 24.6685
Standard deviation = 61.3523

Right-hand Variables	Estimated Coefficients
Constant	-.26370806
Net Sales 1977	.0071668736
Advertising 1977	-.0047619610
R & D 1977	1.1144750
Receivables 1977	-.00027667019
Inventory 1977	.00064014046
Order Backlog 1977	-.00019356855
SGA Net 1977	.00010353078
COGS 1977	-.0071631069
Plant 1977	-.000031024154
Total Capital 1977	-.0020578903

1978 SELLING, GENERAL, AND ADMINISTRATIVE EXPENSE (NET) EQUATION

Mean of the dependent variable = 158.479
Standard deviation = 298.237

Right-hand Variables	Estimated Coefficients
Constant	4.8259348
Net Sales 1977	.098486654
Advertising 1977	-.065438521
R & D 1977	.053524136
Receivables 1977	-.029654981
Inventory 1977	.18306776
Order Backlog 1977	-.0026600048
SGA Net 1977	.86281071
COGS 1977	-.098434893
Plant 1977	-.00042633166
Total Capital 1977	-.043851429

TABLE 23 (CONTINUED)

1978 OPERATING INCOME IDENTITY (SHOWN IN EXPLICIT EQUATION FORM)

Right-hand Variables	Estimated Coefficients
Constant	-1.1725599
Net Sales 1977	1.0129456
Advertising 1977	-1.7692921
R & D 1977	-.56007863
Receivables 1977	-.013250779
Inventory 1977	-.083795363
Order Backlog 1977	-.028856869
SGA Net 1977	-.84675525
COGS 1977	-1.0124132
Plant 1977	.0043848659
Total Capital 1977	.049961954

Table 24 summarizes 2SLS estimates of model 5:

TABLE 24

2SLS ESTIMATION OF MODEL 5: DISAGGREGATE, 343 FIRMS, NO DISTRIBUTED LAGS

1978 SALES EQUATION

Standard error of the regression = 105.642
Mean of the dependent variable = 1078.09
Standard deviation = 2057.59

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	-2.17775	6.71158	-.324476
Net Sales 1977	1.08257	.0140914	76.8251
Advertising 1978	- .656149	.132725	- 4.94367
R & D 1978	1.25028	.214124	5.83903
Receivables 1977	- .0413222	.0742955	- .556187
Inventory 1977	- .0322895	.0770231	- .419218
Order Backlog 1977	- .0282557	.00685022	- 4.12479
SGA Net 1978	.397917	.04669080	8.52238

1978 COST OF GOODS SOLD EQUATION

Standard error of the regression = 82.9887
Mean of the dependent variable = 716.444
Standard deviation = 1438.36

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	-5.55151	5.22674	-1.06214
COGS 1977	1.13285	.0673572	16.8186
Net Sales 1978	-.0469953	.0619242	-.758917
Plant 1977	.00490649	.0211774	.231686
Inventory 1977	-.131733	.0539392	- 2.44224
R & D 1978	.754382	.272122	2.77221
SGA Net 1978	.397609	.106211	3.74357

TABLE 24 (CONTINUED)

1978 ADVERTISING EXPENSE EQUATION

Standard error of the regression = 5.37616
Mean of the dependent variable = 29.6407
Standard deviation = 64.1591

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	-.138080	.334711	-.412536
Advertising 1977	1.09625	.00777865	140.931
Total Capital 1977	-.00357820	.000793764	-4.50789
Order Backlog 1977	-.00149844	.000314662	-4.76205
Gross Margin 1978	.0108472	.00137681	7.87850

1978 RESEARCH AND DEVELOPMENT EXPENSE EQUATION

Standard error of the regression = 6.19270
Mean of the dependent variable = 24.6685
Standard deviation = 61.3523

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	-.284541	.387680	-.733958
R & D 1977	1.11058	.0153576	67.8938
Total Capital 1977	-.00206093	.000874865	-2.35571
Gross Margin 1978	.00633751	.00153789	4.12091

1978 SELLING, GENERAL, AND ADMINISTRATIVE EXPENSE (NET) EQUATION

Standard error of the regression = 46.3911
Mean of the dependent variable = 158.479
Standard deviation = 298.237

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	4.53965	2.87998	1.57628
SGA Net 1977	.861388	.0332724	25.8889
Total Capital 1977	-.0438932	.0102181	-4.29565
Receivables 1977	-.0258530	.0278645	-.927813
Inventory 1977	.174271	.0283488	6.14738
Gross Margin 1978	.0870896	.0202880	4.29267

The 2SLS estimates of the sales equation of model 5 shared the same signs and similar magnitudes as the comparable OLS estimates of Table 21.

The results are quite different, however, for the cost of goods sold equation. The coefficient of the lagged endogenous determinant shifted from being considerably less than one with OLS to more than one with 2SLS. Net sales and plant became insignificant determinants of cost of goods sold with the 2SLS estimate. The 2SLS estimates reversed the signs of the OLS estimates of the research and development and SGA (net) determinants. In general, the 2SLS estimates of the COGS equation are contrary to expectations relative to OLS estimates.

The 2SLS and OLS estimates of the advertising expense, research and development expense, and SGA (net) equations were similar in all respects.

5.6.2 FORECAST ACCURACY OF MODEL 5.

Table 25 shows the results of forecasting with a model based upon 343 firms, a disaggregation of SGA, and upon no use of distributed lags:

TABLE 25

FORECAST ACCURACY OF MODEL 5:

DISAGGREGATE, 343 FIRMS, NO DISTRIBUTED LAGS

1979 NET SALES FORECASTS

Forecast Accuracy Measures	OLS	OLS Unrestricted Reduced Form	2SLS Derived Reduced Form	2SLS
A	.9947	.9913	.9945	.9949
B	.9894	.9826	.9889	.9898
C	241.6	308.6	246.4	236.9
D	82.68	95.59	81.26	80.50
E	-.1836	6.712	.7930	.02444
F	.9903	.9907	.9904	.9906
G	.04568	.05846	.04659	.04479
H	.0000005775	.0004732	.00001036	.00000001065
I	.001802	.00002051	.001483	.001809
J	.9982	.9995	.9985	.9982
K	.008817	.004979	.008281	.008643
L	.9912	.9945	.9917	.9914

1979 COST OF GOODS SOLD FORECASTS

Forecast Accuracy Measures	OLS	Unrestricted Reduced Form	Restricted Reduced Form	2SLS
A	.9980	.9917	.9936	.9934
B	.9960	.9834	.9873	.9869
C	105.0	213.2	186.3	189.4
D	42.30	71.05	64.09	67.33
E	4.395	9.860	6.082	6.067
F	1.010	1.008	1.006	1.007
G	.02861	.05825	.05079	.05165
H	.001752	.002139	.001066	.001026
I	.03237	.01657	.01160	.01322
J	.9659	.9813	.9873	.9858
K	.02215	.004127	.002627	.003322
L	.9761	.9937	.9963	.9957

TABLE 25 (CONTINUED)

1979 GROSS MARGIN FORECASTS

Forecast Accuracy Measures	OLS	OLS Unrestricted Reduced Form	2SLS Derived Reduced Form	2SLS
A	.9790	.9886	.9937	.9947
B	.9584	.9772	.9875	.9895
C	163.2	117.5	88.32	81.65
D	62.96	41.36	33.34	31.76
E	-4.579	-3.148	-5.289	-6.042
F	.9319	.9633	.9671	.9673
G	.09305	.06762	.05079	.04693
H	.0007872	.0007183	.003586	.005476
I	.05467	.02846	.05551	.06857
J	.9445	.9708	.9409	.9260
K	.1096	.05871	.08361	.09644
L	.8897	.9406	.9128	.8981

1979 ADVERTISING EXPENSE FORECASTS

Forecast Accuracy Measures	OLS	OLS Unrestricted Reduced Form	2SLS Derived Reduced Form	2SLS
A	.9895	.9872	.9876	.9895
B	.9790	.9745	.9753	.9792
C	10.67	11.78	11.73	10.64
D	3.628	3.858	4.079	3.588
E	-.6438	-.5514	-1.054	-.6378
F	.9777	.9731	.9661	.9777
G	.06602	.07290	.07226	.06586
H	.003644	.002189	.008062	.003594
I	.006746	.007907	.01906	.006809
J	.9896	.9899	.9729	.9896
K	.02368	.02824	.04617	.02374
L	.9727	.9696	.9458	.9727

TABLE 25 (CONTINUED)

1979 RESEARCH AND DEVELOPMENT EXPENSE FORECASTS

Forecast Accuracy Measures	OLS	OLS Unrestricted Reduced Form	2SLS Derived Reduced Form	2SLS
A	.9952	.9880	.9948	.9953
B	.9905	.9762	.9896	.9906
C	6.889	10.94	7.224	6.872
D	2.274	3.181	2.216	2.195
E	.07374	.2890	.05090	.08439
F	.9987	.9915	.9952	.9985
G	.04522	.07184	.04736	.04511
H	.0001146	.0006982	.00004964	.0001508
I	.001254	.0005188	.00001464	.001099
J	.9986	.9988	.9999	.9988
K	.0001796	.002997	.002235	.0002414
L	.9997	.9963	.9977	.9996

1979 SELLING, GENERAL, AND ADMINISTRATIVE EXPENSES (NET) FORECASTS

Forecast Accuracy Measures	OLS	OLS Unrestricted Reduced Form	2SLS Derived Reduced Form	2SLS
A	.9957	.9791	.9933	.9951
B	.9914	.9587	.9867	.9902
C	30.70	67.47	38.07	32.93
D	15.20	24.22	17.48	15.49
E	.4469	2.416	.03562	.4963
F	1.008	.9826	1.001	1.009
G	.04091	.08970	.05062	.04390
H	.0002119	.001283	.0000008752	.0002271
I	.01856	.0002919	.004300	.01991
J	.9812	.9984	.9957	.9799
K	.008118	.007251	.00006096	.008394
L	.9917	.9915	.9999	.9914

TABLE 25 (CONTINUED)

1979 OPERATING INCOME BEFORE DEPRECIATION FORECASTS

Forecast Accuracy Measures	OLS	OLS Unrestricted Reduced Form	2SLS Derived Reduced Form	2SLS
A	.9102	.9912	.9879	.9882
B	.8284	.9824	.9760	.9766
C	154.1	50.82	57.42	59.52
D	63.11	19.99	25.23	26.03
E	-4.456	-5.302	-4.322	-5.985
F	.8370	.9383	.9397	.9241
G	.1954	.06522	.07388	.07596
H	.0008363	.01089	.005664	.01011
I	.03764	.1435	.09305	.1590
J	.9615	.8456	.9013	.8309
K	.1547	.1921	.1422	.2175
L	.8445	.7970	.8522	.7724

FORECAST ACCURACY MEASURES CODES

A Correlation Coefficient
B Correlation Coefficient Squared
C Root-Mean-Squared Error
D Mean Absolute Error
E Mean Error
F Regression Coefficient of Actual on Predicted
G Theil's Inequality Coefficient
H Fraction of Error Due to Bias
I Fraction of Error Due to Different Variation
J Fraction of Error Due to Different Co-Variation

Alternative Decompositions of the last 2 components of Theil's Inequality Coefficient:

K Fraction of Error Due to Difference of Regression Coefficient from Unity
L Fraction of Error Due to Residual Variance

In Table 15, unrestricted reduced form forecasts of operating income were more accurate than of gross margin. This happened again with the disaggregate model for the same firms. The best forecast of operating income for disaggregate model 5 was worse than the best forecast of operating income for model 3. The additional disclosures of

the components of SGA did not help produce better forecasts of operating income for the models of this study. OLS produced the best forecasts cost of goods sold and of SGA (net). This is the same pattern as the results of forecasts of COGS and of SGA in Table 15. The difference with the disaggregate model is that 2SLS derived reduced form did not produce the best forecasts for any equation in model 5. The best forecasts of sales, gross margin, advertising expense, and of research and development expense came from the 2SLS estimates of model 5. Theil's inequality coefficient was .03519 for the OLS forecasts of SGA in model 3. The disaggregation of SGA in model 5 resulted in poorer inequality coefficients for each of the smaller components of SGA.

5.7 MODEL 6: DISAGGREGATE, 343 FIRMS, UNCONSTRAINED LAGS.

Model 6 provided a starting point for considering the use of distributed lags in the disaggregate model. Comparisons of model 6 with model 5 show improvements in fit and in forecast accuracy, if any, over a disaggregate model not using distributed lags (model 5). Comparisons of model 6 with model 4 show differences between lagged formulations of aggregate and of disaggregate models.

5.7.1 ESTIMATION OF MODEL 6.

Table 26 summarizes the findings for OLS estimation of model 6:

TABLE 26

OLS ESTIMATION OF MODEL 6: DISAGGREGATE, 343 FIRMS, UNCONSTRAINED LAGS

1978 SALES EQUATION

Standard error of the regression	= 64.2274
Mean of the dependent variable	= 1078.09
Standard deviation	= 2057.59
R-squared	= .999071
Adjusted r-squared	= .999026

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	-2.61826	4.12195	-.635198
Net Sales 1977	1.08423	.00919480	117.917
Advertising 1978	- .732279	.769493	-.951638
Advertising 1977	2.47143	1.34877	1.83237
Advertising 1976	-2.85396	.854903	-3.33835
Advertising 1975	.555235	.541498	1.02537
R & D 1978	3.91334	.838620	4.66640
R & D 1977	.451272	1.87870	.240205
R & D 1976	-3.37003	1.89364	-1.77965
R & D 1975	-1.27299	1.03970	-1.22438
Receivables 1977	- .00222839	.0468189	-.0475959
Inventory 1977	.0215614	.0520012	.414633
Order Backlog 1977	- .0196358	.00511794	- 3.83666
SGA Net 1978	1.21604	.0952813	12.7626
SGA Net 1977	.192132	.319557	.601243
SGA Net 1976	-.369177	.496041	-.744247
SGA Net 1975	-1.11046	.327627	-3.38940

TABLE 26 (CONTINUED)

1978 COST OF GOODS SOLD EQUATION

Standard error of the regression	= 52.0506
Mean of the dependent variable	= 716.444
Standard deviation	= 1438.36
R-squared	= .998736
Adjusted r-squared	= .998690

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	-2.49075	3.30819	-.752905
COGS 1977	.693646	.0326425	21.2498
Net Sales 1978	.361088	.0294987	12.2408
Plant 1977	-.0705124	.0127932	-5.51170
Inventory 1977	.0492834	.0372500	1.32305
R & D 1978	2.64346	.672115	3.93304
R & D 1977	.313376	1.50757	.207868
R & D 1976	-4.49635	1.49710	-3.00337
R & D 1975	-.631745	.805076	-.784702
SGA Net 1978	-.641424	.0813167	-7.88798
SGA Net 1977	1.63476	.248903	6.56785
SGA Net 1976	-1.27040	.366682	-3.46458
SGA Net 1975	-.339133	.240309	-1.41124

1978 ADVERTISING EXPENSE EQUATION

Standard error of the regression	= 4.81175
Mean of the dependent variable	= 29.6407
Standard deviation	= 64.1591
R-squared	= .994474
Adjusted r-squared	= .994375

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	-.156918	.299699	-.523585
Advertising 1977	1.49685	.0527931	28.3531
Advertising 1976	-.246765	.0611754	-4.03372
Advertising 1975	-.218699	.0368329	-5.93758
Total Capital 1977	-.00398597	.000698060	-5.71007
Order Backlog 1977	-.00196500	.000283697	-6.92640
Gross Margin 1978	.0107216	.00121912	8.79460

TABLE 26 (CONTINUED)

1978 RESEARCH AND DEVELOPMENT EXPENSE EQUATION

Standard error of the regression	= 4.86691
Mean of the dependent variable	= 24.6685
Standard deviation	= 61.3523
R-squared	= .993799
Adjusted r-squared	= .993707

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	-.243090	.304894	-.797295
R & D 1977	2.01291	.0715218	28.1440
R & D 1976	-.987193	.121640	-8.11567
R & D 1975	-.0121893	.0727643	-.167518
Total Capital 1977	.0000725401	.000704220	.103008
Gross Margin 1978	.00205440	.00123706	1.66072

1978 SELLING, GENERAL, AND ADMINISTRATIVE EXPENSE (NET) EQUATION

Standard error of the regression	= 39.7291
Mean of the dependent variable	= 158.479
Standard deviation	= 298.237
R-squared	= .982618
Adjusted r-squared	= .982254

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	6.10616	2.47286	2.46927
SGA Net 1977	1.91844	.125408	15.2976
SGA Net 1976	-1.53773	.217201	-7.07974
SGA Net 1975	.238612	.161265	1.47963
Receivables 1977	-.0322210	.0242570	-1.32832
Inventory 1977	.241489	.0258434	9.34435
Total Capital 1977	-.0770494	.00857810	-8.98211
Gross Margin 1978	.150750	.0163741	9.20659

The use of lagged advertising, research and development, and of SGA (net) determinants in the sales equation of model 6 reduced the standard error of the regression from 10% of average sales to 6%. In Table 21, the coefficient for the advertising determinant had been negative, contrary to expectations. With the introduction of lags, the

advertising determinant for the current period became insignificant. The coefficient for advertising expenditures of the year prior to the sales being explained was positive. However, the problem of mixed signs for coefficients of some of the lagged advertising, research and development, and SGA (net) determinants continues to appear in the disaggregate model as it did in the aggregate models. The patterns of coefficients were quite different for the three sales-generating lagged determinants. Advertising was insignificant in the current period, showed a positive sign for lag 1, showed a larger negative sign for lag 2, and showed a small, positive sign for lag 3. Research and development expenditures showed a strong, positive relationship with sales of the current period, an insignificant relationship for lag 1, and strong, negative relationships for lags 2 and 3. SGA (net) exhibited the expected positive relationship with sales of the current period but was insignificant for lags 1 and 2 and negative for lag 3.

The OLS estimate of the cost of goods sold equation of model 6 displayed a better fit than did its counterpart of model 5. The introduction of lagged research and development and of lagged SGA (net) determinants changed the sign of the constant term from negative to insignificant and retained similar values for coefficients of lagged cost of goods sold, net sales, and of plant determinants. However, there was a sign reversal, contrary to expectations, for the inventory determinant. In addition to the mixed sign problem for the lagged cost-reducing determinants, the use of lagged determinants brought a sign reversal for research and development expenditures of the current period.

The advertising equation contained lagged advertising determinants but no lagged research and development or SGA (net) determinants. The result was a better fit than for the advertising equation of model 5. There were mixed signs for the advertising determinants. As has been seen in previous tables, the sum of the advertising coefficients in model 6 was nearly the same as the single coefficient for the advertising determinant in model 5.

The use of lagged research and development determinants in the research and development equation improved the fit but not the explanation. The invested capital determinant became insignificant. The coefficient for the research and development determinant of lag 1 increased from 1.10228 in Table 21 to 2.01291.

A similar outcome resulted in fitting the SGA (net) equation. An important difference was that invested capital remained a significant determinant of SGA (net).

Table 27 shows the results of unrestricted reduced form estimates of model 6:

TABLE 27

UNRESTRICTED REDUCED FORM ESTIMATION OF MODEL 6:

DISAGGREGATE, 343 FIRMS, UNCONSTRAINED LAGS

1978 SALES EQUATION

Standard error of the regression	= 73.7985
Mean of the dependent variable	= 1078.09
Standard deviation	= 2057.59
R-squared	= .998774
Adjusted r-squared	= .998714

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	-2.24394	4.73764	-.473642
Net Sales 1977	.919646	.080068	11.4857
Advertising 1977	1.40792	.889615	1.58261
Advertising 1976	-2.55440	.975474	-2.61863
Advertising 1975	1.04367	.606775	1.72003
R & D 1977	6.57854	1.39653	4.71065
R & D 1976	-3.90021	2.13261	-1.82884
R & D 1975	-2.29516	1.21757	-1.88503
Receivables 1977	-.219495	.0574394	-3.82133
Inventory 1977	-.131163	.071103	-1.84469
Order Backlog 1977	-.038783	.00652665	-5.19076
SGA Net 1977	2.53931	.319681	7.94327
SGA Net 1976	-1.93921	.531608	-3.64783
SGA Net 1975	-.765740	.364209	-2.10248
COGS 1977	.229093	.0797560	2.87243
Plant 1977	-.424344	.0505442	-8.39552
Total Capital 1977	.382112	.0505490	7.55923

TABLE 27 (CONTINUED)

1978 COST OF GOODS SOLD EQUATION

Standard error of the regression	= 58.4125
Mean of the dependent variable	= 716.444
Standard deviation	= 1438.36
R-squared	= .998428
Adjusted r-squared	= .998351

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	-5.23335	3.74991	-1.39560
Net Sales 1977	-.0398272	.0633753	-.628433
Advertising 1977	.190662	.704143	.270772
Advertising 1976	-1.83130	.772100	-2.37184
Advertising 1975	1.20390	.480271	2.50670
R & D 1977	4.45788	1.10537	4.03293
R & D 1976	-3.88740	1.68799	-2.30298
R & D 1975	-1.17888	.963727	-1.22325
Receivables 1977	-.0147911	.0454641	-.325335
Inventory 1977	-.130572	.0562791	-2.32007
Order Backlog 1977	-.0171914	.00516593	-3.32784
SGA Net 1977	1.34073	.253032	5.29866
SGA Net 1976	-.481952	.420775	-1.14539
SGA Net 1975	-.792895	.288276	-2.75047
COGS 1977	1.13695	.0631280	18.0102
Plant 1977	-.205373	.0400064	-5.13350
Total Capital 1977	.200886	.0400102	5.02087

TABLE 27 (CONTINUED)

1978 ADVERTISING EXPENSE EQUATION

Standard error of the regression	= 4.75318
Mean of the dependent variable	= 29.6407
Standard deviation	= 64.1591
R-squared	= .994768
Adjusted r-squared	= .994512

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	-.0244680	.305140	-.0801860
Net Sales 1977	-.00618574	.0051702	-1.19948
Advertising 1977	1.49038	.0572980	26.0111
Advertising 1976	-.237924	.0628279	-3.78692
Advertising 1975	-.180477	.0390809	-4.61803
R & D 1977	.0580253	.0899469	.645107
R & D 1976	.107771	.137356	.784607
R & D 1975	-.135543	.0784211	-1.72840
Receivables 1977	-.00163524	.00369954	-.442012
Inventory 1977	-.000357121	.00457958	-.0779812
Order Backlog 1977	-.00195916	.000420366	-4.66062
SGA Net 1977	.0806605	.0205899	3.91748
SGA Net 1976	-.0693881	.0342396	-2.02655
SGA Net 1975	-.00354864	.0234578	-.151278
COGS 1977	.00778030	.00513689	1.51459
Plant 1977	.00114528	.00325543	.351807
Total Capital 1977	-.00235853	.00325574	-.724422

TABLE 27 (CONTINUED)

1978 RESEARCH AND DEVELOPMENT EXPENSE EQUATION

Standard error of the regression	= 4.15396
Mean of the dependent variable	= 24.6685
Standard deviation	= 61.3523
R-squared	= .995630
Adjusted r-squared	= .995416

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	-.312527	.266672	-1.17195
Net Sales 1977	-.0159984	.00450689	-3.54976
Advertising 1977	.0372200	.0500746	.743290
Advertising 1976	.0200897	.0549074	.365884
Advertising 1975	-.0578159	.0341541	-1.69279
R & D 1977	1.69583	.0786075	21.5734
R & D 1976	-.660184	.120040	-5.49968
R & D 1975	.0580978	.0685347	.847713
Receivables 1977	-.00258475	.00323315	-.799455
Inventory 1977	-.00414710	.00400225	-1.03619
Order Backlog 1977	-.000431832	.000367371	-1.17546
SGA Net 1977	.113728	.0179942	6.32029
SGA Net 1976	-.190386	.0299231	-6.36250
SGA Net 1975	.0970733	.0205005	4.73516
COGS 1977	.0174826	.00448930	3.89429
Plant 1977	-.00920632	.00284503	-3.23594
Total Capital 1977	.00955290	.00284530	3.35743

TABLE 27 (CONTINUED)

1978 SELLING, GENERAL, AND ADMINISTRATIVE EXPENSE (NET) EQUATION

Standard error of the regression	= 34.9330
Mean of the dependent variable	= 158.479
Standard deviation	= 298.237
R-squared	= .986922
Adjusted r-squared	= .986280

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	3.60948	2.24259	1.60951
Net Sales 1977	-.152723	.0379009	-4.02954
Advertising 1977	.556382	.421105	1.32124
Advertising 1976	-.332694	.461746	-.720513
Advertising 1975	.272381	.287221	.948333
R & D 1977	1.10418	.661054	1.67033
R & D 1976	.372559	1.00949	.369058
R & D 1975	-.982014	.576346	-1.70386
Receivables 1977	-.104229	.0271893	-3.83345
Inventory 1977	-.0280320	.0336571	.832869
Order Backlog 1977	-.00976944	.00308943	-3.16222
SGA Net 1977	1.98196	.151323	13.0975
SGA Net 1976	-1.04458	.251640	-4.15110
SGA Net 1975	-.00612496	.172400	-.0355275
COGS 1977	.192949	.037753	5.11084
Plant 1977	-.131644	.0239254	-5.50227
Total Capital 1977	.110674	.0239277	4.62534

The use of the unrestricted reduced form estimator did not improve the fit of the sales equation or of the cost of goods sold equation over the OLS estimates of Table 26. The opposite was the case for the advertising, research and development, and for the SGA (net) equations. OLS estimates of each equation included endogenous variables as determinants and, except for the sales equation, excluded one or more of the lagged advertising, research and development, and SGA (net) determinants. By contrast, unrestricted reduced form estimates of each equation excluded all endogenous variables as determinants and included

all lagged advertising, research and development, and SGA (net) determinants.

The results of 2SLS derived reduced form estimates of model 6 appear in Table 28:

TABLE 28

2SLS DERIVED REDUCED FORM ESTIMATION OF MODEL 6:

DISAGGREGATE, 343 FIRMS, UNCONSTRAINED LAGS

1978 SALES EQUATION
Mean of the dependent variable = 1078.09
Standard deviation = 2057.59

Right-hand Variables	Estimated Coefficients
Constant	10.164539
Net Sales 1977	1.0245245
Advertising 1977	-.90673032
Advertising 1976	-.34826157
Advertising 1975	.60576988
R & D 1977	.45586009
R & D 1976	2.4091797
R & D 1975	-2.3957022
Receivables 1977	-.041112262
Inventory 1977	.63348622
Order Backlog 1977	-.0040795074
SGA Net 1977	7.0545122
SGA Net 1976	-8.4582741
SGA Net 1975	.91780548
COGS 1977	.046122336
Plant 1977	-.00052785176
Total Capital 1977	-.093152019

TABLE 28 (CONTINUED)

1978 COST OF GOODS SOLD EQUATION

Mean of the dependent variable = 716.444
Standard deviation = 1438.36

Right-hand Variables	Estimated Coefficients
Constant	-2.6223311
Net Sales 1977	.13867433
Advertising 1977	-.12273032
Advertising 1976	-.047138881
Advertising 1975	.081993871
R & D 1977	12.242671
R & D 1976	-11.697891
R & D 1975	-2.5082271
Receivables 1977	.027608555
Inventory 1977	-.077853413
Order Backlog 1977	-.00055218098
SGA Net 1977	-.18231164
SGA Net 1976	2.3116599
SGA Net 1975	-2.3805832
COGS 1977	.93172046
Plant 1977	-.010663169
Total Capital 1977	.048655783

TABLE 28 (CONTINUED)

1978 GROSS MARGIN IDENTITY (SHOWN IN EXPLICIT EQUATION FORM)

Right-hand Variables	Estimated Coefficients
Constant	12.786870
Net Sales 1977	.88585020
Advertising 1977	-.78400000
Advertising 1976	-.30112268
Advertising 1975	.52377600
R & D 1977	-11.786811
R & D 1976	14.107071
R & D 1975	.11252490
Receivables 1977	-.068720817
Inventory 1977	.71133964
Order Backlog 1977	-.0035273264
SGA Net 1977	7.2368239
SGA Net 1976	-10.769934
SGA Net 1975	3.2983887
COGS 1977	-.88559813
Plant 1977	.010135318
Total Capital 1977	-.14180780

TABLE 28 (CONTINUED)

1978 ADVERTISING EXPENSE EQUATION

Mean of the dependent variable = 29.6407
Standard deviation = 64.1591

Right-hand Variables	Estimated Coefficients
Constant	-.017869858
Net Sales 1977	.0084464665
Advertising 1977	1.5028047
Advertising 1976	-.25847517
Advertising 1975	-.21530686
R & D 1977	-.11238571
R & D 1976	.13450908
R & D 1975	.0010729103
Receivables 1977	-.00065524406
Inventory 1977	.0067825310
Order Backlog 1977	-.0019300926
SGA Net 1977	.069002175
SGA Net 1976	-.10268992
SGA Net 1975	.031449707
COGS 1977	-.0084440630
Plant 1977	.000096638937
Total Capital 1977	-.0047444890

TABLE 28 (CONTINUED)

1978 RESEARCH AND DEVELOPMENT EXPENSE EQUATION

Mean of the dependent variable = 24.6685
Standard deviation = 61.3523

Right-hand Variables	Estimated Coefficients
Constant	-.18019831
Net Sales 1977	.0010613194
Advertising 1977	-.00093929472
Advertising 1976	-.00036076907
Advertising 1975	.00062752556
R & D 1977	2.0169185
R & D 1976	-.98384860
R & D 1975	-.012997686
Receivables 1977	-.000082333036
Inventory 1977	.00085224179
Order Backlog 1977	-.0000042260192
SGA Net 1977	.0086702939
SGA Net 1976	-.012903243
SGA Net 1975	.0039517335
COGS 1977	-.0010610174
Plant 1977	.000012142921
Total Capital 1977	.00019822491

TABLE 28 (CONTINUED)

1978 SELLING, GENERAL, AND ADMINISTRATIVE EXPENSE (NET) EQUATION

Mean of the dependent variable = 158.479
Standard deviation = 298.237

Right-hand Variables	Estimated Coefficients
Constant	7.3494701
Net Sales 1977	.070112918
Advertising 1977	-.062051719
Advertising 1976	-.023833138
Advertising 1975	.041455614
R & D 1977	-.93289778
R & D 1976	1.1165408
R & D 1975	.0089060757
Receivables 1977	-.040145088
Inventory 1977	.30984783
Order Backlog 1977	-.00027917942
SGA Net 1977	2.6738072
SGA Net 1976	-2.4176944
SGA Net 1975	.42703155
COGS 1977	-.070092966
Plant 1977	.00080218607
Total Capital 1977	-.067426147

TABLE 28 (CONTINUED)

1978 OPERATING INCOME IDENTITY (SHOWN IN EXPLICIT EQUATION FORM)

Right-hand Variables	Estimated Coefficients
Constant	5.6354680
Net Sales 1977	.80622950
Advertising 1977	-2.2238136
Advertising 1976	-.018453612
Advertising 1975	.69699973
R & D 1977	-12.758446
R & D 1976	13.839869
R & D 1975	.11554360
Receivables 1977	-.027838152
Inventory 1977	.39385704
Order Backlog 1977	-.0013138284
SGA Net 1977	4.4853442
SGA Net 1976	-8.2366464
SGA Net 1975	2.8359557
COGS 1977	-.80600008
Plant 1977	.0092243498
Total Capital 1977	-.069835390

Table 29 contains the results of 2SLS estimates of model 6:

TABLE 29

2SLS ESTIMATION OF MODEL 6: DISAGGREGATE, 343 FIRMS, UNCONSTRAINED LAGS

1978 SALES EQUATION

Standard error of the regression = 191.962
Mean of the dependent variable = 1078.09
Standard deviation = 2057.59

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	-21.3004	26.5890	-.801097
Net Sales 1977	1.07066	.0471118	22.7260
Advertising 1978	-35.8085	22.7096	-1.57680
Advertising 1977	53.1333	33.1459	1.60301
Advertising 1976	-9.51674	5.26947	-1.80601
Advertising 1975	-7.25560	6.27411	-1.15644
R & D 1978	-13.5761	38.2709	-.354737
R & D 1977	27.4156	62.0020	.442172
R & D 1976	-10.4424	25.6120	-.407715
R & D 1975	-2.56813	4.95343	-.518455
Receivables 1977	.0893197	.253957	.351711
Inventory 1977	-.308493	.304589	-1.01282
Order Backlog 1977	-.0721726	.0370609	-1.94740
SGA Net 1978	3.86132	3.03102	1.27393
SGA Net 1977	-.681340	1.65306	-.412169
SGA Net 1976	-2.97513	5.17945	-.574411
SGA Net 1975	.448716	3.85197	.116490

TABLE 29 (CONTINUED)

1978 COST OF GOODS SOLD EQUATION

Standard error of the regression = 90.5768
Mean of the dependent variable = 716.444
Standard deviation = 1438.36

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	5.77127	6.22516	.927087
COGS 1977	.880485	.0893683	9.85233
Net Sales 1978	.177390	.0814970	2.17664
Plant 1977	-.0100768	.0285388	-.353091
Inventory 1977	.0749224	.0681330	1.09965
R & D 1978	19.4969	5.02224	3.88212
R & D 1977	-28.0102	9.22717	-3.03562
R & D 1976	8.07209	4.76778	1.69305
R & D 1975	-1.82174	1.47255	-1.23714
SGA Net 1978	-.909369	.336688	-2.70093
SGA Net 1977	.828722	.682255	1.21468
SGA Net 1976	1.86507	1.19722	1.55783
SGA Net 1975	-2.23211	.637801	-3.49970

1978 ADVERTISING EXPENSE EQUATION

Standard error of the regression = 4.81853
Mean of the dependent variable = 29.6407
Standard deviation = 64.1591

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	-.139791	.300147	-.465743
Advertising 1977	1.51028	.0529560	28.5195
Advertising 1976	-.255604	.0612947	-4.17009
Advertising 1975	-.220301	.0368867	-5.97236
Total Capital 1977	-.00339237	.000712005	-4.76453
Order Backlog 1977	-.00189646	.000284526	-6.66533
Gross Margin 1978	.00953487	.00125042	7.62535

TABLE 29 (CONTINUED)

1978 RESEARCH AND DEVELOPMENT EXPENSE EQUATION

Standard error of the regression	= 4.87037
Mean of the dependent variable	= 24.6685
Standard deviation	= 61.3523

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	-.195518	.305493	-.640007
R & D 1977	2.03104	.0718092	28.2839
R & D 1976	-1.00075	.121805	-8.21601
R & D 1975	-.0131325	.0728167	-.180350
Total Capital 1977	.000368122	.000711089	.517687
Gross Margin 1978	.00119808	.00126814	.944761

1978 SELLING, GENERAL, AND ADMINISTRATIVE EXPENSE (NET) EQUATION

Standard error of the regression	= 40.8472
Mean of the dependent variable	= 158.479
Standard deviation	= 298.237

Right-hand Variables	Estimated Coefficients	Standard Errors	t-Statistics
Constant	6.33742	2.54254	2.49255
SGA Net 1977	2.10103	.129943	16.1689
SGA Net 1976	-1.56528	.223328	-7.00890
SGA Net 1975	.165972	.165928	1.00026
Receivables 1977	-.0347060	.0249406	-1.39154
Inventory 1977	.253547	.0265920	9.53469
Total Capital 1977	-.0562024	.00900979	-6.23793
Gross Margin 1978	.0791476	.0179843	4.40094

The results of using 2SLS to estimate the sales equation of model 6 show greatly inflated coefficients for the advertising, research and development, and the SGA (net) determinants. This problem remains in the cost of goods sold equation for the lagged research and development determinants but not for the lagged SGA (net) determinants. By contrast, there was little difference between OLS and 2SLS estimates of the advertising, research and development, and of the SGA (net)

equations. These last three equations differ from the sales and the cost of goods sold equations by having lagged endogenous variables as determinants but not distributed lags for other endogenous variables.

5.7.2 FORECAST ACCURACY OF MODEL 6.

Table 30 contains the forecast accuracy results for model 6, the model of 343 firms with disaggregate disclosures and distributed lags:

TABLE 30

FORECAST ACCURACY OF MODEL 6:

DISAGGREGATE, 343 FIRMS, UNCONSTRAINED LAGS

1979 NET SALES FORECASTS

Forecast Accuracy Measures	OLS	OLS Unrestricted Reduced Form	2SLS Derived Reduced Form	2SLS
A	.9943	.9872	.9763	.9646
B	.9887	.9746	.9531	.9304
C	251.1	377.2	517.9	669.2
D	81.10	101.1	137.2	216.1
E	-11.50	-12.96	-33.32	-54.80
F	.9852	.9745	.9548	.8978
G	.04734	.07100	.09695	.1226
H	.002096	.001180	.004139	.006706
I	.007425	.006471	.01023	.06728
J	.9905	.9923	.9856	.9260
K	.01931	.02548	.04330	.01466
L	.9786	.9733	.9526	.8466

1979 COST OF GOODS SOLD FORECASTS

Forecast Accuracy Measures	OLS	OLS Unrestricted Reduced Form	2SLS Derived Reduced Form	2SLS
A	.9963	.9893	.9899	.9975
B	.9926	.9787	.9798	.9950
C	142.4	240.7	235.2	119.6
D	47.06	70.69	73.74	57.00
E	-4.579	-.5745	-.2771	5.842
F	.9997	.9943	.9878	1.016
G	.03862	.06539	.06370	.03267
H	.001034	.000005694	.000001388	.002386
I	.001554	.001170	.0002220	.06026
J	.9974	.9988	.9998	.9373
K	.00001417	.001524	.007396	.04448
L	.9990	.9985	.9926	.9531

TABLE 30 (CONTINUED)

1979 GROSS MARGIN FORECASTS

Forecast Accuracy Measures	OLS	OLS Unrestricted Reduced Form	2SLS Derived Reduced Form	2SLS
A	.9855	.9783	.8548	.8186
B	.9712	.9571	.7307	.6701
C	139.7	162.3	427.3	658.1
D	54.04	45.50	111.6	207.3
E	-6.919	-12.39	-33.05	-60.64
F	.9312	.9468	.7944	.5572
G	.07935	.09294	.2395	.3188
H	.002454	.005826	.005981	.008492
I	.09944	.02401	.01806	.2898
J	.8981	.9702	.9760	.7017
K	.1551	.06545	.1529	.5572
L	.8424	.9287	.8411	.4343

1979 ADVERTISING EXPENSE FORECASTS

Forecast Accuracy Measures	OLS	OLS Unrestricted Reduced Form	2SLS Derived Reduced Form	2SLS
A	.9880	.9840	.9854	.9880
B	.9761	.9683	.9711	.9761
C	11.58	13.55	12.83	11.59
D	3.823	4.244	4.299	3.803
E	-1.019	-1.384	-1.339	-1.023
F	.9645	.9498	.9571	.9642
G	.07127	.08290	.07873	.07129
H	.007735	.01043	.01088	.007802
I	.02329	.03745	.02816	.02394
J	.9690	.9521	.9610	.9683
K	.05198	.07795	.06261	.05292
L	.9403	.9116	.9265	.9393

TABLE 30 (CONTINUED)

1979 RESEARCH AND DEVELOPMENT EXPENSE FORECASTS

Forecast Accuracy Measures	OLS	OLS Unrestricted Reduced Form	2SLS Derived Reduced Form	2SLS
A	.9900	.9827	.9894	.9898
B	.9800	.9658	.9789	.9797
C	10.31	13.21	10.60	10.40
D	2.504	3.218	2.507	2.493
E	-.3554	-.5188	-.3951	-.3556
F	.9652	.9750	.9643	.9644
G	.06676	.08617	.06862	.06734
H	.001189	.001542	.001390	.001169
I	.03093	.001828	.03016	.03199
J	.9679	.9966	.9684	.9668
K	.05985	.01825	.05974	.06157
L	.9390	.9802	.9389	.9373

1979 SELLING, GENERAL, AND ADMINISTRATIVE EXPENSES (NET) FORECASTS

Forecast Accuracy Measures	OLS	OLS Unrestricted Reduced Form	2SLS Derived Reduced Form	2SLS
A	.9648	.9504	.9252	.9573
B	.9308	.9032	.8559	.9164
C	87.63	105.3	129.6	96.69
D	25.41	27.33	33.86	26.15
E	-5.271	-3.822	-8.241	-5.626
F	.9716	.9343	.9076	.9591
G	.1161	.1383	.1696	.1278
H	.003619	.001318	.004047	.003386
I	.0007075	.002897	.002432	.00004053
J	.9957	.9958	.9935	.9966
K	.01130	.04397	.05774	.01950
L	.9851	.9547	.9382	.9771

TABLE 30 (CONTINUED)

1979 OPERATING INCOME BEFORE DEPRECIATION FORECASTS

Forecast Accuracy Measures	OLS	OLS Unrestricted Reduced Form	2SLS Derived Reduced Form	2SLS
A	.9231	.9898	.7035	.5894
B	.8522	.9797	.4949	.3474
C	151.1	54.01	292.8	604.8
D	59.28	20.40	81.59	205.5
E	-.2740	-6.662	-23.07	-53.64
F	.8090	.9382	.5979	.2734
G	.1880	.06930	.3553	.5266
H	.000003288	.01521	.006210	.007865
I	.1019	.1208	.04254	.4266
J	.8981	.8640	.9512	.5655
K	.2432	.1700	.3052	.7837
L	.7568	.8148	.6886	.2085

FORECAST ACCURACY MEASURES CODES

A Correlation Coefficient
B Correlation Coefficient Squared
C Root-Mean-Squared Error
D Mean Absolute Error
E Mean Error
F Regression Coefficient of Actual on Predicted
G Theil's Inequality Coefficient
H Fraction of Error Due to Bias
I Fraction of Error Due to Different Variation
J Fraction of Error Due to Different Co-Variation

Alternative Decompositions of the last 2 components of Theil's Inequality Coefficient:

K Fraction of Error Due to Difference of Regression Coefficient from Unity
L Fraction of Error Due to Residual Variance

The use of a model with both disaggregate disclosures and distributed lags produced forecasting results quite different from those of the previous five models. OLS produced the best forecasts of sales, gross margin, advertising, research and development, and of SGA (net). The best cost of goods sold forecasts came from 2SLS. Model 6 is the

only case of 2SLS producing the best cost of goods sold forecasts. Unrestricted reduced form produced the best forecast of operating income. However, this best forecast of operating income was worse than the best forecasts of models 3, 4, and 5.

CHAPTER 6

CONCLUSIONS

6.1 EMPIRICAL EVIDENCE ON IMPROVING THE RELIABILITY OF FORECASTING.

Proposals to mandate or to provide guidelines for the public disclosure of forecasted income statements have encountered numerous objections. Much of the controversy remains because of the paucity of empirical research to support proposed guidelines. The few empirical studies in the literature have been based upon one or a small number of firms. This study represents an attempt to ascertain empirical support or lack of support for major issues surrounding the public disclosure of forecasted income statements. Six income statement models were estimated for as many as 1,674 firms. Estimation and forecast accuracy results are the product of the use of four estimation techniques: (a) ordinary least squares; (b) unrestricted reduced form; (c) two stage least squares; (d) two stage least squares derived reduced form.

The conclusions of this chapter will follow the framework suggested by Ijiri (1975) for the improvement of the reliability of the forecasting process. Within Ijiri's framework, there will be a discussion of answers to questions raised in the statement of scope of Chapter 1.

6.2 RESTATEMENT OF THE SCOPE WITH BRIEF CONCLUSIONS.

The research objectives of this study were to provide empirical insights relating to a set of research questions. A brief statement of research findings for each question is presented prior to examining each point of Ijiri's framework for improving the reliability of financial forecast reporting.

(a) Is it possible to develop benchmarks for use by managers, auditors, investors, and accounting rule makers in evaluating the reliability of a forecasting process?

The estimation of six cross-sectional income statement models, using the data of 1,674 firms or of 343 firms, has shown that it is possible to use highly aggregate models to generate accurate forecasts for a wide variety of firms. Firms included in this study ranged from small, single-industry firms to large, multinational enterprises. Tables in Chapter 5 show that several forecast accuracy measures reveal the accuracy possible with cross-sectional models. The overall forecast accuracy results were surprisingly good for all models. These findings are supportive of the highly aggregate AICPA financial forecast guidelines. It is possible to generate accurate forecasts in spite of

adjustments for different fiscal years, or in spite of numerous other possible adjustments reducing the number of firms in research studies. Future researchers may be able to improve upon already excellent forecast accuracy results by limiting their research to all firms in a single industry. Pharmaceutical or chemical firms would be ideal for future research because: (a) there are a large number of firms in each industry; (b) advertising and research and development data tend to be available; (c) economists have developed extensive theories on the economics of these industries.

While the empirical results suggest that it is time for accounting rule setting bodies to begin the development of benchmark models, certain important concerns await future empirical research. This study provides empirical insights for the use of cross-sectional models in 1978 and for the use of these models in generating forecasts for 1979. These years were relatively stable years in terms of the American economy. Policy makers need to develop cross-sectional models for several years to determine how sensitive the results of this study are to the choice of a base year. The income statement models used in this study stopped with operating income. Future benchmark models may need to include net income available to common shareholders. Further, balance sheet models have not been incorporated in this study or in any of the studies reviewed in Chapter 2. Managements of most firms disclosing forecasts will use time series data models, not cross-sectional models. Econometricians have not yet developed comprehensive techniques for comparing cross-sectional and time series data models. A particularly difficult problem is that economy-wide determinants are

missing from cross-sectional models because the values of these determinants do not vary across firms in a given year. Hence, aggregate benchmark models will not have the same specification as firm-specific models used by managements. This may not be a major concern as long as firm-specific models generate forecasts better than those of aggregate, cross-sectional models. Aggregate, cross-sectional models may be useful to policy makers as long as their forecast accuracies remain more accurate than is possible with simpler forecasting models.

(b) Is there, in the existing literature or in this study, empirical support for existing proposed guidelines for the public disclosure of forecasted income statements?

The proposed guidelines appearing in the current accounting literature, and reviewed in Chapters 2 and 3, are highly aggregate. The suggestions appear to be appropriate for single-product firms, if at all. It is not surprising that American managements remain reluctant to disclose forecasts based upon such limited guidelines. However, this study and several earlier empirical studies continue to indicate that accurate forecasts are possible with aggregate, general models of firms. Authors of future guidelines need to support their proposals with all available empirical findings. Available evidence is no longer limited to hypothetical examples or to single-firm, empirical studies.

(c) Will additional disaggregation of an income statement permit improved forecasts?

Investors and the Securities and Exchange Commission have insisted that American managements disclose more disaggregate data. The materiality debates in the accounting literature have revealed the need of accountants to support their decisions on the level of aggregation of corporate disclosures. The empirical evidence of Chapter 5 relates only to the disaggregation of selling, general, and administrative expenses. Knowledge of the advertising expense and of the research and development expense components resulted in less accurate forecasts than those generated by the aggregate model for the same 343 firms. While these findings are quite interesting, future researchers need to consider other possible disaggregations of accounting data. An example would be the disaggregation of the Inventories variable into its components: Raw Materials; Work in Process; and Finished Goods. Accounting researchers, in particular, need to reexamine their information theory literature to establish the conditions under which further disaggregations of accounting data can result in poorer explanations or in poorer forecasts.

Adding more equations to systems of simultaneous equations means that model builders must specify the determinants for each new equation. Accounting and marketing researchers have been more concerned with specifying single-equation models of sales or of net income than they have been with the development of sets of equations. This means that model builders have less theoretical support for the specification of some lines of income statement models than they do for others. Accounting researchers, in particular, need to be concerned with the development of adequate theories of the relationships between the

accounting variables they define, measure, and disclose.

(d) How sensitive are forecast accuracy results to the choice of determinants in income statement models?

Accountants have been reluctant to use econometric models because economists and accountants do not agree on the specification of those models. However, accountants may claim objectivity only by listing the accounting policies of a firm. Two accountants working independently may generate the same income statements for a firm if someone provides them with a chart of accounts and with accounting choices selected by the management. For example, all accountants would not conclude that straight line depreciation is appropriate for a given firm. They are likely to generate the same calculation of depreciation expense if someone tells them to use straight line depreciation.

Earlier studies, reviewed in Chapter 2, involved the use of different model specifications. This study was no exception. Researchers developing econometric models of income statements have not used all of the same determinants. The use of cross-sectional models in this study meant that any economy-wide determinant used in earlier time series data studies needed to be omitted for lack of variability across firms in a single year. The importance of model specification was examined empirically in this study by the use of more than one model for the same set of firms. The tables of Chapter 5 reveal that forecast accuracy measures differ somewhat depending upon the choice of model specification. However, even the worst forecast accuracy measure results are better than what can be achieved by simpler models. All models used in this study represent benchmarks for the narrowing of

results are better than what can be achieved by simpler models. All models used in this study represent benchmarks for the narrowing of managerial choices of forecasting processes.

(e) Can forecasters improve their accuracy by incorporating distributed lag specifications in income statement models?

Economists have been critical of accountants for failing to incorporate into historical financial statements distributed lag effects. Accountants have been divided on the issue of showing as assets variables such as advertising and research and development. J. W. Elliott, in several studies reviewed in Chapters 2 and 3, offered empirical evidence of the existence of distributed lag effects for some of the firms used in his studies. The tables of Chapter 5 reveal that attempts to generalize his findings failed. This does not mean that distributed lags do not exist. It does mean that future researchers need to examine different lengths of lags. The data for the firms of this study showed little variability from year to year for advertising and for research and development expenditures. Some researchers have argued that American managers regard such expenditures as costs of doing business. Under this viewpoint, managers match what managers in other firms spend. The opposing view is that such expenditures are strategic expenditures. Under the opposing view, managers of different firms vary the amounts spent and try to hide the amounts spent. Of the 1,674 firms in this study, only 343 firms disclosed as separate line items both advertising and research and development expenditures. Many non-disclosing firms were large firms famous for research departments, patents, and major research and development efforts. The 343 firms

study when the number of firms decreased from 1,674 to 343. Accountants need to clarify their materiality decisions with respect to advertising and research and development expenditures. It is not obvious, from the tables of Chapter 5, why medium-sized firms with little variability in these accounting variables from year to year disclose them yet larger firms do not.

(f) Does an increase in the number of firms used to estimate income statement models decrease the accuracy of the forecasts?

Some critics of the public disclosure of forecasts have argued that managements which disclose forecasts do so because their firms are not typical of most American firms. They have suggested that some firms operate in more stable markets than other firms do. This means that the forecasting accuracies of managements of firms making voluntary disclosures are not representative of forecast accuracies under a mandatory disclosure rule.

By using 343 and 1,674 firms in this study, it was possible to examine the impact of the method of selecting firms for a study. The larger group of firms was selected by using all firms on the annual industrial COMPUSTAT tapes disclosing income statement data of the type used in earlier studies. There are approximately 2,400 firms on these tapes. Each year, Standard & Poor's adds some firms and drops others for reasons shown in their manuals. Even if all firms on the tapes had survived the simple test of data availability, the firms used in the study would not represent a random sample of some 12,000 firms making public disclosures to the Securities and Exchange Commission. The 343 firms used in this study represent the only firms among the 1,674 firms

disclosing advertising and research and development expenditures as separate line items. Thus, the smaller group of firms was not a random sample. In the absence of a uniform chart of accounts for American firms, accounting researchers attempting to model financial statements will be limited in terms of generalizations about the possible impacts of new disclosure rules on all firms reporting to the Securities and Exchange Commission.

The tables of Chapter 5 show that forecasts of the income statements of the 343 firms were more accurate than forecasts for all 1,674 firms. The smaller group of firms included neither the largest nor the smallest firms in the study. The smaller variability of their income statement variables meant that forecast accuracy would be better. A different finding could be possible if firms are selected for a different characteristic. Policy makers can improve this situation by studying the reports they receive from individual firms. The benchmark models developed in this study represent an approach to the development of an understanding of the firms complying with disclosure rules.

(g) Must or should a forecaster consider simultaneous relationships among accounting variables?

The accounting literature contains a large number of single-equation model studies. The literature review of Chapter 2 revealed that accountants seldom consider the importance of simultaneous relationships between accounting or other variables. The tables of Chapter 5, in terms of forecast accuracy, reveal that no single estimation technique resulted consistently in generating the best forecasts. Ordinary least squares, a technique which ignores

simultaneous relationships, generated the most accurate forecasts of some of the income statement variables in some of the models. Two stage least squares (which theoretically should produce poor forecasts) and two stage least squares derived reduced form (which should produce better forecasts) generated the most accurate forecasts of some of the income statement variables in some of the models. These estimation techniques incorporate some aspects of simultaneous relationships. Researchers need to continue using several estimation techniques with a single set of firms in order to examine the importance or lack of importance of simultaneous relationships in structural estimation and in forecasting of the economic behavior of firms. While researchers interested in the estimation of models of the firm need to continue studying simultaneous relationships among accounting variables, the results of this study suggest also a need for forecasters to do the same.

These questions will be addressed further within Ijiri's framework for the improvement of the reliability of forecasting processes. Each of these questions has had major impacts on the design, the focus, and on the techniques used in this study.

6.3 THE IJIRI FRAMEWORK AND THE RESEARCH FINDINGS.

The seven points of the Ijiri framework for the improvement of the reliability of forecasting processes have been used as a vehicle for analyzing the controversy over the public disclosure of financial forecasts. The empirical research findings of this study suggest directions for the further development of the framework.

6.3.1 INPUT DATA.

Proponents of the public disclosure of forecasted income statements reject managerial disclosures limited to historical financial statements. They have argued, as reviewed in Chapters 1 and 2, that managers have the advantage in forecasting of possessing superior input data: operating plans. The Securities and Exchange Commission has taken the position that managers must alert the public if the use of popular forecasting methods with the historical financial statement data of the firm would result in misleading forecasts. Managers have retorted that the public disclosure of operating plans would place disclosing firms at a competitive disadvantage relative to firms not reporting to the SEC. Even if managers disclosed their operating plans, the problem of comparing the forecasting processes of different firms would remain.

The models of this study used only published, firm-level data for inputs. Hence, there is no direct empirical evidence in this study of the competitive disadvantage limits to the disclosure of operating plans. However, the findings of this study suggest that researchers need to be more concerned about the disaggregation issues in the disclosure of historical financial statements and of forecasts. For 343

firms in this study disclosing as separate line items advertising expense and research and development expense, income statement forecasts were less accurate than when the more aggregate selling, general and administrative expenses variable was used. Future accounting researchers need to examine extensively the relationships between the variables accountants define, measure, and report. Industrial organization theorists have attempted to adjust accounting data series to permit the serious study of relationships between firm-, industry-, and macroeconomic-level variables.

Accounting researchers have been reluctant to use econometric models, profit theory, industrial organization theory, and microeconomic theory. Existing theories in these literatures are very general. One profit theorist complained that the theory of the firm is so general that it should be renamed a theory of markets. The specification of models in these literatures has been very different for different firms. Accountants have been concerned that managers could vary the specifications of their forecasting models until they found sets of determinants producing the desired forecasts. The empirical findings of this study do not support claims that the public disclosure of financial forecasts must await the development of economic theories to guide the choice of determinants. Model specifications for the six models used in this study varied considerably. While differences in model specification meant differences in estimates of coefficients of determinants (and, sometimes, even differences in estimated signs of coefficients), the range of forecast accuracies was similar for all models. Further, even the least accurate model generated forecasts more

accurate than would be possible by forecasting naively that next year's income statement will be the same as this year's income statement.

Ijiri (1975) did not suggest the use of benchmark forecasting models. Instead, he proposed the development of standardized guidelines for the managerial choice of determinants in their forecasting models. His goal was to have uniform and comparable forecasting processes across firms. This is difficult to achieve because managements need not prepare uniform and comparable historical financial statements. A proposal, based upon this study, is that a benchmark model be applied to all firms making mandatory disclosures to the SEC. The benchmark model could be estimated for all firms reporting to the SEC and could have the same determinants. While the benchmark model could be a cross sectional or time series data model, managements are likely to use time series data for their models. Annually, managements would need to explain to the public why their forecasts are so much better or worse than the benchmark forecasts. Users of financial forecasts would become aware of the determinants managements use as input data for their forecasts.

6.3.2 FORECASTING METHODS.

The possession of superior input data does not guarantee that all users of the data will generate superior forecasts. Consumers, competitors, and governmental leaders throughout the world are making their own plans. Forecasters use different methods. Ijiri (1975) offered examples of two issues: (a) econometric versus Box-Jenkins time series forecasting methods; (b) whether managers need to forecast at the overall firm level or forecast by division and aggregate forecasts.

This study involved the use of four econometric estimation techniques with data for the same set of firms. The accounting literature contains numerous studies of the time series properties of annual and of quarterly accounting variables. Both time series analysis methods and forecast accuracy measures provide quantitative benchmarks for the evaluation of managerial disclosures of forecasts. Econometric models, based upon the specification of determinants, provide explanations to support forecasts.

The forecasting literature reviewed in this study revealed that forecasters advocate the reporting of competing forecasting methods and forecast accuracy measures for the same data base. Future forecasting guidelines may incorporate this practice by requiring the reporting of benchmark forecasting methods and forecast accuracy measures by all firms. For example, the guidelines could specify the use of two stage least squares derived reduced form forecasts plus the disclosure of the mean absolute percentage errors for both a benchmark model and for the firm's forecasting model. Managers would be responsible for explaining why there are differences between historical data forecasting models

used by outsiders and their forecasts incorporating operating plans.

The use of public data in this study meant that divisional level data of firms were not available. Hence, it was not possible to examine Ijiri's concerns about the use by firms of aggregate models or of divisional models which are later aggregated. However, the disaggregation of selling, general, and administrative expenses was studied. Some of the tables of Chapter 5 show gross margin and operating income equations in their implicit behavioral equation form rather than in the form of identities. Ijiri (1975) suggested it would be necessary to develop forecasting principles as to whether managements could forecast profit variables using only past values of the same profit variables or indirectly by forecasting sales and cost of goods sold first. The findings of this study were that the benchmark models need to explain and forecast each line of the income statement. Further, users of financial forecasts may benefit from the publication of profit equations in their implicit behavioral equation form.

Forecasting methods were not evaluated in this study based upon their effect upon decisions and consequences of their decisions, as suggested by Demski and Feltham (1972). Ijiri (1975) was concerned about the problem of many investors using forecasts in different ways. He suggested it may be necessary to develop a representative user. At some point in the future development of forecasting principles, it will be necessary to tie in financial economic theory. The models of this study were developed using the assumption of financial economics that it is possible to separate operating and financing decisions of managements. The income statement models of this study stopped with

operating income. Future researchers will need to consider incorporating more lines in the income statement to study financing decisions. After that, it will be necessary to consider how investors use historical and forecast data disclosed by managements. The benchmark models of this study serve as examples of what can be achieved using only public data. There is no suggestion that typical users of financial statements model each line of the income statement. Instead, the use of benchmark models need to serve as the best possible forecasting standards against which managerial forecasts may be evaluated. The managerial contribution would take the form of explanations as to why their forecasts are so much better or poorer than benchmark forecasts.

The literature review of Chapter 2 revealed that many researchers have stressed the importance of forecasting each line of the income statement. Ijiri (1975) provided the example of firms having large fixed costs/total costs ratios. A small percentage change in demand for such firms' products can result in large percentage changes in profits. The models of this study showed also the importance of examining for simultaneous relationships between accounting variables.

6.3.3 FORECAST RECORDING.

Guidelines on forecast recording will need to be both comprehensive and flexible. Some firms may use a forecasting process based upon the aggregation of forecasts made by managers of profit centers. Other firms may decide to use aggregate forecasting models developed at head offices. Regardless of the approach selected, all other forecasting guidelines need to apply. This study contains no proposed formats for forecast working papers.

6.3.4 FORECAST VARIANCE ANALYSES.

Preoccupation with the bottom line by many forecasters has meant that little has been learned about why forecasts vary from actual data. The literature review of Chapter 2 revealed that many researchers have urged that disclosures consist of each line of the income statement. In this study, some lines of the income statement were easier to forecast than other lines. Cost of goods sold equations had small forecast errors. Selling, general, and administrative expense equations tended to have larger forecast errors. Future accounting researchers need to direct their efforts towards reducing estimation and forecasting errors. This effort will consist of studying the determinants of corporate profitability of a line by line basis.

6.3.5 FORECAST REPORTING.

The use of benchmark forecasts represents a major departure from the current practice of voluntary forecasts. Many firms disclose voluntarily forecasted income statement variables. However, their managements may choose not to make the disclosures one year and to make them the following year. They argue that in some years it is more difficult to make forecasts than in other years. Both managements and users of financial forecasts need to understand the forecasting process. This increased understanding will come with the consistent use of a historical chart of accounts and with the consistent reporting of forecasts. The use in this study of a single year for estimation and a single year for forecasting provides limited empirical evidence of the relationship between the best fitting historical models and the most accurate forecasting models. If managements disclose their forecasts and benchmark forecasts each year, it will be possible for future researchers to study whether those firms with the least accurate forecasts also have the poorest fitting historical models. Industry membership, the number of segments of the business, the geographical spread of the business, and other factors may affect forecast accuracy.

The aggregation of income statements needs to be a concern for future accounting researchers. In terms of forecasting issues, this study provides evidence that the disaggregation of selling, general, and administrative expenses into advertising and research and development components resulted in less accurate forecasts. Greater disclosures did not assist the forecasting of operating profits. A forecaster may overcome this problem by testing competing forecasting models. The

choice of a more aggregate forecasting model would be possible. These generalizations are based upon the data of the 343 firms which disclosed as separate line items advertising and research and development expenditures. Virtually all firms advertise. Yet, only 343 of 1,674 firms in this study disclosed advertising as a separate line item. The future improvement of the forecasting process is tied to disclosure practices for historical financial statements. Somehow, managers and auditors decided that separate disclosures of advertising and of research and development expenditures were material for 343 firms but not for the others. The use of econometric models in this study suggests that materiality tests in the accounting literature need to be tied to models of the firm, not to rules of thumb about the size of an accounting variable relative to sales or to net income.

6.3.6 FORECAST AUDITING.

The use of one or more benchmark forecasting models and forecast accuracy measures means that it is possible to train auditors in the use of the benchmarks. Managements would have the flexibility of using different forecasting methods. However, the extent to which the methods managements select depart from the methods used for benchmarks, the greater the evidence on the forecasting process auditors would need to collect. Over time, auditors would develop considerable experience in dealing with managerial forecasting processes relative to benchmark forecasting processes used by auditors. This approach to forecast auditing is comparable to the approach used currently by auditors in audits of historical financial statements. Similar forecast auditing techniques will evolve similar to the current audit tests used to evaluate the reasonableness of historical financial data.

6.3.7 FORECAST RESPONSIBILITY.

The legal responsibilities for the public disclosures of financial forecasts were reviewed in Chapter 1. The Securities and Exchange Commission offered a safe harbor rule. In spite of minimal legal risks for the public disclosure of financial forecasts, few managements have opted to disclose forecasts voluntarily.

Missing from the forecasting process today is the publication of financial forecasts by the SEC for each of the firms making mandatory public disclosures of historical financial statements. Managements of each of these firms need to respond to a new section of Form 10-K or to a new form as to whether benchmark forecasts using historical data are

misleading to users. Current SEC rules provide only vague suggestions that managers need to act if financial analysts seem to be making non-ballpark forecasts of earnings per share or other financial variables.

If the SEC fails to fill the role of providing benchmark forecasts, the FASB, the AICPA, or individual audit firms need to start filling the void. The AICPA has published general guidelines for the public disclosure of financial forecasts. However, those guidelines lack any provision for the publication of benchmark forecasts. Users of financial forecasts need to evaluate managerial forecasts by comparing the forecasts of other managements and benchmark forecasts. While managements could develop numerous competing forecasting models and disclose the results of all of them, comparability of forecasting processes awaits the development of generally accepted forecasting standards by auditors or by accounting rule setting bodies.

6.4 LIMITATIONS AND SUGGESTIONS FOR FUTURE RESEARCH.

This empirical study avoided many of the limitations of earlier studies. The SEC's segmental disclosure rules of the 1970's have meant a tremendous increase in the number of firms disclosing disaggregated income statements. Earlier researchers found it necessary to use only one firm or a small number of firms in their studies because of the lack of data on advertising or on research and development expenditures. In this study, 343 firms disclosed data necessary for estimating models. A more general income statement model was feasible for 1,674 firms. Yet, it was necessary to exclude some annual industrial COMPUSTAT firms because of the lack of cost of goods sold or of other basic income statement variables. This problem will remain for future researchers as long as American accounting lacks a uniform chart of accounts or clear materiality rules.

While the use of 1,674 firms in this study represents a major increase in the number of firms used in the research of corporate profitability, the findings may not be representative for the 12,000 firms reporting to SEC. A comparison of the tables in Chapter 5 reveals differences in findings between the 1,674 firms used for the aggregate models and the 343 firms used for the disaggregate models. The 343 firms disclosing advertising and research and development expenditures were neither the largest or the smallest firms in the study. The narrower range of their income statement variables meant errors would be smaller. Should the SEC decide to disseminate data on 12,000 or more firms using COMPUSTAT's format, it is likely that the range of income statement data will widen. Benchmark models based upon 12,000 firms are

likely to be less accurate than the models of this study based upon 343 and upon 1,674 firms.

Ordinary least squares, unrestricted reduced form, two stage least squares, and two stage least squares derived reduced form were used as estimators of the six models in this study. Earlier researchers tended to use a single model, a single estimation technique, and a single forecast accuracy measure. The empirical approach of this study provides future researchers with empirical evidence of the role of the choice of model specification, estimation technique, and of forecast accuracy measure in research findings. Such evaluations are difficult or impossible if researchers have not used the same data base. Future researchers will want to consider the use of other estimation techniques, such as three stage least squares.

Six models were used in this study to evaluate the effects of different levels of aggregation of historical income statements and of the incorporation of distributed lag determinants. However, only selling, general, and administrative expenses were disaggregated. Future researchers need to consider other disaggregations of accounting variables. Advertising expense and research and development expense data have been available for a large number of firms for only a few years. As time passes, and if the SEC retains segmental disclosure requirements, it will be possible for future researchers to study distributed lag effects.

While this study is one of a small number of studies involving line by line models of the income statement, there remains considerable room for future researchers to add additional lines of the income statement and to add the balance sheet in their models of firms. Accounting researchers, in particular, need to be concerned that they understand the relationships between the variables they define, measure, and disclose. The literature review revealed that profit theorists, industrial organization theorists, system scientists, and forecasters have researched similar issues without referencing the other literatures.

Earlier researchers chose to report one or two forecast accuracy measures. Current forecasting literature suggests the need to use numerous forecast accuracy measures. The tables in Chapter 5 included all forecast accuracy measures generated by Time Series Processor (TSP). Future researchers need to be aware that some of the better forecast accuracy measures, such as mean absolute percentage error, are missing from computer packages. The rapid increase in computer memory capacities will mean that future researchers can improve the comparison of forecast accuracy measures on the same data base.

Some forecasting models use forecasts of exogenous variables. The emphasis in this study was upon the testing of the structures of proposed models. Only actual future values of exogenous variables were used. Future researchers will want to make endogenous any balance sheet determinants which were exogenous in this study. The determinants in this study were firm-level variables. If future researchers use time series data models in order to incorporate economic determinants, they

may wish to compare the use of actual values of economic variables with the forecasted values used by decision makers.

It is feasible for the SEC, FASB, AICPA, or for individual auditing firms to develop and disclose benchmark forecasts for all firms subject to mandatory disclosure requirements. Until large numbers of managements provide public responses to benchmark forecasts, future researchers will be limited in what can be learned about the importance of knowledge of operating plans. The improvement of benchmark forecasting standards may, however, reduce the differences between actions managers take and actions users of financial statements expected them to take. Users of public data have not made full use of the vast amount of data already available to them.

LIST OF REFERENCES

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Accountants International Study Group (1974), PUBLISHED PROFIT FORECASTS, American Institute of Certfified Public Accountants, 1974.

Alfeld, Louis Edward, and Alan K. Graham (1976), INTRODUCTION TO URBAN DYNAMICS, Wright-Allen Press, 1976.

Almon, Shirley (1965), "The Distributed Lag between Capital Appropriations and Expenditures," ECONOMETRICA (January 1965): 178- 196.

Ames, E., and S. Reiter (1961), "Distributions of Correlation Coefficients in Economic Time Series," JOURNAL OF THE AMERICAN STATISTICAL ASSOCIATION (1961): 637-656.

Anderson, T. W., and T. Sawa (1973), "Distribution of Estimates of Coefficients of a Single Equation in a Simultaneous System and their Asymptotic Expansions," ECONOMETRICA, 41: 683-714.

Armstrong, J. Scott (1970a), "An Application of Econometric Models to International Marketing," JOURNAL OF MARKETING RESEARCH (May 1970): 190-198.

-----(1970b), "How to Avoid Exploratory Research," JOURNAL OF ADVERTISING RESEARCH (August 1970b): 27-30.

-----(1978), LONG-RANGE FORECASTING, Wiley, 1978.

-----, and Michael C. Grohman (1972), "A Comparative Study of Methods for Long-Range Market Forecasting," MANAGEMENT SCIENCE (October 1972): 211-221.

Ayres, Robert U. (1969), TECHNOLOGICAL FORECASTING AND LONG-RANGE PLANNING, McGraw-Hill, 1969.

Bain, Joe S. (1956), BARRIERS TO NEW COMPETITION, Harvard University Press, 1956.

Barnea, Amir, Simcha Sadan, and Michael Schiff (1979), PUBLISHING EARNINGS FORECASTS, Ross Institute of Accounting Research, New York University, 1979.

Barrett, James P. (1974), "The Coefficient of Determination--Some Limitations," AMERICAN STATISTICIAN (February 1974): 19-20.

Basmann, R. L. (1961), "A Note on the Exact Finite Sample Frequency Functions of Generalized Classical Linear Estimators in Two Leading Over-Identified Cases," JOURNAL OF THE AMERICAN STATISTICAL ASSOCIATION (1961): 619-636.

-----(1962), "Letter to the Editor," ECONOMETRICA (October 1962): 824-826.

-----(1963), "A Note on the Exact Finite Sample Frequency Functions of Generalized Classical Linear Estimators in a Leading Three Equation Case," JOURNAL OF THE AMERICAN STATISTICAL ASSOCIATION (1963): 161- 171.

-----(1974), "Exact Finite Sample Distributions for Some Econometric Estimators and Test Statistics: A Survey and Appraisal," in M. D. Intriligator and D. A. Kendrick, eds., FRONTIERS OF QUANTITATIVE ECONOMICS, Vol. II, North-Holland, Amsterdam, 1974.

Bass, Frank M. (1969), "A Simultaneous Equation Regression Study of Advertising and Sales of Cigarettes," JOURNAL OF MARKETING RESEARCH (August 1969): 291-300.

Baumol, W. J. (1959), ECONOMIC DYNAMICS, 2nd edition, Macmillan, 1959.

Beaver, William H. (1970), "The Time-Series Behavior of Earnings," EMPIRICAL RESEARCH IN ACCOUNTING: SELECTED STUDIES, 1970, Supplement to Vol. 8, JOURNAL OF ACCOUNTING RESEARCH, pp. 62-99.

-----(1977), "The Nature of Mandated Disclosure," in REPORT OF THE ADVISORY COMMITTEE ON CORPORATE DISCLOSURE TO THE SECURITIES AND EXCHANGE COMMISSION, Committee Print 95-29, 1:618-656.

-----(1981), FINANCIAL REPORTING: AN ACCOUNTING REVOLUTION, Prentice-Hall, 1981.

Bedford, Norton M. (1965), INCOME DETERMINATION THEORY: AN ACCOUNTING FRAMEWORK, Addison-Wesley, 1965.

Belkaoui, Ahmed (1981), ACCOUNTING THEORY, Harcourt Brace Jovanovich, 1981.

Berlinski, David (1976), ON SYSTEMS ANALYSIS, MIT, 1976.

Bernhard, A. (1959), THE EVALUATION OF COMMON STOCKS, Simon and Schuster, 1959.

Blalock, Hubert M., Jr. (1969), THEORY CONSTRUCTION, Prentice-Hall, 1969.

Bliemel, F. (1973), "Theil's Forecast Accuracy Coefficient: A

Clarification," JOURNAL OF MARKETING RESEARCH (November 1973): 444- 446.

Bonini, C. P. (1963), SIMULATION OF INFORMATION AND DECISION SYSTEMS IN THE FIRM, Prentice-Hall, 1963.

Boulding, K. E. (1958), THE SKILLS OF THE ECONOMIST, H. Allen, 1958.

Bowerman, Bruce L., and Richard T. O'Connell (1979), TIME SERIES AND FORECASTING, Duxbury, 1979.

Box, George E. P., and J. R. Cox (1964), "An Analysis of Transformations," JOURNAL OF THE ROYAL STATISTICAL SOCIETY, Series B, (1964): 211-243.

-----, and Gwilym M. Jenkins (1976), TIME SERIES ANALYSIS, Revised Edition, Holden-Day, 1976. First Edition (1970).

-----, and D. A. Pierce (1970), Distribution of Residual Autocorrelations in Autoregressive-Integrated Moving Average Time Series Models," JOURNAL OF THE AMERICAN STATISTICAL ASSOCIATION (December 1970): 1509-1526.

-----, and G. C. Tiao (1975), "Intervention Analysis with Applications to Economic and Environmental Problems," JOURNAL OF THE AMERICAN STATISTICAL ASSOCIATION (March 1975): 70-80.

Brown, Lawrence D., and Michael S. Rozeff (1978), "The Superiority of Analyst Forecasts: Evidence from Earnings," THE JOURNAL OF FINANCE (March 1978): 1-16.

Brown, Robert G. (1963), SMOOTHING, FORECASTING AND PREDICTION OF DISCRETE TIME SERIES, Prentice-Hall, 1963.

Brozen, Yale (1974), "Entry Barriers: Advertising and Product Differentiation," in Harvey J. Goldschmid, H. Michael Mann, and J. Fred Weston, eds., INDUSTRIAL CONCENTRATION: THE NEW LEARNING, Little, Brown and Company, 1974, pp. 115-137.

Burill, C. W., and L. Quinto (1972), COMPUTER MODEL OF A GROWTH COMPANY, Gordon and Breach, 1972.

Cassidy, Henry J. (1981), USING ECONOMETRICS: A BEGINNER'S GUIDE, Reston, 1981.

Chandler, Alfred D., Jr. (1962), STRATEGY AND STRUCTURE, MIT, 1962.

Chang, Davis L. S., and Shu S. Liao (1977), "Measuring and Disclosing Forecast Reliability," THE JOURNAL OF ACCOUNTANCY (May 1977): 76-87.

Chatfield, C. (1977), "Some Recent Developments in Time Series Analysis," JOURNAL OF THE ROYAL STATISTICAL SOCIETY, Series A, (1977): 492-510.

-----, and D. L. Prothero (1973), "Box-Jenkins Seasonal Forecasting: Problems in a Case Study," JOURNAL OF THE ROYAL STATISTICAL SOCIETY, Series A, (1973): 295-315.

Chenery, H. B. (1952), "Overcapacity and the Acceleration Principle," ECONOMETRICA (January 1952): 1-28.

Chow, G. C. (1968), "Two Methods of Computing Full-Information Maximum Likelihood Estimates in Simultaneous Equations," INTERNATIONAL ECONOMIC REVIEW (February 1968): 100-112.

-----(1975), ANALYSIS AND CONTROL OF DYNAMIC ECONOMIC SYSTEMS, Wiley, 1975.

Churchman, C. West (1968), THE SYSTEMS APPROACH, Delta, 1968.

Clark, J. M. (1958), "The Uses of Diversity: Competitive Bearings of Diversities in Cost and Demand Functions," AMERICAN ECONOMIC REVIEW, Papers and Proceedings, (May 1958): 474-482.

Clark, John J. (1969), ed., THE MANAGEMENT OF FORECASTING, St. John's University Press, 1969.

Cochrane, D., and G. H. Orcutt (1949), "Application of Least Squares Regression to Relationships Containing Auto-Correlated Error Terms," JOURNAL OF THE AMERICAN STATISTICAL ASSOCIATION (March 1949): 32-61.

Cohen, Kalman J. (1960), COMPUTER MODELS OF THE SHOE, LEATHER, HIDE SEQUENCE, Prentice-Hall, 1960.

-----, and Richard M. Cyert (1961), "Computer Models in Dynamic Economics," THE QUARTERLY JOURNAL OF ECONOMICS (February 1961): 112-127.

Cole, Arthur H. (1959), BUSINESS ENTERPRISE IN ITS SOCIAL SETTING, Harvard University Press, 1959.

Cole, H. S. D., Christopher Freeman, Marie Jahoda, and K. L. R. Pavitt (1973), eds., MODELS OF DOOM, Universe, 1973.

Collins, Daniel W. (1976), "Predicting Earnings with Sub-Entity Data: Some Further Evidence," JOURNAL OF ACCOUNTING RESEARCH (Spring 1976): 163-177.

Cooper, J. P., and C. R. Nelson (1975), "The Ex Ante Prediction Performance of the St. Louis and FRB-MIT-PENN Econometric Models and Some Results on Composite Predictors," JOURNAL OF MONEY, CREDIT AND BANKING (March 1975): 1-32.

Copeland, R., and R. J. Marioni (1972), "Executives' Forecasts of Earnings per Share versus Forecasts of Naive Models," JOURNAL OF BUSINESS (October 1972): 497-512.

Copeland, Thomas E., and J. Fred Weston (1979), FINANCIAL THEORY AND CORPORATE POLICY, Addison-Wesley, 1979.

Cragg, J. (1967), "On the Relative Small-Sample Properties of Several Structural-Equation Estimators," ECONOMETRICA, 35: 89-110.

Crum, W. L. (1939), CORPORATE SIZE AND EARNING POWER, Harvard University Press, 1939.

Cyert, Richard M. (1966), "A Description and Evaluation of Some Firm Simulations," IBM SCIENTIFIC COMPUTING SYMPOSIUM ON SIMULATION MODELS AND GAMING, Proceedings, IBM Data Processing Division, 1966, pp. 3-22.

Cyert, Richard M., and J. G. March (1963), A BEHAVIORAL THEORY OF THE FIRM, Prentice-Hall, 1963.

Daily, R. A. (1971), "The Feasibility of Reporting Forecasted Information," THE ACCOUNTING REVIEW (October 1971): 686-692.

Demski, Joel S. (1972), INFORMATION ANALYSIS, Addison-Wesley, 1972.

-----, and G. Feltham (1972), "Forecast Evaluation," ACCOUNTING REVIEW (July 1972): 533-548.

Dhrymes, Phoebus J., E. Philip Howrey, Saul H. Hymans, Jan Kmenta, Edward E. Leamer, Richard E. Quandt, James B. Ramsey, Harold T. Shapiro, and Victor Zarnowitz, "Criteria for Evaluation of Econometric Models," ANNALS OF ECONOMIC AND SOCIAL MEASUREMENT (1972): 291-324.

Dopuch, Nicholas, Jacob G. Birnberg, and Joel Demski (1974), COST ACCOUNTING, Second Edition, Harcourt Brace Jovanovich, 1974.

Dorfman, Robert, and Peter O. Steiner (1954), "Optimal Advertising and Optimal Quality," AMERICAN ECONOMIC REVIEW (September 1954): 826-836.

Downie, Jack (1958), THE COMPETITIVE PROCESS, Gerald Duckworth & Co., Ltd., London, 1958.

Durbin, J. (1957), "Testing for Serial Correlation in Systems of Simultaneous Regression Equations," BIOMETRIKA (December 1957): 370-377.

-----(1969), "Tests for Serial Correlation in Regression Analysis Based on the Periodogramm of Least-Squares Residuals," BIOMETRIKA (March 1969): 1-15.

-----(1970), "Testing for Serial Correlation in Least Squares Regression when some of the Regressors are Lagged Dependent Variables," ECONOMETRICA (May 1970): 410-421.

Dutta, M. (1975), ECONOMETRIC METHODS, South-Western, 1975.

Edwards, E., and P. Bell (1961), THE THEORY AND MEASUREMENT OF BUSINESS

INCOME, University of California Press, 1961.

Eisner, Robert (1960), "A Distributed Lag Investment Function," ECONOMETRICA (January 1960): 1-29.

-----(1967), "A Permanent Income Theory for Investment: Some Empirical Explorations," AMERICAN ECONOMIC REVIEW (June 1967): 363-390.

Elliott, Jan Walter (1971a), "Funds Flow vs. Expectational Theories of Research and Development Expenditures in the Firm," THE SOUTHERN ECONOMIC JOURNAL (April 1971): 409-422.

-----(1971b), "A Comparison of Models of Marketing Investment in the Firm," THE QUARTERLY REVIEW OF ECONOMICS & BUSINESS (Spring 1971): 53-70.

-----(1972a), "Forecasting and Analysis of Corporate Financial Performance with an Econometric Model of the Firm," JOURNAL OF FINANCIAL AND QUANTITATIVE ANALYSIS (March 1972): 1499-1526.

-----(1972b), "Funds-Flow Multipliers in Firms: An Econometric Exploration," THE SOUTHERN ECONOMIC JOURNAL (July 1972): 19-30.

-----(1973), ECONOMIC ANALYSIS FOR MANAGEMENT DECISIONS, Irwin, 1973.

-----, and H. L. Uphoff (1972), "Predicting the Near Term Profit and Loss Statement with an Econometric Model: A Feasibility Study," JOURNAL OF ACCOUNTING RESEARCH (Autumn 1972): 259-274.

Fair, R.(1970), "The Estimation of Simultaneous Equation Models with Lagged Endogenous Variables and First Order Serially Correlated Errors," ECONOMETRICA (May 1970): 507-516.

-----(1973), "A Comparison of Alternative Estimators of Macroeconomic Models," INTERNATIONAL ECONOMIC REVIEW (June 1973): 261-277.

Fama, Eugene F., and H. Babiak (1968), "Dividend Policy: An Empirical Analysis," JOURNAL OF THE AMERICAN STATISTICAL ASSOCIATION (December 1968): 1132-1161.

Fama, Eugene F., and Merton H. Miller (1972), THE THEORY OF FINANCE, Dryden Press, 1972.

Farrar, D. E., and R. R. Glauber (1967), "Multicollinearity in Regression Analysis: The Problem Revisited," REVIEW OF ECONOMICS AND STATISTICS (February 1967): 92-107.

Feintuch, R. (1976), "Soft Information; Liability Standards and Safe Harbors (Case Law)," Memorandum dated June 18, 1976, to M. Lipton, of Wachtell, Lipton, Rosen & Katz, in APPENDIX TO THE REPORT OF THE ADVISORY COMMITTEE ON CORPORATE DISCLOSURE TO THE SECURITIES AND EXCHANGE COMMISSION, Committee Print 95-30, House Committee on

Interstate and Foreign Commerce, November 3, 1977, U. S. Government Printing Office, pp. A-330 through A-376.

Feldstein, Martin S. (1971), "The Error of Forecast in Econometric Models when the Forecast-Period Exogenous Variables are Stochastic," ECONOMETRICA (January 1971): 55-60.

Fellner, William (1965), PROBABILITY AND PROFIT, Irwin, 1965.

Fels, Rendigs, and C. Elton Hinshaw (1968), FORECASTING AND RECOGNIZING BUSINESS CYCLE TURNING POINTS, National Bureau of Economic Research, Columbia University Press, 1968.

----- and ----- (1974), "An Analysis of Turning Point Forecasts: A Fairly Polite Comment," AMERICAN ECONOMIC REVIEW (1974): 724-727.

Fisher, F. M. (1965), "The Choice of Instrumental Variables in the Estimation of Economy-Wide Econometric Models," INTERNATIONAL ECONOMIC REVIEW (September 1965): 245-274.

Fisher, Irving (1906), THE NATURE OF CAPITAL AND INCOME, Macmillan, 1906.

-----(1930), THE THEORY OF INTEREST, The Macmillan Co., 1930.

Florence, P. Sargant (1957), "New Measures of the Growth of Firms," ECONOMIC JOURNAL (June 1957): 244-248.

Forecasts and Projections Task Force (1979), REVIEW OF A FINANCIAL FORECAST, Proposed Guide, Exposure Draft, Auditing Standards Division, American Institute of Certified Public Accountants, 1979.

Foreman, Clarence J. (1930), EFFICIENCY AND SCARCITY PROFITS, The University of Chicago Press, 1930.

Forrester, Jay W. (1959), "Advertising: A Problem in Industrial Dynamics," HARVARD BUSINESS REVIEW (March-April 1959): 100-110.

-----(1968), "Market Growth as Influenced by Capital Investment," INDUSTRIAL MANAGEMENT REVIEW (Winter 1968): 83-105.

Foster, George (1973), "Stock Market Reaction to Estimates of Earnings per Share by Company Officials," JOURNAL OF ACCOUNTING RESEARCH (Spring 1973): 25-37.

-----(1978), FINANCIAL STATEMENT ANALYSIS, Prentice-Hall, 1978.

Foster, William Trufant, and Waddill Catchings (1925), PROFITS, Houghton Mifflin, 1925.

Fox, K., J. Sengupta, and E. Thorbecke (1966), THE THEORY OF QUANTITATIVE ECONOMIC POLICY, North-Holland, 1966.

Frank, R. E., and W. F. Massy (1971), AN ECONOMETRIC APPROACH TO A MARKETING DECISION MODEL, MIT, 1971.

Gadd, A., and H. O. A. Wold (1964), "The Janus Quotient: A Measure for the Accuracy of Prediction," in H. O. A. Wold (1964), ECONOMETRIC MODEL BUILDING: ESSAYS ON THE CAUSAL CHAIN APPROACH, North-Holland, 1964, pp. 229-235.

Gershefski, George W. (1970), "Corporate Models--The State of the Art," MANAGEMENT SCIENCE (February 1970): B303-B312.

Geurts, M. D., and I. B. Ibrahim (1975), "Comparing the Box-Jenkins Approach with the Exponentially Smoothed Forecasting Model Application to Hawaii Tourists," JOURNAL OF MARKETING RESEARCH (May 1975): 182- 188.

Ghosh, Prafulla Chandra (1933), THE THEORY OF PROFITS, University of Calcutta, 1933.

Gibson, John E. (1981), MANAGING RESEARCH AND DEVELOPMENT, Wiley, 1981.

Gillman, Joseph M. (1957), THE FALLING RATE OF PROFIT, Dennis Dobson, London, 1957.

Glass, Gene V., Victor L. Willson, and John M. Gottman (1975), DESIGN AND ANALYSIS OF TIME-SERIES EXPERIMENTS, Colorado Associated University Press, 1975.

Godfrey, L. G. (1976), "Testing for Serial Correlation in Dynamic Simultaneous Equations Models," ECONOMETRICA (September 1976): 1077-1084.

Goldberger, Arthur S. (1964), ECONOMETRIC THEORY, Wiley, 1964.

-----, A. L. Nagar, and H. S. Odeh (1961), "The Covariance Matrices of Reduced-Form Coefficients and of Forecasts for a Structural Econometric Model," ECONOMETRICA (October 1961): 556-573.

Goldfeld, S. M., and R. E. Quandt (1972), NONLINEAR METHODS IN ECONOMETRICS, North-Holland, 1972.

Goldschmid, Harvey J., H. Michael Mann, and J. Fred Weston (1974), eds., INDUSTRIAL CONCENTRATION: THE NEW LEARNING, Little, Brown and Company, 1974.

Gonedes, Nicholas J., and Nicholas Dopuch (1974), "Capital Market Equilibrium, Information-Production and Selecting Accounting Techniques: Theoretical Framework and Review of Empirical Work," STUDIES ON FINANCIAL ACCOUNTING OBJECTIVES 1974, Supplement to JOURNAL OF ACCOUNTING RESEARCH, 12: 48-169.

Gonedes, Nicholas J., Nicholas Dopuch, and Stephen H. Penman (1976), "Disclosure Rules, Information-Production, and Capital Market

Equilibrium: The Case of Forecast Disclosure Rules," JOURNAL OF ACCOUNTING RESEARCH (Spring 1976): 89-137.

Gordon, M. J. (1962), THE INVESTMENT, FINANCING AND VALUATION OF THE CORPORATION, Irwin, 1962.

Granger, C. W. J., and P. Newbold (1973), "Some Comments on the Evaluation of Economic Forecasts," APPLIED ECONOMICS (1973): 35-47.

-----, and -----(1977), FORECASTING ECONOMIC TIME SERIES, Academic Press, 1977.

Gray, William S. (1974), "The Role of Forecast Information in Investment Decisions," in Prem Prakash and Alfred Rappaport, eds., PUBLIC REPORTING OF CORPORATE FINANCIAL FORECASTS, Commerce Clearing House, 1974, pp. 53-54.

Green, P. E., and R. E. Frank (1967), A MANAGER'S GUIDE TO MARKETING RESEARCH, Wiley, 1967.

-----, and -----(1973), "On the Analysis of Interactions in Marketing Research Data," JOURNAL OF MARKETING RESEARCH (November 1973): 410- 420.

Griliches, Zvi (1974), "Errors in Variables and other Unobservables," ECONOMETRICA (November 1974): 971-998.

Grinyer, P. H., and J. Wooller (1975), CORPORATE MODELS TODAY, The Institute of Chartered Accountants in England and Wales, London, 1975.

Groff, Gene (1973), "Empirical Comparison of Models for Short-Range Forecasting," MANAGEMENT SCIENCE (September 1973): 22-31.

GUIDELINES FOR SYSTEMS FOR THE PREPARATION OF FINANCIAL FORECASTS (1975), Management Advisory Services, American Institute of Certified Public Accountants, 1975.

Gujarati, Damodar (1978), BASIC ECONOMETRICS, McGraw-Hill, 1978.

Haitovsky, T. (1969), "Multicollinearity in Regression Analysis: Comment," REVIEW OF ECONOMICS AND STATISTICS (November 1969): 486- 489.

Hall, Bronwyn H., and Robert E. Hall (1980), TIME SERIES PROCESSOR VERSION 3.5 USER'S MANUAL, TSP International, 1980.

Hamberg, Daniel (1966), R & D: ESSAYS ON THE ECONOMICS OF RESEARCH AND DEVELOPMENT, Random House, 1966.

Hansen, Palle (1962), THE ACCOUNTING CONCEPT OF PROFIT, North-Holland, 1962.

Hart, A. G. (1940), ANTICIPATIONS, UNCERTAINTY, AND DYNAMIC PLANNING, University of Chicago Press, 1940.

Harvey, A. C. (1981), THE ECONOMETRIC ANALYSIS OF TIME SERIES, Philip Allan, Oxford, 1981.

Haugh, Larry D., and G. E. P. Box (1977), "Identification of Dynamic Regression (Distributed Lag) Models connecting Two Time Series," JOURNAL OF THE AMERICAN STATISTICAL ASSOCIATION (March 1977): 121- 130.

Helmer, R. M., and J. K. Johansson (1977), "An Exposition of the Box-Jenkins Transfer Function Analysis with an Application to the Advertising-Sales Relationship," JOURNAL OF MARKETING RESEARCH (May 1977): 227-239.

Hendriksen, Eldon S. (1977), ACCOUNTING THEORY, Third Edition, Irwin, 1977.

Hertz, D. B. (1964), "Risk Analysis in Capital Investment," HARVARD BUSINESS REVIEW (January-February 1964): 95-106.

Herwitz, (1973), "Projections and Forecasts," ANN. INST. SEC. REG. (1973): 323.

Hicks, John Richard (1946), VALUE AND CAPITAL, 2nd Edition, Oxford University Press, London, 1946.

Howrey, E. P. (1973), "Selection and Evaluation of Econometric Models," in W. Goldberg, ed., PROCEEDINGS OF THE CONFERENCE ON SIMULATION VERSUS ANALYTICAL SOLUTIONS FOR BUSINESS AND ECONOMIC MODELS, 1973, pp. 1-38.

Ijiri, Yuji (1974), "Improving Reliability of Publicly Reported Corporate Financial Forecasts," in P. Prakash and A. Rappaport (1974), eds., PUBLIC REPORTING OF CORPORATE FINANCIAL FORECASTS, Commerce Clearing House, pp. 161-188.

-----(1975), THEORY OF ACCOUNTING MEASUREMENT, American Accounting Association, 1975.

-----, and R. K. Jaedicke (1966), "Reliability and Objectivity of Accounting Measurements," ACCOUNTING REVIEW (July 1966): 474-483.

-----, R. K. Jaedicke, and J. L. Livingstone (1965), "The Effect of Inventory Costing Methods on Full and Direct Costing," JOURNAL OF ACCOUNTING RESEARCH (Spring 1968): 63-74.

INDUSTRIAL COMPUSTAT MANUAL, Standard & Poor's Compustat Services, Inc., 7400 South Alton Court, Englewood, Colorado 80112, (800) 525-8640.

Intriligator, Michael D. (1978), ECONOMETRIC MODELS, TECHNIQUES, & APPLICATIONS, Prentice-Hall, 1978.

Johnson, Orace (1967), "A Consequential Approach to Accounting for R & D," JOURNAL OF ACCOUNTING RESEARCH (Autumn 1967): 164-172.

Joy, O. Maurice, and John O. Tollefson (1975), "On the Financial Applications of Discriminant Analysis," JOURNAL OF FINANCIAL AND QUANTITATIVE ANALYSIS (1975): 723-739.

Judge, George G., William E. Griffiths, R. Carter Hill, and Tsoung-Chao Lee (1980), THE THEORY AND PRACTICE OF ECONOMETRICS, Wiley, 1980.

Kadane, J. B. (1971), "Comparison of k-Class Estimators when the Disturbances are Small," ECONOMETRICA (1971): 723-737.

Kaldor, N. (1966), "Marginal Productivity and the Macroeconomic Theories of Distribution," REVIEW OF ECONOMIC STUDIES (October 1966): 309-319.

Kelejian, Harry H., and Wallace E. Oates (1981), INTRODUCTION TO ECONOMETRICS, Second Edition, Harper & Row, 1981.

Kessel, R. A. (1956), "Inflation-caused Wealth Redistribution: A Test of a Hypothesis," AMERICAN ECONOMIC REVIEW (March 1956): 128-141.

Kidd, Robert H. (1976), EARNINGS FORECASTS, The Canadian Institute of Chartered Accountants, 1976.

Kierstead, B. S. (1953), AN ESSAY IN THE THEORY OF PROFITS AND INCOME DISTRIBUTION, Basil Blackwell, Oxford, 1953.

Kieso, Donald E., and Jerry J. Weygandt (1980), INTERMEDIATE ACCOUNTING, Third Edition, Wiley, 1980.

King, Mervyn A. (1974a), "Taxation and the Cost of Capital," REVIEW OF ECONOMIC STUDIES (January 1974): 21-36.

-----(1974b), "Dividend Behaviour and the Theory of the Firm," ECONOMICA (February 1974): 25-34.

Klein, L. R. (1971), THEORY OF ECONOMIC PREDICTION, Markham, 1971.

Knight, Frank H. (1921), RISK, UNCERTAINTY AND PROFIT, Houghton Mifflin, 1921.

Kohler, Eric L. (1975), A DICTIONARY FOR ACCOUNTANTS, Fifth Edition, Prentice-Hall, 1975.

Kotler, Philip (1971), MARKETING DECISION MAKING: A MODEL BUILDING APPROACH, Holt, Rinehart, and Winston, 1971.

Kripke, Homer (1970), "The SEC, The Accountants, Some Myths and Some Realities," NEW YORK UNIVERSITY LAW REVIEW (1970): 1151.

-----(1975), "A Search for a Meaningful Securities Disclosure Policy," THE BUSINESS LAWYER (November 1975): 293-317.

Kuh, E. (1963), CAPITAL STOCK GROWTH: A MACROECONOMIC APPROACH, North-Holland, Amsterdam, 1963.

Kuznets, S. (1966), MODERN ECONOMIC GROWTH, Yale University Press, 1966.

Lamberton, D. M. (1965), THE THEORY OF PROFIT, Basil Blackwell, Oxford, 1965.

Lev, Baruch (1969), ACCOUNTING & INFORMATION THEORY, American Accounting Association, 1969.

-----(1974), FINANCIAL STATEMENT ANALYSIS: A NEW APPROACH, Prentice-Hall, 1974.

Lintner, J. (1965), "Distribution of Income of Corporations among Dividends, Retained Earnings and Taxes," AMERICAN ECONOMIC REVIEW, PAPERS AND PROCEEDINGS (1965): 97-114.

Liviatan, N. (1963), "Consistent Estimation of Distributed Lags," INTERNATIONAL ECONOMIC REVIEW (1963): 44-52.

Livingstone, J. Leslie, and Thomas J. Burns (1971), eds., INCOME THEORY AND RATE OF RETURN, College of Administrative Science Monograph No. 5- 2, The Ohio State University, 1971.

Lord, F. M. (1950), "Efficiency of Prediction When a Regression Equation from One Sample is Used in a New Sample," RESEARCH BULLETIN 50-40, Educational Testing Service, 1950.

Lorek, Kenneth S. (1979), "Predicting Annual Net Earnings with Quarterly Earnings Time-Series Models," JOURNAL OF ACCOUNTING RESEARCH (Spring 1979): 190-204.

Maddala, G. S. (1977), ECONOMETRICS, McGraw-Hill, 1977.

Makridakis, Spyros, and Steven C. Wheelwright (1977), "Adaptive Filtering: An Integrated Autoregressive/Moving Average Filter for Time Series Forecasting," OPERATIONAL RESEARCH QUARTERLY (1977): 425- 437.

-----, and -----(1978a), FORECASTING: METHODS AND APPLICATIONS, Wiley, 1978.

-----(1978b), INTERACTIVE FORECASTING, Second Edition, Holden-Day, 1978.

Malinvaud, E. (1970), STATISTICAL METHODS OF ECONOMETRICS, 2nd Edition, North-Holland, 1970.

Malkiel, B. G. (1963), "Equity Yields, Growth, and the Structure of Share Prices," AMERICAN ECONOMIC REVIEW (December 1963): 1004-1031.

Mandel, Joseph D., and David E. Altschul (1977), "Financial Forecasts

and Projections: A Pitfall for the Uninitiated Accountant," THE JOURNAL OF ACCOUNTANCY (May 1977): 46-50.

Manetsch, Thomas J., and Gerald L. Park (1973), SYSTEM ANALYSIS AND SIMULATION WITH APPLICATIONS TO ECONOMIC AND SOCIAL SYSTEMS, Parts I and II, Department of Electrical Engineering and System Science, Michigan State University, 1973.

Marquardt, D. W. (1963), "An Algorithm for Least-Squares Estimation of Nonlinear Parameters," JOURN. SOC. INDSTR. APPL. MATH. (1963): 431-441.

Marris, Robin (1971), "Some New Results on Growth and Profitability," in Robin Marris and Adrian Wood, ed., THE CORPORATE ECONOMY, Harvard University Press, 1971, pp. 422-427.

-----, and Adrian Wood (1971), ed., THE CORPORATE ECONOMY, Harvard University Press, 1971.

Marshall, Alfred (1919), INDUSTRY AND TRADE, Macmillan, London, 1919.

Martin, Stephen (1979), "Advertising, Concentration, and Profitability: the Simultaneity Problem," THE BELL JOURNAL OF ECONOMICS (Autumn 1979): 639-647.

McConnell, J. L. (1945), "Corporate Earnings by Size of Firm," SURVEY OF CURRENT BUSINESS (May 1945): 6-12.

-----(1946), "1942 Corporate Profits by Size of Firm," SURVEY OF CURRENT BUSINESS (January 1946): 10-16, 20.

McDonald, C. L. (1973), "An Empirical Examination of the Reliability of Published Predictions of Future Earnings," THE ACCOUNTING REVIEW (July 1973): 502-510.

McLaughlin, R. L. (1962), TIME SERIES FORECASTING, American Marketing Association, 1962.

-----(1975), "The Real Reocrd of Econometric Forecasters," BUSINESS ECONOMICS (1975): 28-36.

-----, and J. J. Boyle (1968), SHORT TERM FORECASTING, American Marketing Association, 1968.

McNemar, Quinn (1962), PSYCHOLOGICAL STATISTICS, Wiley, 1962.

Meadows, Donella H., Dennis L. Meadows, Jorgen Randers, and William W. Behrens III (1972), THE LIMITS TO GROWTH, Universe, 1972.

Melrose, Kendrick B. (1969), "An Empirical Study on Optimizing Advertising Policy," JOURNAL OF BUSINESS (July 1969): 282-292.

Mesarovic, Mihajlo, and Eduard Pestel (1974), MANKIND AT THE TURNING POINT, Signet, 1974.

Meyer, Henry I. (1977), CORPORATE FINANCIAL PLANNING MODELS, Wiley, 1977.

Meyer, J., and E. Kuh (1957), "How Extraneous Are Extraneous Estimates?" REVIEW OF ECONOMICS AND STATISTICS (1957): 380-393.

Mincer, Jacob, and Victor Zarnowitz (1969), "The Evaluation of Economic Forecasts," in Jacob Mincer, ed., ECONOMIC FORECASTS AND EXPECTATIONS: ANALYSES OF FORECASTING BEHAVIOR AND PERFORMANCE, Columbia University Press, 1969.

Mize, Jan L., and Edwin F. Ulveling (1970), "The Demand for Domestic Airline Passenger Transportation: An Analysis and a Forecast for 1975," MISSISSIPPI VALLEY JOURNAL OF BUSINESS AND ECONOMICS (Fall 1970): 56-68.

Modigliani, Franco, and M. H. Miller (1958), "The Cost of Capital, Corporation Finance and the Theory of Investment," AMERICAN ECONOMIC REVIEW (June 1958): 261-297.

-----(1961), "Dividend Policy, Growth and the Valuation of Shares," JOURNAL OF BUSINESS (1961): 411-433.

-----(1967), "Estimates of the Cost of Capital Relevant for Investment Decisions under Uncertainty," in R. Ferber, DETERMINANTS OF INVESTMENT BEHAVIOR, 1967, pp. 179-213.

Montgomery, David B., and G. L. Urban (1969), MANAGEMENT SCIENCE IN MARKETING, Prentice-Hall, 1969.

-----, and Alvin J. Silk (1972), "Estimating Dynamic Effects of Market Communications Expenditures," MANAGEMENT SCIENCE (1972): B485-B501.

-----, and Donald G. Morrison (1973), "A Note on Adjusting $R\underline{2}$," JOURNAL OF FINANCE (1973): 1009-1013.

Moomjian, G. (1976), "Soft Information; Liability Standards and Safe Harbors (Rule Proposals)," Memorandum, dated June 28, 1976, to M. Lipton, of Wachtell, Lipton, Rosen & Katz, in APPENDIX TO THE REPORT OF THE ADVISORY COMMITTEE ON CORPORATE DISCLOSURE TO THE SECURITIES AND EXCHANGE COMMISSION, Committee Print 95-30, House Committee on Interstate and Foreign Commerce, November 3, 1977, U. S. Government Printing Office, pp. A-377 through A-408.

Mosbaek, E. J., and H. O. Wold (1970), INTERDEPENDENT SYSTEMS, STRUCTURE AND ESTIMATION, North-Holland, 1970.

Moss, Scott J. (1981), AN ECONOMIC THEORY OF BUSINESS STRATEGY, Halsted, 1981.

Most, Kenneth S. (1977), ACCOUNTING THEORY, Grid, 1977.

Mueller, Dennis C., "The Firm Decision Process: An Econometric Investigation," QUARTERLY JOURNAL OF ECONOMICS (February 1967): 58- 87.

Murdick, Robert G., and Arthur E. Schaefer (1967), SALES FORECASTING FOR LOWER COSTS AND HIGHER PROFITS, Prentice-Hall, 1967.

Nagar, A. L. (1959), "The Bias and Moment Matrix of the General k-Class Estimators of the Parameters in Simultaneous Equations," ECONOMETRICA (1959): 575-595.

-----(1962), "Double k-Class Estimators of Parameters in Simultaneous Equations and their Small Sample Properties," INTERNATIONAL ECONOMIC REVIEW (1962): 168-188.

Naylor, Thomas H., Joseph L. Balintfy, Donald S. Burdick, and Kong Chu (1966), COMPUTER SIMULATION TECHNIQUES, Wiley, 1966.

-----(1971), COMPUTER SIMULATION EXPERIMENTS WITH MODELS OF ECONOMIC SYSTEMS, Wiley, 1971.

-----, and H. Schauland (1976), "Experience with Corporate Simulation Models--A Survey," LONG RANGE PLANNING (April 1976): 94-100.

-----(1979a), CORPORATE PLANNING MODELS, Addison-Wesley, 1979.

-----(1979b), ed., SIMULATION MODELS IN CORPORATE PLANNING, Praeger, 1979.

Nelson, C. (1973), APPLIED TIME SERIES ANALYSIS, Holden-Day, 1973.

Nerlove, M. (1968), "Preliminary Results on Factors Affecting Differences Among Rates of Return on Investments in Individual Common Stocks," Harvard Institute of Economic Research Paper 23.

Newman, Maurice S. (1968), "Equating Return from R & D Expenditures," FINANCIAL EXECUTIVE (April 1968): 26-33.

Nickerson, Charles A., Larry G. Pointer, and Robert H. Strawser, "Published Forecasts: Choice or Obligation?", FINANCIAL EXECUTIVE (February 1974): 70-73.

Ohlin, Lloyd E., and O. D. Duncan (1949), "The Efficiency of Prediction in Criminology," AMERICAN JOURNAL OF SOCIOLOGY (1949): 441-452.

Orcutt, G. H. (1962), "Microanalytic Models of the United States Economy: Need and Development," AMERICAN ECONOMIC REVIEW (1962): 229-240.

-----, M. Greenberger, J. Korbel, and A. M. Rivlin (1961),

MICROANALYSIS OF SOCIOECONOMIC SYSTEMS: A SIMULATION STUDY, Harper & Row, 1961.

-----, H. W. Watts, and J. B. Edwards (1968), "Data Aggregation and Information Loss," AMERICAN ECONOMIC REVIEW (September 1968): 773- 787.

Paton, William A. (1965), CORPORATE PROFITS, Irwin, 1965.

Pierce, David A. (1977), "Relationships--and the Lack Thereof--Between Economic Time Series with Special Reference to Money and Interest Rates," JOURNAL OF THE AMERICAN STATISTICAL ASSOCIATION (March 1977): 11-22.

Pindyck, Robert S., and Daniel L. Rubinfeld (1981), ECONOMETRIC MODELS AND ECONOMIC FORECASTS, Second Edition, McGraw-Hill, 1981. First Edition (1976).

Platt, Robert B. (1971), "Some Measures of Forecast Accuracy," BUSINESS ECONOMICS (May 1971): 30-39.

Prais, S. J. (1957), "The Financial Experience of Giant Companies," ECONOMIC JOURNAL (June 1957): 249-264.

PRESENTATION AND DISCLOSURE OF FINANCIAL FORECASTS (1975), Statement of Position 75-4, Accounting Standards Division, American Institute of Certified Public Accountants, 1975.

PUBLISHED PROFIT FORECASTS (1974), Accountants International Study Group, 1974.

Raiffa, H., and R. Schlaifer (1961), APPLIED STATISTICAL DECISION THEORY, MIT, 1961.

Rao, Potluri, and Roger LeRoy Miller (1971), APPLIED ECONOMETRICS, Wadsworth, 1971.

REPORT OF THE ADVISORY COMMITTEE ON CORPORATE DISCLOSURE TO THE SECURITIES AND EXCHANGE COMMISSION (1977), Committee Print 95- 29, House Committee on Interstate and Foreign Commerce, in two volumes, U. S. Government Printing Office, 1977.

Revell, J., and J. Moyle (1966), "The Owners of Quoted Ordinary Shares," Published Paper 7 of "A Programme for Growth," Department of Applied Economics, Cambridge University, 1966.

Revsine, Lawrence (1973), REPLACEMENT COST ACCOUNTING, Prentice-Hall, 1973.

Richards, R. Malcolm (1976), "Analysts' Performance and the Accuracy of Corporate Earnings Forecasts," THE JOURNAL OF BUSINESS (July 1976): 350-357.

Richards, R. Malcolm, and Donald R. Fraser (1977), "Further Evidence on the Accuracy of Analysts' Earnings Forecasts: A Comparison Among Analysts," JOURNAL OF ECONOMICS AND BUSINESS (October 1977): 193-197.

-----(1978), "The Predictability of Corporate Earnings," ATLANTA ECONOMIC REVIEW (March-April 1978): 43-47.

Roberts, Edward B. (1978), ed., MANAGERIAL APPLICATIONS OF SYSTEM DYNAMICS, MIT, 1978.

-----, Dan I. Abrams, and Henry B. Weil (1968), "A Systems Study of Policy Formulation in a Vertically-Integrated Firm," MANAGEMENT SCIENCE (August 1968): B-674--B-694.

Roberts, H. V. (1965), "Probabilistic Prediction," JOURNAL OF THE AMERICAN STATISTICAL ASSOCIATION (March 1965): 50-62.

Robinson, Joan (1953), "Imperfect Competition Revisited," ECONOMIC JOURNAL (September 1953): 579-593.

Rosenkranz, Friedrich (1979), AN INTRODUCTION TO CORPORATE MODELING, Duke University Press, 1979.

-----, and S. Pellegrini (1976), "Corporate Modeling: Methodology and Computer-Based Model Design Procedure," APPLIED INFORMATICS (1976): 259-267.

Ross, S. (1977), "Disclosure Regulation in Financial Markets," in KEY ISSUES IN FINANCIAL REGULATION, 1977.

Rothschild, K. W. (1947), "Price Theory and Oligopoly," ECONOMIC JOURNAL (September 1947): 299-320.

Saginor, Irving (1967), FORECAST OF SCHEDULED DOMESTIC AIR PASSENGER TRAFFIC FOR THE ELEVEN TRUNKLINE CARRIERS, 1968-1977, Civil Aeronautics Board, 1967.

Saltzman, S. (1967), "An Econometric Model of a Firm," REVIEW OF ECONOMICS AND STATISTICS (August 1967): 332-342.

Sandilands, F. E. P. (1975), INFLATION ACCOUNTING: REPORT OF THE INFLATION ACCOUNTING COMMITTEE, Her Majesty's Stationery Office, London, 1975.

Sargan, J. D., and W. M. Mikhail (1971), "A General Approximation to the Distribution of Instrumental Variable Estimates," ECONOMETRICA (1971): 131-169.

Scherer, F. M. (1980), INDUSTRIAL MARKET STRUCTURE AND ECONOMIC PERFORMANCE, Second Edition, Rand McNally, 1980.

Schmidt, Peter J. (1974), "A Modification of the Almon Distributed

Lag," JOURNAL OF THE AMERICAN STATISTICAL ASSOCIATION (September 1974): 679-681.

-----(1976), ECONOMETRICS, Marcel Dekker, 1976.

Schneider, (1972), "Nits, Grits and Soft Information in SEC Filings," University of Pennsylvania Law Review (1972): 254.

Schrieber, A. N. (1970), ed., CORPORATE SIMULATION MODELS, University of Washington, 1970.

Sharpe, William F. (1970), PORTFOLIO THEORY AND CAPITAL MARKETS, McGraw- Hill, 1970.

Singh, A., and G. Whittington (1968), GROWTH, PROFITABILITY, AND VALUATION, Cambridge, 1968.

Smith, Charles H. (1971), "The Modern Systems Approach, General Systems Theory, and Accounting Theory in the Age of Synthesis," THE INTERNATIONAL JOURNAL OF ACCOUNTING (Spring 1971): 59-73.

Smith, V. K. (1973), MONTE CARLO METHODS, Lexington Books, 1973.

Smyth, D. J. (1966), "How Well Do Australian Economists Forecast?" ECONOMIC RECORD (1966): 293-311.

Snee, R. D. (1977), "Validation of Regression Models: Methods and Examples," TECHNOMETRICS (1977): 415-428.

Solomons, D. (1968), "Breakeven Analysis under Absorption Costing," ACCOUNTING REVIEW (July 1968): 447-452.

Spence, A. M. (1974), MARKET SIGNALING: INFORMATIONAL TRANSFER IN HIRING AND RELATED SCREENING PROCESSES, Harvard University Press, 1974.

Spencer, Robert S. (1966), "Modelling Strategies for Corporate Growth," in Edward B. Roberts, ed., MANAGERIAL APPLICATIONS OF SYSTEM DYNAMICS, MIT, 1978, pp. 341-354.

Stein, C. (1956), "Inadmissibility of the Usual Estimator for the Mean of a Multivariate Normal Distribution," PROCEEDINGS OF THE THIRD BERKELEY SYMPOSIUM, Vol. 1, University of California Press, 1956, pp. 197-206.

Stekler, Herman O. (1968), "Forecasting with Econometric Models: An Evaluation," ECONOMETRICA (July-October 1968): 437-463.

Sterling, Robert (1970), THEORY OF THE MEASUREMENT OF ENTERPRISE INCOME, University of Kansas Press, 1970.

Stern, E. H. (1955), "Industrial Production and Profits in the United Kingdom and the United States," ECONOMIC JOURNAL (September 1955):

485-497.

Summers, Robert (1965), "A Capital Intensive Approach to the Small-Sample Properties of Various Simultaneous Equation Estimators," ECONOMETRICA (1965): 1-41.

Sutton, C. J. (1980), ECONOMICS AND CORPORATE STRATEGY, Cambridge University Press, 1980.

Szatrowski, Zenon (1945), "The Relationship between Price Changes and the Price Level for Common Stocks," JOURNAL OF THE AMERICAN STATISTICAL ASSOCIATION (December 1945): 467-483.

Tapiero, Charles S. (1977), MANAGERIAL PLANNING: AN OPTIMUM AND STOCHASTIC CONTROL APPROACH, volumes one and two, Gordon and Breach, 1977.

Theil, Henri (1961), ECONOMIC FORECASTS AND POLICY, Second edition, North-Holland, 1961. First edition (1958).

-----(1966), APPLIED ECONOMIC FORECASTING, North-Holland, 1966.

-----(1967), ECONOMICS AND INFORMATION THEORY, North-Holland, 1967.

-----(1971), PRINCIPLES OF ECONOMETRICS, Wiley, 1971.

Thomas, Arthur L. (1969), THE ALLOCATION PROBLEM IN FINANCIAL ACCOUNTING THEORY, American Accounting Association, 1969.

-----(1974), THE ALLOCATION PROBLEM: PART TWO, American Accounting Association, 1974.

Thorelli, Hans B. (1977), ed., STRATEGY + STRUCTURE = PERFORMANCE, Indiana University Press, 1977.

Tinbergen, J. (1955), ON THE THEORY OF ECONOMIC POLICY, Second edition, North-Holland, 1955.

Tintner, Gerhard (1941), "The Pure Theory of Production under Technological Risk and Uncertainty," ECONOMETRICA (July-October 1941): 305-312.

Trigg, D. W. (1964), "Monitoring a Forecasting System," OPERATIONAL RESEARCH QUARTERLY (1964): 271-274.

Tukey, John Wilder (1977), EXPLORATORY DATA ANALYSIS, Addison-Wesley, 1977.

Uhl, Norman, and Terry Eisenberg (1970), "Predicting Shrinkage in the Multiple Correlation Coefficient," EDUCATIONAL AND PSYCHOLOGICAL MEASUREMENT (1970): 487-489.

Veit, Kenneth P. (1976), "System Dynamics in Corporate Long-Range Strategic Planning," in Edward B. Roberts, ed., MANAGERIAL APPLICATIONS OF SYSTEM DYNAMICS, MIT, 1978, pp. 533-544.

Watts, R. (1973), "The Information Content of Dividends," JOURNAL OF BUSINESS (April 1973): 191-211.

Weil, Henry B., Thomas A. Bergan, and Edward B. Roberts (1973), "The Dynamics of R & D Strategy," in Edward B. Roberts (1978), ed., MANAGERIAL APPLICATIONS OF SYSTEM DYNAMICS, MIT, 1978, pp. 325-340.

Welch, Eric, and Tom Panas (1981), "Economic Forecasting Systems," ICP INTERFACE ADMINISTRATIVE & ACCOUNTING (Autumn 1981): 22-26, 28, 29.

Wells, F. A. (1957), "The Relationship between Physical and Financial Comparisons of Productivity," in INTER-FIRM COMPARISON, European Productivity Agency of the Organization for European Economic Co-operation, Paris, 1957.

Weston, J. Fred (1950), "A Generalized Uncertainty Theory of Profit," AMERICAN ECONOMIC REVIEW (March 1950): 40-60.

-----(1954), "The Profit Concept and Theory: A Restatement," JOURNAL OF POLITICAL ECONOMY (April 1954): 152-170.

Wheelwright, Steven C., and Spyros Makridakis (1980), FORECASTING METHODS FOR MANAGEMENT, Third Edition, Wiley, 1980.

Wherry, R. J. (1931), "A New Formula for Predicting the Shrinkage of the Coefficient of Multiple Correlation," ANNALS OF MATHEMATICAL STATISTICS (1931): 440-457.

Whitbeck, V. S., and M. Kisor, Jr. (1963), "A New Tool in Investment Decision-Making," FINANCIAL ANALYSTS JOURNAL (May-June 1963): 55-62.

Williamson, Oliver E. (1963), THE ECONOMICS OF DISCRETIONARY BEHAVIOR: MANAGERIAL OBJECTIVES IN A THEORY OF THE FIRM, Prentice-Hall, 1963.

Wold, H. O. A. (1964), ed., ECONOMETRIC MODEL BUILDING: ESSAYS ON THE CAUSAL CHAIN APPROACH, North-Holland, 1964.

Wood, Adrian (1975), A THEORY OF PROFITS, Cambridge University Press, 1975.

Yang, Charles Y. (1969), "Advertising and Sales Promotion as a Predictor Variable," in John J. Clark, ed., THE MANAGEMENT OF FORECASTING, St. John's University Press, 1969, pp. 269-288.

Zellner, A. (1969), "On the Aggregation Problem: A New Approach to a Troublesome Problem," in K. A. Fox, et. al., eds., ECONOMIC MODELS, ESTIMATION AND RISK PROGRAMMING, Springer, 1969, pp. 365-374.

Watts, R. (1973), "The Information Content of Dividends," JOURNAL OF BUSINESS (April 1973): 191-211.

Weil, Henry B., Thomas A. Bergan, and Edward B. Roberts (1973), "The Dynamics of R & D Strategy," in Edward B. Roberts (1978), ed., MANAGERIAL APPLICATIONS OF SYSTEM DYNAMICS, MIT, 1978, pp. 325-340.

Wells, F. A. (1957), "The Relationship between Physical and Financial Comparisons of Productivity," in INTER-FIRM COMPARISON, European Productivity Agency of the Organization for European Economic Co-operation, Paris, 1957.

Weston, J. Fred (1950), "A Generalized Uncertainty Theory of Profit," AMERICAN ECONOMIC REVIEW (March 1950): 40-60.

-----(1954), "The Profit Concept and Theory: A Restatement," JOURNAL OF POLITICAL ECONOMY (April 1954): 152-170.

Whitbeck, V. S., and M. Kisor, Jr. (1963), "A New Tool in Investment Decision-Making," FINANCIAL ANALYSTS JOURNAL (May-June 1963): 55-62.

Wold, H. O. A. (1964), ed., ECONOMETRIC MODEL BUILDING: ESSAYS ON THE CAUSAL CHAIN APPROACH, North-Holland, 1964.

Wood, Adrian (1975), A THEORY OF PROFITS, Cambridge University Press, 1975.

Yang, Charles Y. (1969), "Advertising and Sales Promotion as a Predictor Variable," in John J. Clark, ed., THE MANAGEMENT OF FORECASTING, St. John's University Press, 1969, pp. 269-288.

Zellner, A. (1969), "On the Aggregation Problem: A New Approach to a Troublesome Problem," in K. A. Fox, et. al., eds., ECONOMIC MODELS, ESTIMATION AND RISK PROGRAMMING, Springer, 1969, pp. 365-374.

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