



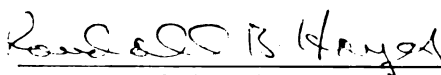
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MODELING THE UTILIZATION OF ACCOUNTING DATA:
AN EMPIRICAL STUDY

presented by

David Allen Ziebart

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Doctor of
Philosophy degree in Accounting


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MODELING THE UTILIZATION OF ACCOUNTING DATA:
AN EMPIRICAL STUDY

By

David Allen Ziebart

A DISSERTATION

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

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ABSTRACT

MODELING THE UTILIZATION OF ACCOUNTING DATA: AN EMPIRICAL STUDY

By

David Allen Ziebart

Previous research evidence indicates that investors react to the issuance of corporate financial information. Earnings data has been found to possess information content. Little evidence on the information usage process regarding other types of financial information is available. A specification of the process by which capital markets use financial data is a necessary prerequisite for understanding the interaction of accounting as an information system and the capital markets as users of the accounting data. This dissertation investigates that process.

An investigation of the use of data concerning the liquidity, leverage, profitability, and activity dimensions of a firm by the securities market is conducted utilizing the abnormal performance index research paradigm. Two types of market reaction, abnormal returns and abnormal trading activity, are causally linked to expectation errors regarding the economic dimensions of a firm. Through decomposition of the variation in the market reactions into the components attributable to the variation in the expectation errors of the information cues, the usefulness of each cue is inferred. A causal model configuration is hypothesized, estimated, and tested using Full Information Maximum Likelihood estimation techniques.

The results of this study are based upon a sample of two hundred manufacturing firms. These companies are listed on the New York Stock Exchange and possessed the requisite return, trading, and accounting

data. The findings of this project indicate that the expectation errors regarding various financial ratios do not fall categorically into the associated liquidity, leverage, profitability, and activity dimensions they are expected to measure. Instead, each ratio must be treated as a unique attribute of the firm.

Evidence is found that information regarding the profitability, leverage, and activity dimensions of a firm are used by investors. Market price reactions are found to be linked to the expectation errors regarding the defensive interval and primary earnings per share. Volume reactions are found to be linked to the expectation errors regarding times interest earned, return on total assets, and primary earnings per share. For both market reaction measures the primary earnings per share cue is most significant. The abnormal trading activity market reaction is driven by the abnormal price reaction with no significant reciprocal causality.

This dissertation is dedicated in loving memory of my grandparents,
Elmer and Versia Ferrell.

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CHAPTER I

Introduction

Purpose of the Research

In previous research, Benston (1967), Ball and Brown (1968), Beaver (1968), Brown (1970), May (1971), Brown and Kennelly (1972), Kiger (1972), Hagerman (1973), Gonedes (1974, 1975), Beaver, Clarke, and Wright (1979) and others have investigated the reactions of the securities market to the announcement of corporate financial accounting information. The financial accounting information cue investigated was the earnings per share datum.

Evidence indicates the market reacts to the announcement of the earnings per share figure. Earnings per share is recognized as having information content, a statistical dependency between earnings per share expectation errors and abnormal security returns and/or trading volume. However, little evidence concerning the roles played by other financial information cues in the securities market's information usage process is available. This research project investigates the use of the financial cues derived from the announcement of earnings and the issuance of the financial statements. A financial cue is a potential stimulus of investment behavior derived from the difference between expected and actual financial results.

A specification of the process by which capital markets use various types of financial data is a necessary prerequisite for understanding the interaction of accounting as an information system and the capital market as a user of information. Modeling the relationship between various types of financial information and the reaction of the security market to the announcement of the cues allows assessment of the importance

each of these cues play in setting relative prices. Since both price and volume reactions are studied, the relationships between the cues and the effects on the market are analyzed from both an individual's and a total market point of view. This is very important to the understanding of the use of information by individuals and by the total market.

Research Paradigm

The abnormal performance research paradigm is employed in this study. A graphical depiction of the abnormal performance experimental design, adapted from Patell (1979), follows.

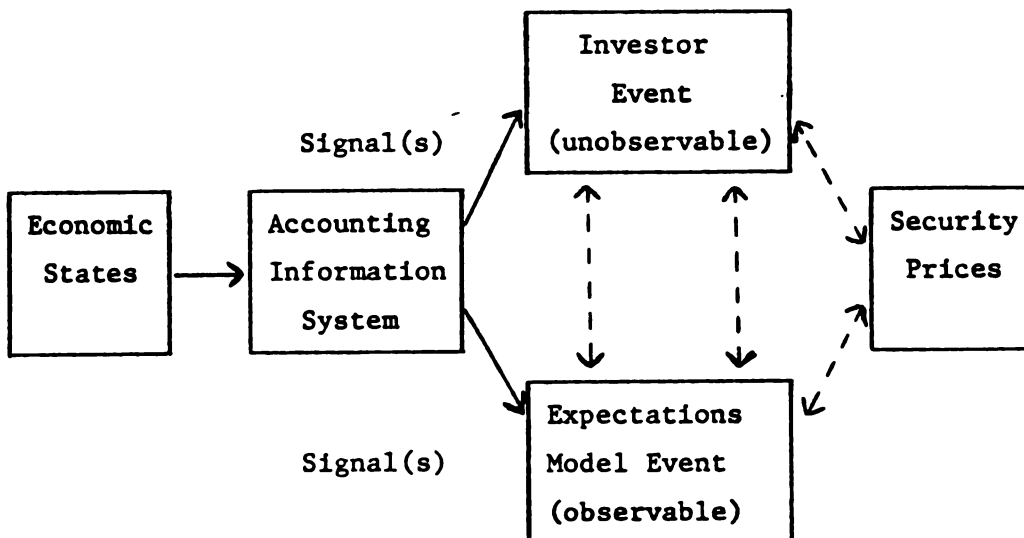


Figure 1. Abnormal Performance Experiment Paradigm

For each firm studied, at a particular point in time the firm's financial position is depicted by its economic states. Those economic states are characterized by the accounting system where they are recorded and aggregated in some form. The accounting system provides a signal or multiple signals concerning these economic states to investors through the announcement of earnings or the issuance of financial statements.

The investor event, which is unobservable, contains the revision of expectations due to the signals provided by the accounting system. Since the investor event is unobservable, a representation of the expectations regarding the signal(s) must be formulated. This is the expectations model event. The difference between the expected signal and the actual signal from the accounting system is the incremental information resulting from the announcement. From the security prices or returns, a measure of abnormal performance is computed.

The traditional use of this paradigm has been to investigate information content. One assumes: (1) the signal or cue is used by the investor and (2) the expectations model results in a valid representation of the unexpected news resulting from the signal announcement. A measure of abnormal performance is analyzed to infer information content. This use is depicted in Figure 2.

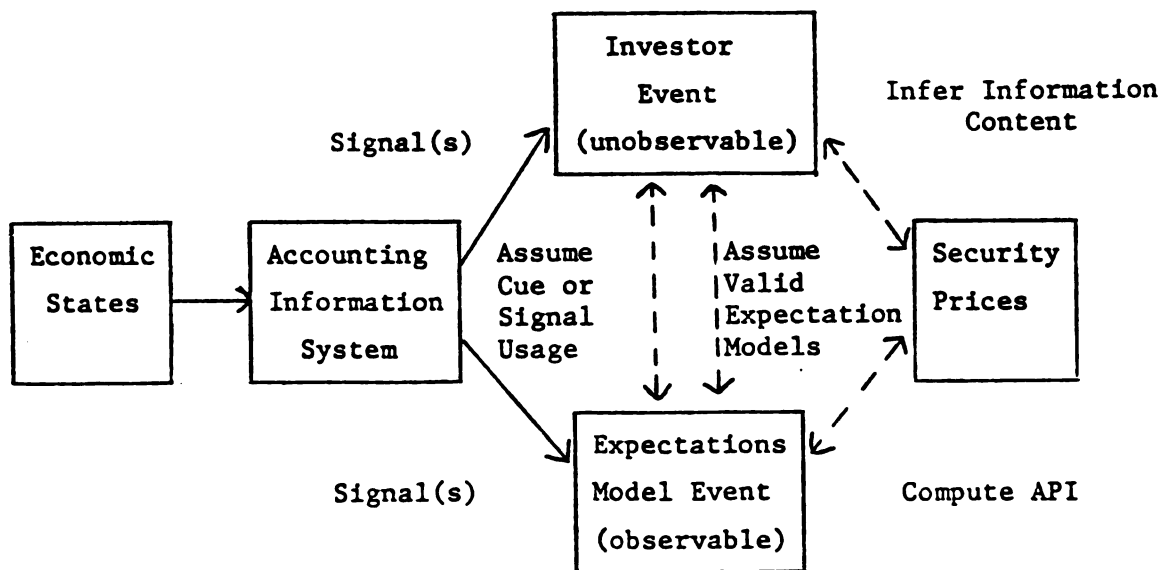


Figure 2. API Research Paradigm; Information Content Investigation

Patell (1979) demonstrates that if one assumes cue usage and information content an evaluation of the expectation models can be made.

This is shown in Figure 3.

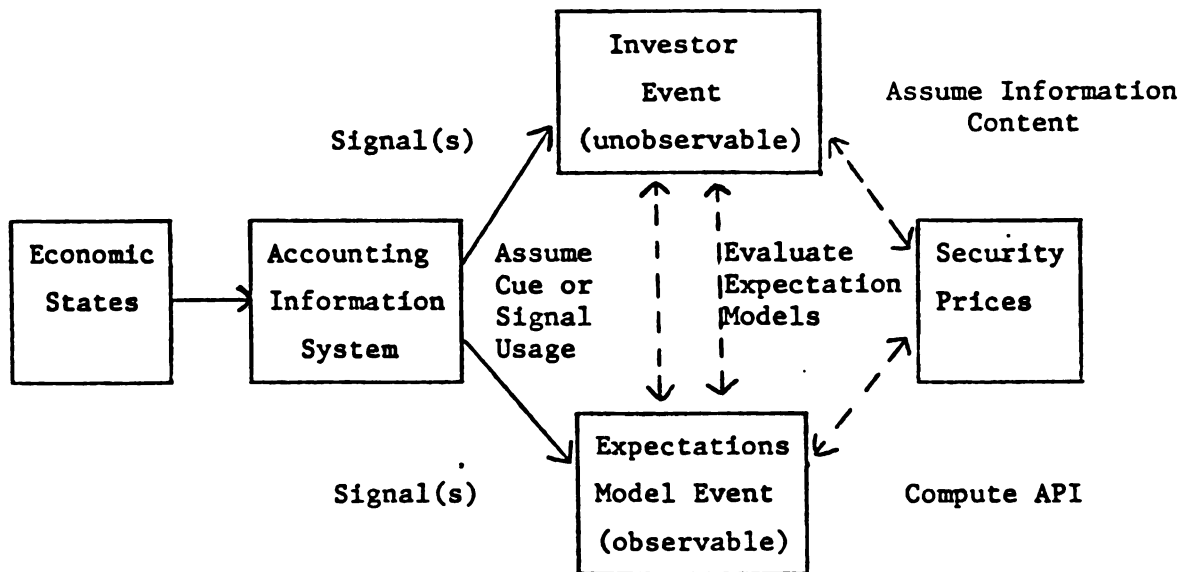


Figure 3. API Research Paradigm; Expectation Model Investigation

This research study assumes a valid expectations model and information content in the announcement of financial data; it investigates the usage of various cues or signals resulting from the release of the firm's financial data. By decomposition of the variation in the abnormal performance measures into the components attributable to the variation in the expectation errors of the cues, the usefulness of each cue is inferred. This use of the abnormal performance experimental design is depicted in Figure 4.

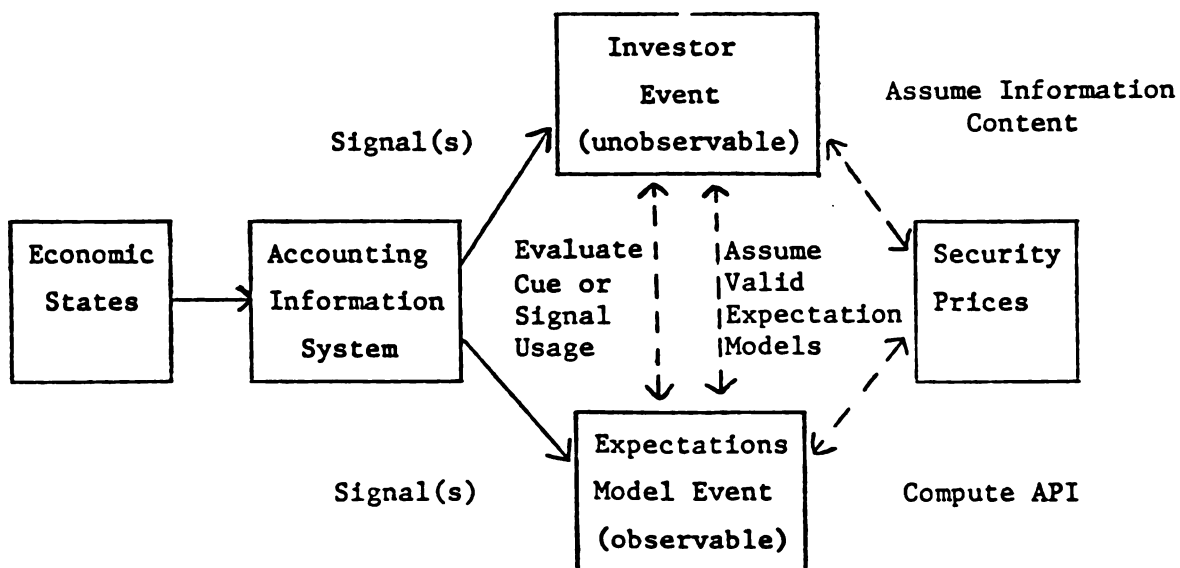


Figure 4. API Research Paradigm; Cue Usage Investigation

Organization of the Study

Based upon theoretical reasoning and previous research evidence, a causal model is formulated linking the expectation errors of the various cues and the resulting abnormal price and volume reactions of the securities market. The parameter coefficients associated with each of the cues are estimated and tested. An overall test of the hypothesized model configuration is made. Based upon these results the model is respecified and tested.

Chapter II contains a discussion of the role of accounting data in security analysis and investment decision making. Previous research concerning the relationships among the variables in the hypothesized causal model is reviewed and implications for this study are discussed.

Chapter III describes the components of the hypothesized causal model. The relationships among the variables are described and explained.

Chapter IV discusses the research methodology employed. A description of the causal modeling technique is provided and the procedures for parameter estimation, parameter testing, and model evaluation are discussed.

Chapter V contains the data analysis. The research steps employed and an explanation of each step is provided. The results of the parameter estimation and model testing are presented.

Chapter VI contains a brief summary of the study. It also includes a list of the major conclusions and implications of this project. Recommendations for future areas of study are provided.

CHAPTER II

The Role of Accounting Data in Security Pricing

Use of Accounting Data from a Portfolio Perspective

The role of accounting data in security analysis depends upon the decision context in which the accounting data are used (Beaver, 1981, p. 33). One common decision context for investor decision making is the one period, mean-variance portfolio model. By placing sufficient restrictions on the preferences and beliefs of the investor, the decision behavior of the investor is portrayed as if the investor's choice among securities or portfolios is based upon two parameters. These two parameters are the expected return of the security or portfolio and the variance of that expected return. Although somewhat restrictive, this decision context describes a variety of investor types; diversified, non-diversified, active, and passive (Beaver, 1981, p. 33).

Concerning the role of accounting in a portfolio investment context, Beaver (1981, pp. 33-35) notes three pertinent aspects of portfolio theory.

1. The consequences of concern of the investor are characterized as the expected return and the variance of the return of the portfolio. The attributes of the returns of individual securities are relevant only in so far as they contribute to the expected return or risk of the portfolio.
2. A portion of the variance of individual securities' returns can be diversified away, and therefore the variance of the portfolio return is not merely an average of the variances of the securities' returns that comprise it.
3. The security-specific information of interest to the investor will vary in a manner related to the portfolio strategy chosen.

In this context, the role of accounting information is potentially to alter the investor's beliefs regarding the expected return and variance

of return for all feasible portfolios. These two portfolio parameters are functions of the expected return on the individual securities, the variance of the return for the individual securities, and the covariance among returns of the individual securities that comprise the portfolio (Beaver, 1981, p. 34).

The return of an individual security can be decomposed into systematic and unsystematic components. Utilizing the market model (Fama, 1976), the systematic component reflects that portion of the security return that is linearly related to the return on a "market portfolio." After removing the systematic portion of the security's return the residual or unsystematic portion remains. This relationship is depicted as: (Fama, 1976, p. 100)

$$R_i = \alpha_i + \beta_i R_m + U_i$$

where: R_i is the return on security i .

R_m is the return on the market portfolio.

U_i is the unsystematic portion of the return for security i .

$\alpha_i + \beta_i R_m$ is the systematic portion of the return for security i .

α_i is the intercept of the linear relationship between the return of security i and the return of the market portfolio.

β_i is the slope of the linear relationship between R_i and R_m .

β_i , a measure of a security's systematic volatility, is dependent upon the extent to which the returns of the individual security covary with the market returns.

$$\beta_i = \frac{\sigma(R_i, R_m)}{\sigma^2(R_m)} = \frac{E(R_i R_m) - E(R_i) E(R_m)}{\sigma^2(R_m)}$$

where: $\sigma(R_i, R_m)$ is the covariance between R_i and R_m .

$\sigma^2(R_m)$ is the variance of the market return.

The variance of the return on security i is equal to the sum of the variances associated with the systematic and unsystematic components of the return.

$$\sigma^2(R_i) = \beta_i^2 \sigma^2(R_m) + \sigma^2(U_i)$$

$$\sigma^2(R_i) = \left[\frac{\sigma(R_i, R_m)}{\sigma^2(R_m)} \right]^2 \sigma^2(R_m) + \sigma^2(U_i)$$

The relevant investor beliefs regarding the two parameters in the one period, mean-variance portfolio model are:

1. the mean return on the market portfolio, $E(R_m)$
2. the variance of returns on the market portfolio, $\sigma^2(R_m)$
3. the intercept of the security's linear relationship with the market return, α_i
4. the slope of the security's linear relationship with the market return, β_i
5. the variance of the unsystematic return, $\sigma^2(U_i)$
6. the covariance among the unsystematic returns for securities i and j , $\sigma(U_i, U_j)$

Useful information to the investor provides a basis for the investor to alter or validate his or her beliefs concerning these parameters. In regards to firm specific information, only the α_i , β_i , $\sigma^2(U_i)$, and $\sigma(U_i, U_j)$ parameters are affected. For the diversified investor, only information that alters the beliefs concerning the systematic portion of the security return, α_i and β_i , is useful. The potential role of firm specific data is to alter the investor's beliefs concerning the

covariation of the security return and the return of the market index. Data that alter beliefs concerning the covariation of security and market returns, the unsystematic return, U_i , and the covariation among the unsystematic returns for securities i and j , $\sigma(U_i, U_j)$, is useful to the undiversified investor.

Ohlson (1979) provides an analytic model relating accounting information to security prices. He examines security valuation relative to the stochastic behavior of accounting numbers and develops this valuation function: (p. 334)

$$P_t = A + \sum_{i=1}^N B_i X_{it} + CD_t$$

where: P_t is the price of the security at time t .

$\underline{X}_t = (X_{1t}, X_{2t}, \dots, X_{nt}, D_t)$ is a vector of datum concerning the economic attributes of the firm at time t .

X_{it} denotes financial accounting numbers that represent the economic attributes of the firm at time t .

D_t is dividends paid at time t .

$A, B_1, B_2, \dots, B_n, C$ are the valuation parameters obtained by solving a system of simultaneous equations.

Ohlson does not stipulate the accounting numbers to be used. Instead he asserts (p. 318), "the fundamental characteristics of financial variables are their (joint) stochastic time-series behavior. . . information variables in this mode of analysis can be any type of variable that affects investors' expectations about future events." The role of financial accounting data in the one period, mean variance portfolio theory investment context is apparent. Any financial variable that has a non-orthogonal relationship with the return stream of the security can be useful to the decision maker.

The number of data items inherent in financial reporting is very large. In many cases, these items are highly interrelated and purport to measure the same economic attribute of the firm. The approach of this study, adapted from Ohlsen (1979, p. 317), "stipulates the existence of 'real' economic variables and then uses accounting data as estimates of the real variables." Lev (1974, p. 12) and Foster (1978, p. 28) suggest that four different economic dimensions of a firm are considered in evaluating a firm's performance. Van Horne (1980, pp. 710-713) and Weston and Brigham (1972, pp. 17-19) assert that the liquidity, leverage, profitability, and efficiency or activity dimensions are used to evaluate the financial condition and performance of a firm. In security analysis the investor uses these four economic dimensions of a firm to help formulate expectations of future returns. These expected returns are then utilized in the determination of a value for the security.

Let: $\hat{R}_{it}$ denote a vector of expected returns for security i at time t .

LI_{it} is the liquidity dimension of firm i at time t .

LE_{it} is the leverage dimension of firm i at time t .

PR_{it} is the profitability dimension of firm i at time t .

AC_{it} is the activity dimension of firm i at time t .

The expected returns for security i at time t are contingent on the economic dimensions at time t , given a covariation between each dimension and the return series.

Therefore: $\hat{R}_{it} = f(LI_{it}, LE_{it}, PR_{it}, AC_{it})$

By substitution into the market model, the role of accounting information (surrogates for the four underlying economic dimensions of the firm) in the two parameter, one period, mean-variance portfolio model for a single security portfolio is expressed as:

$$\hat{R}_{it} = \alpha + \frac{\sigma [\hat{R}_i | (LI_{it}, LE_{it}, PR_{it}, AC_{it}), \hat{R}_m]}{\sigma^2(\hat{R}_m)} \hat{R}_{mt} + U_t$$

Expected Variance of Return;

$$\sigma^2(R_{it}) = \left(\frac{\sigma [\hat{R}_i | (LI_{it}, LE_{it}, PR_{it}, AC_{it}), \hat{R}_m]}{\sigma^2(\hat{R}_m)} \right)^2 \sigma^2(\hat{R}_m) + \sigma^2(U_i)$$

Assuming; $\sigma R_i, LI_i \neq 0$

$\sigma R_i, LE_i \neq 0$

$\sigma R_i, PR_i \neq 0$

$\sigma R_i, AC_i \neq 0$

Previous Research Evidence

Previous research related to the use of accounting data in an investment context can be divided into six categories. The first category consists of studies investigating the empirical similarity of various accounting ratios. The second category contains studies of information content and the third category investigates the relationship between financial accounting variables and the rate of return on securities. Studies concerning the link between financial data and bankruptcy comprise the fourth category. The fifth category is the relationships between accounting variables and beta while the sixth category contains studies of the use of various accounting data in behavioral contexts.

The intent of this literature review is to provide a summary of previous research that is pertinent to this research project. Although not exhaustive, this review provides examples of research previously conducted, the results, and the implications of these findings to this project.

Empirical Similarity of Accounting Ratios

The degree to which financial accounting ratios are indicators of various underlying economic dimensions of the firm has been researched by Stevens (1973) and Johnson (1979). Stevens (1973) employed twenty financial ratios in an exploratory principal components analysis. The twenty ratios and their purported underlying financial dimensions are presented in Table 1.

Table 1 Variables of Stevens' Study (Stevens, 1973, p. 151)

<u>Purported Underlying Dimension</u>	<u>Ratio Number</u>	<u>Ratio</u>
Liquidity	11	net working capital/total assets
	17	net working capital/sales
Profitability	1	EBIT/total assets
	5	gross profit/sales
	6	EBIT/sales
	7	net income/sales
	8	EBT/sales
	9	net income/net stockholders equity
Leverage	10	net income/total assets
	4	long-term (LT) debt/market value equity
	18	LT debt/total assets
	13	LT debt/net stockholders equity
	19	LT liabilities/total assets
Activity	20	total liabilities/total assets
	16	sales/total assets
	15	cost of goods sold/inventory
"Other"	14	sales/(current assets - inventory)
	12	interest/(cash + marketable securities)
	2	cash dividends/net income
	3	price/earnings

The results of Stevens' study, factors, eigenvalues, and percentages of variance explained, are provided in Table 2.

Table 2. Stevens Study-Factor Analysis Results

<u>Factor</u>	<u>Eigenvalue</u>	<u>Percent Variance Explained</u>	<u>Cumulative Percentage of Variance Explained</u>
1	6.46	32.32	32.32
2	3.72	18.60	50.92
3	2.49	12.47	63.40
4	1.67	8.38	71.78
5	1.15	5.75	77.54
6	0.99	4.95	82.49
7	0.79	3.97	86.47
8	0.65	3.26	89.74
9	0.52	2.64	92.39
10*	0.44	2.24	94.63

*The remaining factors were omitted from this table and accounted for only 5.37 percent of total variance.

The loadings of the ratios on six factors resulting from a varimax rotation are presented in Table 3.

Table 3. Stevens Study-Factor Loadings

Ratio	Factor					
	1	2	3	4	5	6
4	.888					
13	.933					
18	.937					
19	.927					
20	.815					
1		.908				
6		.787				
8		.781				
9		.784				
10		.751				
14			.794			
16			.850			
11				.842		
2					.811	
1						.896

NOTE: Factor loadings less than .7 were omitted, and variables 5, 7, 12, 15, and 16 do not have loadings high enough to be included in the table.

These results indicate that the ratios representing leverage, profitability, and (to some extent) the activity dimension do possess high degrees of concomitant variation. As such, the validity of these ratios as measures of the associated financial dimension is warranted. However, since Stevens omits any loadings less than .7, it is very difficult to assess the degree to which the ratios loaded on multiple factors.

Johnson (1979) conducted a factor analysis on sixty-one financial ratios using eight factors. His results (p. 1038-1040), presented in Table 4, indicate that some ratios loaded on more than one factor. This implies that some of the ratios may not be good indicators for the underlying financial dimensions.

The results of these studies indicate that a measurement model comprised of ratios as indicators of the four underlying financial dimensions is warranted. However, the existence of some ratios loading on more than one factor indicates that a high degree of covariability may exist between indicators of different dimensions. Both the Stevens (1973) and the Johnson (1979) studies failed to test the adequacy of fit for their factor analytic models. Given the degree of covariability among the indicators of different dimensions, the ability to find an adequate measurement model configuration that is interpretable may be difficult.

Table 4. Johnson Study Factor Loadings

		Factor Loadings			
		1972		1974	
Ratio Number	Ratio Name	Primary Mfg.	Retail	Primary Mfg.	Retail
FACTOR 1--RETURN ON INVESTMENT					
4	Earnings/Sales	.88	.63*	.75	.81*
7	Earnings/Net Worth	.79	.94*	.95	.95*
12	Earnings/Total Assets	.93	.89*	.85	.87*
13	Cash Flow/Total Assets	.92	.85*	.84	.84*
14	Cash Flow/Net Worth	.50	.88*	.79	.93*
15	EBIT/Total Assets	.89	.85*	.77	.84*
16	EBIT/Sales	.89	.61*	.70	.77*
17	Cash Flow/Total Capital	.94	.90*	.85	.93*
18	Earnings/Total Capital	.94	.90*	.88	.94*
19	Cash Flow/Sales	.79	.59*	.87	.74*
41	EBIT/Net Worth	.79 ^a	.92*	.95	.97*
47	Cash Flow/Total Debt	.81	.73*	.84	.70*
48	Earnings/Total Debt	.87	.78*	.86	.73*
53	Operating Funds/Total Assets	.88	.82*	.45	.82*
54	Operating Funds/Net Worth	.25	.75	.63 ^a	.86
55	Operating Funds/Total Capital	.83	.81	.33	.88
FACTOR 2--FINANCIAL LEVERAGE					
2	Net Worth/Total Assets	-.80	-.85*	-.82	-.69 ^a *
5	Long Term Debt/Total Assets	.87	.85	.85	.87
11	Long-Term Debt/Net Worth	.88	.90	.91	.93
29	Long-Term Debt/Net Plant	.85	.81	.80	.81
30	Long-Term Debt/Total Capital	.89	.92	.94	.91
31	Total Debt/Net Worth	.79	.85	.83	.71 ^a
32	Total Debt/Total Assets	.81	.85*	.79	.74*
50	Total Debt and Preferred Stock/Total Assets	.79	.85*	.78	.68*

Table 4. Continued

Ratio Number	Ratio Name	Factor Loadings			
		1972		1974	
		Primary Mfg.	Retail	Primary Mfg.	Retail
FACTOR 3--CAPITAL INTENSIVENESS					
3	Sales/Net Worth	.66	.85*	.70 ^a	.78*
6	Sales/Total Assets	.78 ^a	.81*	.75	.79*
19	Cash Flow/Sales	-.44	-.72 ^a *	--	--
20	Current Liabilities/Net Plant	.81	.49*	.81	.43 ^a
22	Current Assets/Total Assets	.88	.46*	.84	.41
26	Sales/Net Plant	.94	.78*	.91	.79*
27	Sales/Total Capital	.85	.91*	.86	.83*
FACTOR 4--INVENTORY INTENSIVENESS					
1	Working Capital/Sales	.72 ^a	.44*	.69 ^a	.81*
20	Current Liabilities/Net Plant	.33	.71*	--	--
21	Working Capital/Total Assets	.40	.76	.46	.85
22	Current Assets/Total Assets	.39	.83*	.45	.84
24	Current Assets/Sales	.92	.74*	.92	.74*
25	Cost of Goods Sold/Inventory	-.91	-.92*	-.94	-.93*
28	Inventory/Sales	.87	.93*	.94	.93*
FACTOR 5--CASH POSITION					
42	Cash/Total Assets	.91	.93	.89	.81 [*]
43	Cash/Current Liabilities	.84	.88	.83	.87
44	Cash/Sales	.93	.88*	.89	.90*
46	Cash/Fund Expenditures	.91	.86*	.88	.89*
FACTOR 6--RECEIVABLES INTENSIVENESS					
23	Quick Assets/Total Assets	.52	.89*	.68 ^a	.89*
33	Receivables/Inventory	.94	.84*	.80 ^a	.82*
34	Inventory/Current Assets	-.75 ^a	-.70*	-.64	-.76*
35	Receivables/Sales	.72 ^a	.83*	.81	.83*
37	Quick Assets/Sales	.58	.86*	.78	.88*
40	Quick Assets/Current Liabilities	.40	.76*	.46	.81*
45	Quick Assets/Fund Expenditures	.55	.85*	.75	.87*
FACTOR 7--SHORT-TERM LIQUIDITY					
21	Working Capital/Total Assets	--	--	.73	-.35
36	Inventory/Working Capital	--	--	-.79	.16*
38	Current Liabilities/Net Worth	--	--	-.55 ^a	.80
39	Current Assets/Current Liabilities	.91	.64*	.90	-.61
40	Quick Assets/Current Liabilities	.77	.37*	.76	-.31*
49	Current Liabilities/Total Assets	--	--	-.64 ^a	.78*
51	Net Defensive Assets/Fund Expenditures	.55	.74*	.75	-.52 ^a *

Table 4. Continued

		Factor Loadings			
		1972		1974	
Ratio Number	Ratio Name	Primary Mfg.	Retail	Primary Mfg.	Retail
FACTOR 8--DECOMPOSITION MEASURES					
56	Asset Decomposition	.68	.74	--	--
58	Equity Decomposition	.84	.84	.86	.87
60	Noncurrent Items				
	Decomposition	.83	.78	.87	.85
61	Time Horizon Decomposition	--	--	.62	.70

^aIndicates variables having a within-sample cross-loading of between .50 and .70 on one other factor.

* t-test of untransformed data significant at $p < .05$.

Information Content of Financial Accounting Information

Many researchers have investigated the information content of corporate earnings announcements. Benston (1967), Ball and Brown (1968), Brown (1970), May (1971), Brown and Kennelly (1972), Hagerman (1973), Gonedes (1974, 1975), and others have found evidence indicative of a market reaction to the announcement of earnings. Beaver (1968) and Kiger (1972) studied both price and volume reactions associated with the announcement of earnings; both reactions were found to be significant.

The relationship between the magnitude of change in expectations regarding earnings and the magnitude of abnormal price reactions has been investigated by Beaver, Lambert, and Morse (1980) and Beaver, Clarke, and Wright (1979). The former project found a correlation of .49 between percentage changes in security prices and percentage changes in expected earnings at the individual firm level. Beaver, Clarke, and Wright found similar evidence with a .38 correlation. The remaining unexplained variation (.76 and .86) is attributed by Beaver (1981) to other firm events beyond the profitability measure. Other cues resulting from financial reporting may be linked to the market reactions.

Gonedes (1974) used discriminant analysis to find significant links between abnormal returns and measures of liquidity, leverage, profitability, and activity. The forecast errors associated with the following ratios were used in his empirical analysis (p. 52).

1. $(\text{current assets} - \text{current liabilities})/(\text{total assets})$
2. $(\text{common equity})/(\text{total assets})$
3. $(\text{operating income})/(\text{total assets})$
4. earnings per share
5. $(\text{total assets})/(\text{sales})$

6. $(\text{net income})/(\text{total assets})$
7. $(\text{net income} + \text{depreciation} + \text{amortization})/(\text{preferred stock} + \text{long term debt} + \text{current liabilities})$

Gonedes (p. 49) states, "The results of our multivariate tests assign a high probability to the statement that the numbers do jointly provide information pertinent to assessing equilibrium expected returns."

The results of these studies imply that data regarding the liquidity, leverage, profitability, and activity dimensions possess information content. Therefore, the information cues regarding these dimensions are used by the investor market. Cue usage is a necessary but not a sufficient condition for information content to be inferred. This research project investigates cue utilization for an expanded set of financial ratios in order to assess the apparent usefulness of various financial ratios and financial dimensions to investors.

Links Between Accounting Data and Security Rates of Return

Using multiple regression, Nerlove (1968) regressed rates of return on eight accounting variables for a sample of three hundred-seventy one firms. He tested three five-year periods and one fifteen-year period. His results (p. 324) are provided in Table 5.

Table 5. Results of Nerlove Study

<u>Variable</u>	<u>Period</u>			
	<u>1950-1954</u>	<u>1955-1959</u>	<u>1960-1964</u>	<u>1950-1964</u>
rate of sales growth	.196 t=3.54	.336 t=6.56	.469 t=6.33	.157 t=2.74
rate of earnings growth	.076 t=4.28	.032 t=3.26	.015 t=3.20	.0094 t=2.64
retained earnings/ total assets	2.105 t=10.20	2.075 t=10.20	1.253 t=5.06	2.022 t=12.26
dividends/total assets	.278 t=1.72	.240 t=1.18	.226 t=1.03	.225 t=1.95
reciprocal of leverage	-.046 t=2.05	-.020 t=.75	-.061 t=1.90	-.066 t=3.98
inventory turnover	-.0017 t=4.08	-.0056 t=1.25	-.0024 t=2.85	-.0003 t=.96
share turnover	.044 t=2.13	.138 t=6.38	-.021 t=.85	.0035 t=.25
gross plant/total assets	.010 t=.90	-.060 t=4.92	-.0034 t=.24	-.028 t=4.14
r^2	.425	.515	.280	.493

Martin (1971) regressed earnings to price ratios on eight accounting variables. The ratios and their significance in explaining the variation in the earnings to price ratios are:

Ratio	Significant at $\alpha \leq .05$
Stability of Sales Over Time	No
Growth in Operating Cash Flow Over Time	Yes
Payout Ratio	No
Operating Income/Sales	Yes
Net Income/Common Equity	Yes
Total Assets	No
Capital Expenditures/Sales	No
Cash Flow/(Long-Term Debt & Preferred Stock)	Yes

The results of the Nerlove study and the Martin study indicate a stochastic relationship among accounting ratios that are indicators of underlying financial dimensions and rates of return. O'Connor (1973) regressed various forms of the rate of return on averaged ratios. The ratios he employed were:

1. total liabilities/net worth
2. working capital/sales
3. sales/total assets
4. income available to common shares/common equity
5. income per share after dividends/income per common share
6. pretax net nonoperating income/sales
7. net income/net income before taxes
8. cash flow/number of common shares
9. current liabilities/inventory
10. earnings per share/price per share

He found that (1), (4), (8), (9), and (10) were significant ($\alpha = .05$) in explaining the variation in the rate of return variable. However,

O'Connor concluded (p. 350), "tests of predictive ability over time provided no evidence that the explanatory relationships were useful in predicting future rate of return rankings."

These results indicate that a relationship exists between current period accounting ratios and current period rates of return. This is consistent with the idea that information regarding these ratios or the financial dimensions they represent is important to the investor for determination of expected returns.

Prediction of Bankruptcy from Accounting Data

A recent study by Ohlsen (1980) investigates the prediction of bankruptcy from these financial ratios:

1. size
2. total liabilities/total assets
3. working capital/total assets
4. current liabilities/current assets
5. indicator variable if total liabilities exceed total assets
6. net income/total assets
7. operating income/total liabilities
8. indicator variable if net income was negative for the last two years
9. change in net income

Using ~~maximum~~ likelihood estimation of the conditioned logit model, Ohlsen identified four basic factors statistically significant in affecting the probability of a failure within one year. These dimensions were company size, leverage, profitability, and liquidity. Altman (1968), using discriminant analysis, found links between firm failure and indicators of liquidity, profitability, and leverage.

These findings indicate that financial accounting data, which are indicators of liquidity, leverage, and profitability, are potentially useful to the investor.

The Association Between Systematic Risk and Accounting Variables

Lev (1974a, p. 105) stresses that the risk of a firm is determined by the financial and operating characteristics of that firm; financial statement data should be linked to beta. Empirically, Roenfeldt and Cooley (1975) used canonical correlation analysis and found both excess returns and risk functionally related to liquidity, leverage, and size. Simkowitz and Logue (1973) demonstrated that a relationship exists between profitability, leverage, and beta. Hamada (1972, p. 451) found twenty-one to twenty-four per cent of the variation in systematic risk explained by leverage.

Bowman (1979) analytically provides a theoretical basis for relationships between systematic risk and financial accounting variables. He shows that a theoretical relationship exists between a firm's systematic risk and the firm's leverage and accounting beta. Also, Hamada (1972) demonstrates that systematic risk is not theoretically related, in a direct manner, to earnings variability, dividends, firm size, or rate of firm growth. However, any accounting variable that is related to the covariability of the firm's earnings and the market's earnings is indirectly related to the systematic risk of the firm.

The results of these studies provide evidence that accounting data is related to the systematic risk of a firm. Since the systematic risk parameter is an important part in the one period, mean-variance portfolio investment model, accounting data that is related to systematic risk is pertinent to the investor.

Behavioral Studies of the Use of Accounting Data

Abdel-Khalik and El-Sheshai (1979) found that lending officers choose profitability, liquidity, and leverage information for predicting default. Pankoff and Virgil (1970) also found profitability, leverage, and liquidity information useful to security analysts. Mayer-Sommer (1979) surveyed Certified Financial Analysts and found that ninety-nine per cent of the respondents believe that analysis of a firm's operating and financing characteristics is used in investment analysis. Financial accounting statements, both audited and quarterly, were found to be used by ninety-three per cent of the respondents. In a behavioral study, Gooding (1978) used multidimensional scaling to find that risk perceptions are multidimensional. He established that company operating and financing characteristics are used by investors to calculate expected returns.

Empirical research has found profitability data, earnings per share, to possess information content. Research has not been conducted on the usefulness of accounting cues regarding liquidity, leverage, profitability, and activity attributes of a firm. This is surprising since the pertinence of accounting data to the investor has been demonstrated through analytical and empirical research linking accounting data to security rates of return, bankruptcy, and systematic risk. This study directly investigates the use of accounting data in a market study. Causal links between expectation errors regarding the four financial dimensions of a firm and two measures of market reactions, abnormal trading and abnormal returns, are hypothesized and tested.

CHAPTER III

Hypothesized Model

Introduction

The relationships between information cues, resulting from the announcement of accounting data, and the associated security market reactions are modeled in this study. In order to operationalize this study, three components are needed. They are the cues, the market reactions, and the framework of hypothesized relationships between the cues and the market reactions. Each of these components is presented and discussed in the following sections.

Information Cues

A cue, which may vary in type and intensity, is the link between the perception of a stimulus and the response. An announcement of earnings or other financial data is a stimulus; it produces cues to the extent that expectations of firm attributes, deemed pertinent for investment decisions, change or are realized. According to Beaver (1981a, p. 36), financial datum becomes information when it alters beliefs about security specific parameters.

The expectation errors for the liquidity, leverage, activity and profitability dimensions, prompted by the announcement of accounting data, are the cues to be investigated in this study. These expectation errors are the differences between expectations of the dimensions prior to the release of the accounting data and the realizations of these dimensions given the publication of the accounting data.

Although these dimensions can be defined, they are unobservable constructs representing the financial and operating aspects of an economic entity. Mock (1976, p. 27) suggests the use of observable surrogates or

indicators as measures of unobservable constructs. The basic model of this approach is: (Mock, 1976, p. 52)

$$X_t = \xi_t + \delta_t$$

where: X_t = the observed number of score which is assigned as the magnitude of the attribute of interest on the t th assignment.

ξ_t = the unobservable true magnitude of the attribute.

δ_t = an unobservable error component.

$t = 1, 2, \dots$ t represents replications (of the measurement process or of objects measured).

It is assumed:

- (1) the relationship is stable.
- (2) the error component is a random variate which is distributed independently of the true score.
- (3) the measurement errors, δ_t , are additive to the true score.

Since it is not possible to observe the four economic dimensions of a firm, certain measurement devices or surrogates must be used. The common measurement devices or surrogates used in financial analysis are financial ratios. Following are the four unobservable financial dimensions and the measures of each used in this project:

Liquidity

Current Ratio = Current Assets/Current Liabilities

Quick Ratio = (Cash + Marketable Securities + Receivables)/
Current Liabilities

Defensive Interval = (Cash + Marketable Securities +
Receivables)/(Expenditures + 365)

Leverage

Total Debt to Equity Ratio = Total Debt/Total Equities

Long-Term Debt to Equity Ratio = Long Term Debt/Total Equities

Times Interest Earned = Income before Interest and Taxes/
Interest

Profitability

Return on Assets = Net Income/Average Total Assets

Earnings to Sales Ratio = Net Income/Net Sales

Primary Earnings Per Share

Return on Common Stock Equity = Net Income after Preferred
Dividends/Common Equity

Activity

Asset Turnover = Net Sales/Average Total Assets

Receivable Turnover = Net Sales/Average Net Receivables

Inventory Turnover = Cost of Goods Sold/Average Total
Assets

The choice of the ratios hypothesized to be indicators of the unobservable financial dimensions is based upon an analysis of textbooks in accounting and finance including Foster (1978, p. 28), Kieso and Weygandt (1977, p. 1020), Van Horne (1980), Weston and Brigham (1972), Schall and Haley (1980, pp. 390-391).

The expectation errors regarding the underlying financial or economic dimensions of a firm and the expectation errors regarding the observable measures of the four dimensions comprise the measurement model portion of the hypothesized causal model.

Let: ξ_1 = expectation error regarding the liquidity dimension

ξ_2 = expectation error regarding the leverage dimension

ξ_3 = expectation error regarding the profitability dimension

ξ_4 = expectation error regarding the activity dimension

x_1 = expectation error of the current ratio

x_2 = expectation error of the quick ratio

x_3 = expectation error of the defensive interval

x_4 = expectation error of the long term debt to equity ratio

x_5 = expectation error of the total debt to equity ratio

x_6 = expectation error of the times interest earned ratio

x_7 = expectation error of the return on total assets

x_8 = expectation error of the earnings to sales ratio

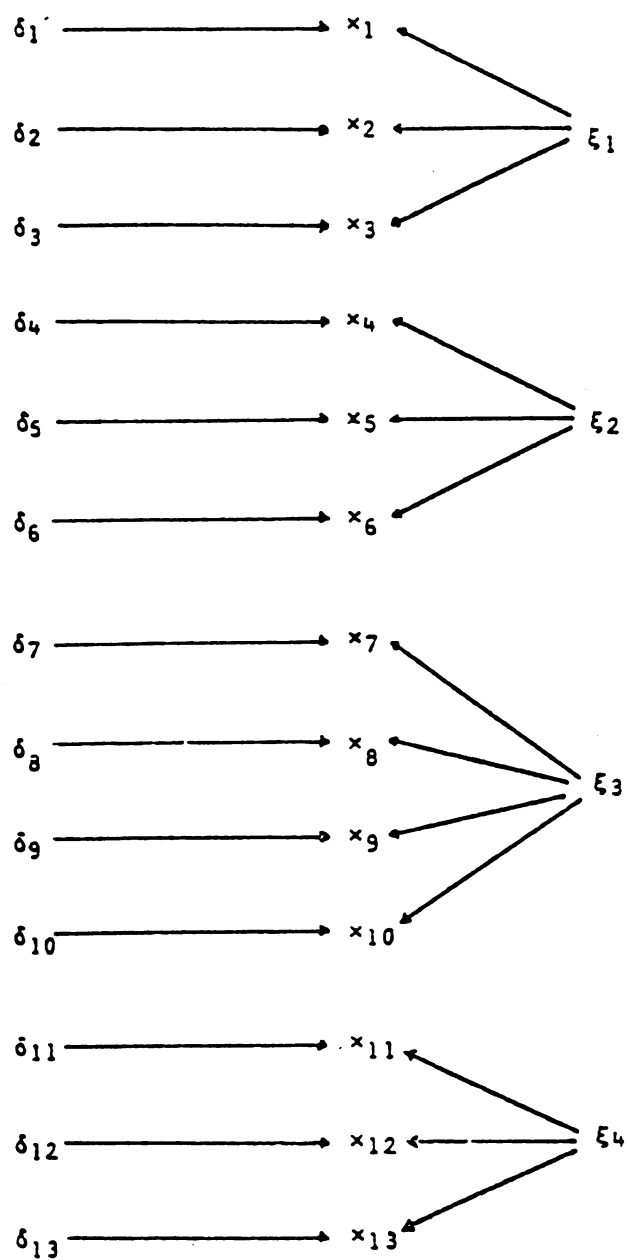
- x_9 = expectation error or primary earnings per share
 x_{10} = expectation error of the return on equity
 x_{11} = expectation error of the total asset turnover
 x_{12} = expectation error of the accounts receivable turnover
 x_{13} = expectation error of the turnover ratio
 λ = measurement coefficient between the observable measure and the underlying/unobservable financial dimension expectation error

δ_1 to δ_{13} = the associated measurement error

The hypothesized measurement model is:

$$\begin{array}{ll}
 x_1 = \lambda_{11} \xi_1 + \delta_1 & x_8 = \lambda_{32} \xi_3 + \delta_8 \\
 x_2 = \lambda_{12} \xi_1 + \delta_2 & x_9 = \lambda_{33} \xi_3 + \delta_9 \\
 x_3 = \lambda_{13} \xi_1 + \delta_3 & x_{10} = \lambda_{34} \xi_3 + \delta_{10} \\
 x_4 = \lambda_{21} \xi_2 + \delta_4 & x_{11} = \lambda_{41} \xi_4 + \delta_{11} \\
 x_5 = \lambda_{22} \xi_2 + \delta_5 & x_{12} = \lambda_{42} \xi_4 + \delta_{12} \\
 x_6 = \lambda_{23} \xi_2 + \delta_6 & x_{13} = \lambda_{43} \xi_4 + \delta_{13} \\
 x_7 = \lambda_{31} \xi_3 + \delta_7 &
 \end{array}$$

Figure 5 is a diagrammatic representation of the hypothesized measurement model. The x 's represent the observed expectation error which are surrogates for the expectation errors of the underlying financial dimensions. The δ 's represent the measurement error of the observed expectation error as an imperfect measure of the unobservable financial dimension expectation error. The observed expectation error is a composite of the underlying dimension expectation error and the measurement error.



where it is assumed that the ξ 's are not orthogonal and may covary.

Figure 5. Hypothesized Measurement Model

Market Reactions

The existence of two types of market reactions has been demonstrated by previous research. Beaver (1968) used both changes in the equilibrium value of current market prices and shifts in portfolio positions, reflected in trading volume, to research information content. Beaver (1968, pp. 68-69) remarks,

An important distinction between the price and volume tests is that the former reflects changes in the expectations of the market as a whole while the latter reflects changes in the expectations of individual investors. A piece of information may be neutral in the sense of not changing the expectations of the market as a whole but it may greatly alter the expectations of individuals. In this situation, there would be no price reaction, but there would be shifts in portfolio positions reflected in volume.

Isolation of a market reaction due to a specific event requires control of other factors or events occurring concurrent with the specific event being studied. To assess price reactions in this study, a measure based upon the market model will be used. The market model states that the returns of an individual security are a linear function of the general market factor (Dyckman, Downes, and Magree, 1975, p. 110). This relationship can be expressed as: (Fama, 1976, p. 100)

$$\hat{R}_{it} = a_i + b_i \hat{R}_{mt} + \hat{e}_{it}$$

where: $\hat{R}_{it}$ is the return on the i th security at time t

$\hat{R}_{mt}$ is the return on the market at time t

a_i and b_i are the regression coefficients

$\hat{e}_{it}$ is the abnormal return or disturbance term

It is assumed:

$$E(\tilde{e}_{it} | R_{mt}) = E(\tilde{e}_{it}) = 0 \quad \text{for all } t$$

$$\sigma^2(R_{it} | R_{mt}) = \sigma^2(\tilde{e}_{it} | R_{mt}) = \sigma^2(\tilde{e}_{it}) = \sigma^2(\tilde{e}_i) \quad \text{for all } t$$

$$\text{cov}(\tilde{e}_{it}, \tilde{R}_{mt}) = 0 \quad \text{for all } t.$$

(The disturbance terms are independent and identically distributed)

The market model separates the stochastic portion of a security's return into a systematic component, $b_k R_{mt}$, and an individualistic component, e_{it} . Since the expected value of e_{it} is zero, the summation of e_{it} for t periods should also be zero in lieu of any firm specific events. As such, one can investigate the effects of firm specific events on the security returns through an analysis of the observed individualistic component, e_{it} .

The measure of market price reactions to be used in this study is the Cumulative Abnormal Return, CAR. It is the summation, over a period of time, of the abnormal return for a security. The Cumulative Abnormal Return, CAR, is:

$$CAR = \sum_t^T e_{it} \quad \text{for time period } t \text{ to } T.$$

To assess market volume reactions, a similar measure will be used. For any security i , one desires to remove the effects of market wide events on the security's trading volume. The following regression model is used (Beaver, 1968 and Kiger, 1972):

$$\tilde{V}_{it} = c_i + d_i \tilde{V}_{mt} + \tilde{u}_{it}$$

where: $\hat{v}_{it}$ is the volume of trading for the i th security at time t
(expressed as a percent of shares outstanding)

$\hat{v}_{mt}$ is the volume of trading for the total market at time t
(expressed as a percent of shares outstanding)

c_i and d_i are the regression coefficients

$\hat{\mu}_{it}$ is the abnormal volume or disturbance term

It is assumed:

$$E(\hat{\mu}_{it} | v_{mt}) = E(\hat{\mu}_{it}) = 0 \text{ for all } t$$

$$\sigma^2(\hat{v}_{it} | v_{mt}) = \sigma^2(\hat{\mu}_{it} | v_{mt}) = \sigma^2(\hat{\mu}_{it}) = \sigma^2(\hat{\mu}_i) \text{ for all } t$$

$$\text{cov}(\hat{\mu}_{it}, \hat{v}_{mt}) = 0 \text{ for all } t.$$

(The disturbance terms are independent and identically distributed)

The measure of volume reaction, Cumulative Abnormal Volume or CAV, is the sum of the $\hat{\mu}_{it}$ over a time period t to T :

$$\text{CAV} = \sum_t^T \mu_{it} \text{ for time period } t \text{ to } T.$$

Beaver (1968) suggests that volume reactions, accompanying price reactions, imply two things: a lack of consensus about how a newly disclosed piece of public information should be interpreted, and the extent to which that information changes investor expectations (Verrecchia, 1981, p. 272). Beaver (1968, p. 68) states:

The relationships posited above are consistent with the economist's notion that volume reflects a lack of consensus regarding the price. The lack of consensus is induced by a new piece of information . . . Since investors may differ in the way they interpret the report, some time may elapse before a consensus is reached, during which time increased

volume would be observed. If consensus were reached on the first transaction, there would be a price reaction but no volume reaction, assuming homogenous risk preferences among investors. If risk preferences differ, there still could be a volume reaction, even after the equilibrium price had been reached.

Foster (1978, p. 343) notes that a trading volume reaction to corporate announcements can occur for a variety of reasons. Investors purchase or sell capital assets due to:

- (1) Coordination of their income earning and income spending activities.
- (2) Maintenance of a diversified portfolio.
- (3) a. Changes in the risk of their portfolios or
b. Changes in their own risk preferences.
- (4) Taxation reasons.
- (5) Revision of their probability assessments of the distribution of returns.

Although Beaver (1968), Kiger (1972), and Foster (1973) found an empirical association between volume reactions and earnings releases, an ambiguous link exists between information content and its inducement of trading activity. An investigation of the relationship between price and volume reactions is provided by Verrecchia (1981). He demonstrates analytically that an abnormal price reaction concurrent with no abnormal volume reaction requires total consensus among investors regarding the interpretation of a piece of information. Verrecchia (1981, pp. 280-282) proves that no trading will occur, if and only if, in addition to total consensus, either (1) investors have homogenous linear risk tolerance and homogenous prior probability beliefs, or (2) individuals have constant risk tolerance. This implies that an abnormal volume reaction occurring simultaneously with an abnormal price reaction does not necessarily denote a lack of consensus regarding the interpretation of a piece

of information. Verrecchia (1981, p. 275) states, "What volume reaction says about consensus is limited to the presumably infrequent case of no trading."

Verrecchia (1981, p. 283) concludes that although volume does not solve the consensus riddle, the simultaneous exploration of volume and price reactions "is a fertile area of research." It can be used to measure the extent to which information changes expectations. "For example, greater volume reaction might imply that the information has caused a greater shift in expectations than less volume reaction."

Hypothesized Relationships Between Financial Dimension Expectation Errors and Market Reactions

Development of a causal model configuration requires a specification of exogenous variables, endogenous variables, and a network of relationships. The exogenous variables, their associated measurement model, and the endogenous variables have been specified. Attention is now focused on the prediction model portion of the causal model. The prediction model consists of the hypothesized causal links between expectation errors of the financial dimensions and the abnormal return and abnormal volume market reactions.

In Chapter II it is demonstrated that any accounting variable may impact the distribution of expected returns for a security. Empirical evidence presented in Chapter II shows that significant relationships exist between firm financial dimensions and rates of return, systematic risk, and bankruptcy. Therefore, this study hypothesizes causal links between each of the financial dimension expectation errors and the market reactions.

A causal link between market price and volume reactions is hypothesized. Beaver (1968) states that a price reaction denotes use of

information by the market in aggregate whereas a volume reaction is indicative of individual investors changing their portfolios. The implication is that the market would not adjust prices due to individual investors making shifts in their portfolios but individual investors may make shifts in their portfolios due to changes in the price of a security.

The hypothesized prediction model is:

$$\eta_1 = \gamma_{11} \xi_1 + \gamma_{12} \xi_2 + \gamma_{13} \xi_3 + \gamma_{14} \xi_4 + \zeta_1$$

$$\eta_2 = \gamma_{21} \xi_1 + \gamma_{22} \xi_2 + \gamma_{23} \xi_3 + \gamma_{24} \xi_4 - \beta_{21} \eta_1 + \zeta_2$$

where: η_1 = market's price reaction as measured by the cumulative abnormal return (CAR)

η_2 = market's volume reaction as measured by the cumulative abnormal volume (CAV)

ξ_1 = expectation error regarding the liquidity dimension

ξ_2 = expectation error regarding the leverage dimension

ξ_3 = expectation error regarding the profitability dimension

ξ_4 = expectation error regarding the activity dimension

γ = causal path coefficient between expectation error regarding the financial position dimension and the market's reaction measure

β = causal path coefficient between the market reaction measures

ζ_1 = prediction error of price reaction

ζ_2 = prediction error of volume reaction

Figure 6 is a diagram of the hypothesized prediction model.

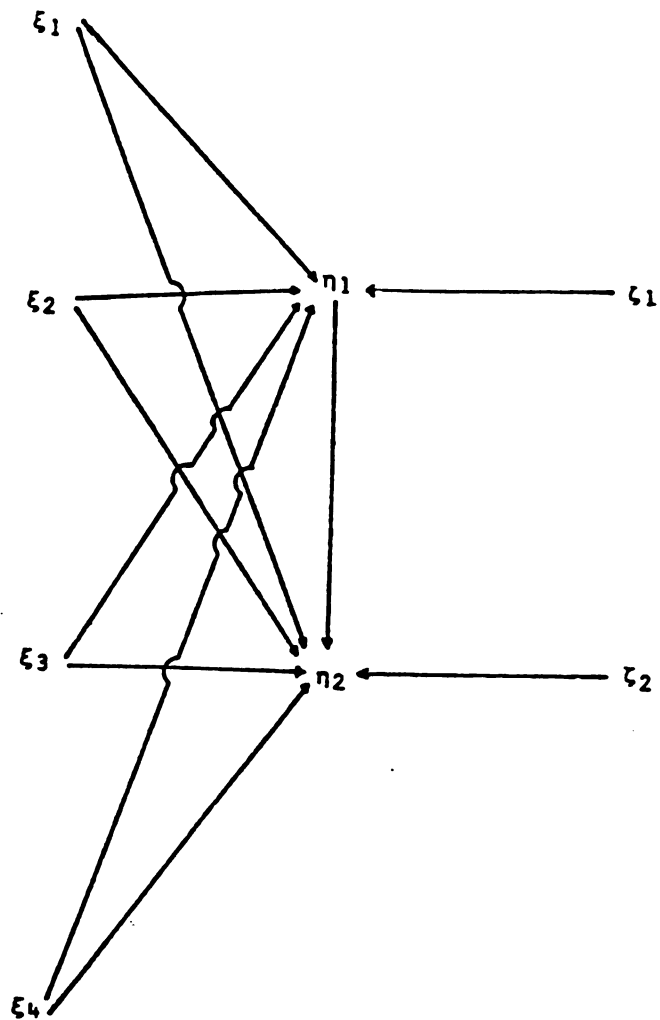


Figure 6. Hypothesized Prediction Model

By combining the hypothesized measurement model and the hypothesized prediction model, the total hypothesized causal model of this project is presented in Figure 7.

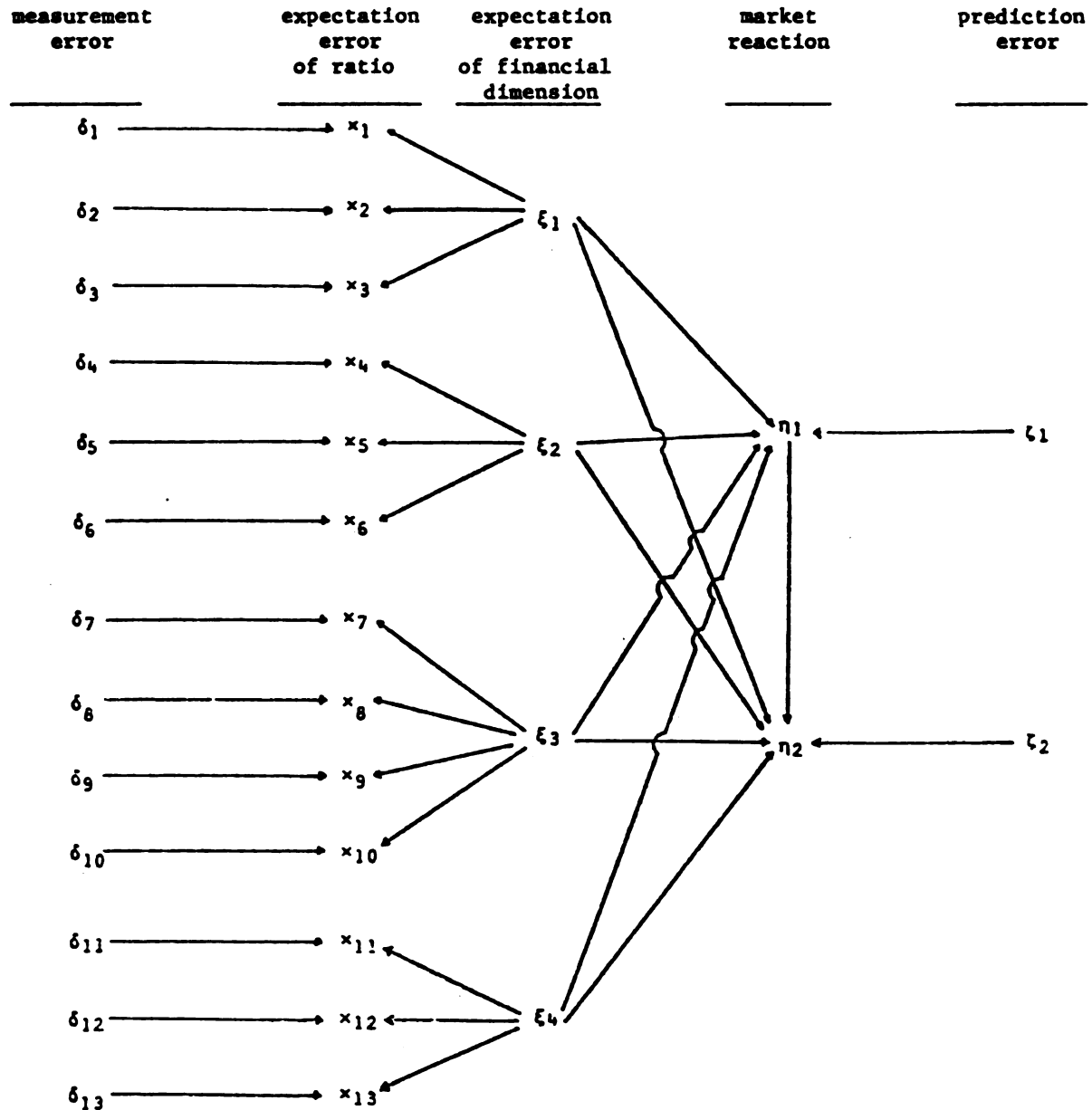


Figure 7. Hypothesized Causal Model

The thesis of the hypothesized causal model is that all four of the information cue regarding the economic dimensions of a firm are impounded by the market. The reaction of the securities market to the use of the four cues is found in the abnormal return and abnormal volume measures. This model also depicts a causal link between abnormal volume and abnormal returns. A volume reaction results from a change in the price of a security but a price reaction is not prompted by abnormal trading.

Since the four economic dimensions of a firm are unobservable, surrogates or indicators are employed in security analysis. The common surrogates used are financial ratios. The expectation error regarding the liquidity dimension is represented by the expectation errors for the current ratio, the quick ratio, and the defensive interval. The indicators of the expectation errors for the leverage dimension are the expectation errors of the long term debt to equity ratio, the total debt to equity ratio, and the times interest earned ratio. The expectation errors for the return on total assets, the earnings to sales ratio, primary earnings per share, and the rate of return on equity are the measures of the profitability dimension expectation error. The expectation error of the activity dimension is represented by the expectation errors for total asset turnover, accounts receivable turnover, and inventory turnover.

CHAPTER IV

Statistical Methodology

Causal Modeling

A model is a "representation of reality to explain some aspect of it" (Miller and Star, 1969, p. 145 and Montgomery and Urban, 1969, p. 9). Representing the underlying conceptual and theoretical structure, a causal model portrays the causal links and chains between the components of the process researched (Abdel-Khalik and Ajinkya, 1979, pp. 20-23). Causal modeling is unique in its effort to develop a structured network of causal relationships built upon theoretical underpinnings. Causality is important; it is a necessary condition for stating that the exogenous variables generate the changes in the endogenous variables in settings beyond the conditions under which the observations were made (Abdel-Khalik and Ajinkya, 1979, p. 24). This research project intends to fulfill the three conditions for establishing causality. These conditions are: (Asher, 1976, pp. 11-12).

- a. There must be concomitant variation between the variables of interest.
- b. There must be a temporal asymmetry between the variables of interest.
- c. Other possible causal factors are either eliminated or controlled.

Non-firm specific events which might affect measures of market reactions are controlled by using the market model approach to develop the CARs and the CAVs. Any firm specific events other than the exogenous variables of interest are controlled through random selection of the sample firms. The condition of temporal asymmetry is met since financial cue utilization must preclude an associated market reaction. Assessment

of concomitant variation between the variables of interest will be investigated through empirical analysis.

Parameter Estimation and Model Testing

To estimate the parameters and test the model, Lisrel: Analysis of Linear Structural Relationships by the Method of Maximum Likelihood by Joreskog and Sorbom (1978) is chosen. Appendix A contains a glossary and a description of the notation used in LISREL. Joreskog and Sorbom describe the program: (1978, p. 3)

The LISREL model is particularly designed to handle models with latent variables, measurement errors and reciprocal causation (simultaneously interdependence). In its most general form it assumes that there is a causal structure among a set of latent variables or hypothetical constructs some of which are designated as dependent variables and others as independent variables. These latent variables are not directly observed variables that are related to the latent variables. Thus the latent variables appear as underlying causes of the observed variables.

The hypothesized causal model of this project,

$$\eta_1 = \gamma_{11} \xi_1 + \gamma_{12} \xi_2 + \gamma_{13} \xi_3 + \gamma_{14} \xi_4 + \gamma_1$$

$$\eta_2 = \gamma_{21} \xi_1 + \gamma_{22} \xi_2 + \gamma_{23} \xi_3 + \gamma_{24} \xi_4 - \beta_{21} \eta_1 + \xi_1$$

$$x_1 = \lambda_{11} \xi_1 + \delta_1$$

$$x_8 = \lambda_{32} \xi_3 + \delta_8$$

$$x_2 = \lambda_{12} \xi_1 + \delta_2$$

$$x_9 = \lambda_{33} \xi_3 + \delta_9$$

$$x_3 = \lambda_{13} \xi_1 + \delta_3$$

$$x_{10} = \lambda_{34} \xi_3 + \delta_{10}$$

$$x_4 = \lambda_{21} \xi_2 + \delta_4$$

$$x_{11} = \lambda_{41} \xi_4 + \delta_{11}$$

$$x_5 = \lambda_{22} \xi_2 + \delta_5$$

$$x_{12} = \lambda_{42} \xi_4 + \delta_{12}$$

$$x_6 = \lambda_{23} \xi_2 + \delta_6$$

$$x_{13} = \lambda_{43} \xi_4 + \delta_{13}$$

$$x_7 = \lambda_{31} \xi_3 + \delta_7$$

is a specified form of the following general model. (Joreskog and Sorbom, 1978, pp. 4-7)

$$\underline{\beta} \underline{\eta} = \underline{\Gamma} \underline{\xi} + \underline{\zeta} \quad (1)$$

where: $\underline{\eta}$ (mx1) is a vector of the latent (underlying/unobservable) endogenous variables

$\underline{\xi}$ (nx1) is a vector of the latent (underlying/unobservable) exogenous variables

$\underline{\beta}$ (mxm) is the matrix of causal coefficients relating the endogenous variables to each other

$\underline{\Gamma}$ (mxn) is the matrix of causal coefficients relating the endogenous variables to the exogenous variables

$\underline{\zeta}$ (mx1) is a vector of random residuals or prediction errors

$$\underline{Y} = \underline{\Lambda}_y \underline{\eta} + \underline{\varepsilon} \quad (2)$$

$$\underline{X} = \underline{\Lambda}_x \underline{\xi} + \underline{\delta} \quad (3)$$

where: $\underline{Y}$ (px1) are observations/indicators/measures of the latent endogenous variables $\underline{\eta}$

$\underline{X}$ (qx1) are observations/indicators/measures of the latent exogenous variables $\underline{\xi}$

$\underline{\Lambda}_y$ (pxm) is a matrix of regression coefficients of $\underline{Y}$ on $\underline{\eta}$

$\underline{\Lambda}_x$ (qxn) is a matrix of regression coefficients of $\underline{X}$ on $\underline{\xi}$

$\underline{\varepsilon}$ is a vector of measurement errors for $\underline{Y}$ as measures of $\underline{\eta}$

$\underline{\delta}$ is a vector of measurement errors for $\underline{X}$ as measures of $\underline{\xi}$

By assuming that all the variables are mean-deviated:

$$E(\underline{\eta}) = 0 \quad E(\underline{\zeta}) = 0$$

$$E(\underline{\xi}) = 0 \quad E(\underline{\delta}) = 0$$

$$E(\underline{x}) = 0 \quad E(\underline{\varepsilon}) = 0$$

$$E(\underline{y}) = 0$$

The normal regression assumptions are also assumed:

$\sigma_{\underline{\zeta}\underline{\zeta}} = 0$; the prediction errors are uncorrelated with the exogenous variables

$\sigma_{\underline{\epsilon}\underline{\eta}} = 0$; the measurement errors of y as a measure of η are uncorrelated with η

$\sigma_{\underline{\delta}\underline{\xi}} = 0$; the measurement errors of x as a measure of ξ are uncorrelated with ξ

$\sigma_{\underline{\epsilon}\underline{\xi}} = 0$; the measurement errors of y as a measure of η are uncorrelated with ξ

$\sigma_{\underline{\delta}\underline{\eta}} = 0$; the measurement errors of x as a measure of ξ are uncorrelated with η

$\sigma_{\underline{\epsilon}\underline{\zeta}} = \sigma_{\underline{\delta}\underline{\zeta}} = 0$; the measurement errors are uncorrelated with the prediction errors

However, in the general LISREL model it is assumed that the measurement errors may be correlated among themselves.

Let: Φ ($n \times n$) = covariance matrix of the exogenous variables, $\underline{\xi}$

Ψ ($m \times m$) = covariance matrix of the prediction errors, $\underline{\zeta}$

$\underline{\Theta}_{\epsilon}$ = covariance matrix of the measurement errors of the endogenous variables

$\underline{\Theta}_{\delta}$ = covariance matrix of the measurement errors of the exogenous variables

The variance-covariance matrix of the x and y variables created by the specified causal model is (Joreskog and Sorbom, 1978, p. 5):

$\underline{\Sigma} ((p + q) \times (p + q)) =$

$$\begin{bmatrix} \underline{\Lambda}_y' (\underline{\beta}^{-1} \underline{\Gamma} \underline{\Phi} \underline{\Gamma}' \underline{\beta}^{-1} + \underline{\beta}^{-1} \underline{\Psi} \underline{\beta}^{-1}) \underline{\Lambda}_y' + \underline{\Theta}_{\epsilon} & \underline{\Lambda}_y' \underline{\beta}^{-1} \underline{\Gamma} \underline{\Phi} \underline{\Lambda}_x' \\ \underline{\Lambda}_x' \underline{\Phi} \underline{\Gamma}' \underline{\beta}^{-1} \underline{\Lambda}_y' & \underline{\Lambda}_x' \underline{\Phi} \underline{\Lambda}_x' + \underline{\Theta}_{\delta} \end{bmatrix} \quad (4)$$

In applications of this general model, the elements of $\underline{\Lambda}_y$, $\underline{\Lambda}_x$, $\underline{\beta}$, $\underline{\Gamma}$, $\underline{\Phi}$, $\underline{\Psi}$, $\underline{\Theta}_\epsilon$, and $\underline{\Theta}_\delta$ are specified to be either free, constrained, or fixed, depending upon the hypothesized causal structure.

The measurement model, equations (2) and (3) can be written in factor analytic form as:

$$\underline{Z} = \underline{\Lambda} \underline{f} + \underline{e}$$

where: $\underline{Z} = (\underline{y}, \underline{x})$

$$\underline{f} = (\underline{\eta}, \underline{\xi})$$

$$\underline{e} = (\underline{\epsilon}, \underline{\delta})$$

$$\underline{\Lambda} = \begin{bmatrix} \underline{\Lambda}_y & \underline{0} \\ \underline{0} & \underline{\Lambda}_x \end{bmatrix}$$

Therefore, the measurement model is a restricted factor analysis model in which the factors $\underline{\eta}$ and $\underline{\xi}$ satisfy a linear structural equation system of the form:

$$\underline{\beta} \underline{\eta} = \underline{\Gamma} \underline{\xi} + \underline{\zeta}$$

By specifying $\underline{\Phi}$, the covariance matrix of the exogenous variables, to be diagonal, an orthogonal solution is derived. If the $\underline{\Phi}$ matrix is specified as full rank, an oblique solution is obtained. For additional references on the use of factor analytic techniques in causal modeling see Jackson and Borgatta (1981, pp. 179-281), Judge, Griffiths, Hill and Lee (1980, pp. 550-554), Hanushek and Jackson (1977, pp. 302-324).

Before one can estimate the parameters of a causal model it is necessary to establish that the parameters are identified. For a given model specification, the structure denoted by $\underline{\Lambda}_y$, $\underline{\Lambda}_x$, $\underline{\beta}$, $\underline{\Gamma}$, $\underline{\Phi}$, $\underline{\Psi}$, $\underline{\Theta}_\epsilon$, and $\underline{\Theta}_\delta$ generates one and only one variance-covariance matrix, $\underline{\Sigma}$, but there may be numerous structures generating the same $\underline{\Sigma}$ (Joreskog and

Sorbom, 1978, pp. 9-11). Two or more structures that generate the same Σ are equivalent. A parameter that has the same value for all equivalent structures is identified. The whole model becomes identified when all of the individual parameters are identified.

Let $\underline{K}$ be a vector of all the independent, free, and constrained parameters specified by a certain model and let t be the order of $\underline{K}$. The problem of identification is whether or not $\underline{K}$ is determinable by Σ . To assess this, consider the equations in (4) of the form:

$$\sigma_{ij} = f_{ij}(\underline{K}), i \leq j$$

There are $(1/2)(p + q)(p + q + 1)$ equations and t unknown elements in $\underline{K}$. A necessary condition for identification of all parameters is that:

$$t \leq (1/2)(p + q)(p + q + 1)$$

The number of estimated parameters must be less than or equal to the number of elements in the lower left triangle of the observed variance covariance matrix for the $\underline{x}$ and $\underline{y}$ variables.

The specified model matrices for the hypothesized causal model of this study and the number of elements to be estimated are as follows:

<u>Matrix</u>	<u>Number of Elements to be Estimated</u>
Λ_{-y}	0
Λ_{-x}	13
$\underline{\beta}$	1
$\underline{\Gamma}$	8
$\underline{\Phi}$	10
$\underline{\Psi}$	3
$\Theta_{-\epsilon}$	0
$\Theta_{-\delta}$	13

Constraining $\underline{\Theta}_\delta$ such that only the main diagonal elements are estimated and the remaining elements of the lower left triangle are fixed at 0, fulfills the necessary condition for identification. The model is over-identified since $48 \leq 1/2 [(p + q) \times (p + q + 1)] = 120$.

This constraint or restriction implies that the measurement errors, δ_1 through δ_{13} , do not covary. No covariance among the measurement error terms presumes that the underlying construct is the only systematic source of variation in the observed indicators. This restriction is commonly employed in traditional factor analytic techniques.

For estimation and testing of the model it is assumed that the distribution of the observed variables can be described by the first two moments, a mean vector and the variance-covariance matrix. The estimation process comprises fitting the $\underline{\Sigma}$, the covariance matrix constructed by the hypothesized model specifications, to the observed covariance matrix $\underline{S}$.

$$\underline{\Sigma} (p + q) \times (p + q) = \begin{bmatrix} \underline{S}_{yy} (p \times p) & \underline{S}_{yx} (p \times q) \\ \underline{S}_{xy} (q \times p) & \underline{S}_{xx} (q \times p) \end{bmatrix}$$

The fitting function:

$$F = \log |\underline{\Sigma}| + \text{tr} (\underline{S} \underline{\Sigma}^{-1}) - \log |\underline{S}| - (p + q)$$

is minimized with respect to $\underline{K}$; $\underline{K}$ is the set of free, constrained, or equivalent parameters designated by the hypothesized causal model. In minimizing the fitting function, one is minimizing the difference between the generalized variance of the created covariance matrix and the generalized variance of the observed covariance matrix. If one assumes that the recreated variance-covariance matrix, $\underline{\Sigma}$, equals the observed

variance-covariance matrix, $\underline{S}$, the determinant of $\underline{\Sigma}$, the generalized variance of $\underline{\Sigma}$, equals the determinant of $\underline{S}$. Hence, $\log |\underline{\Sigma}|$ equals $\log |\underline{S}|$. Since $\underline{S} = \underline{\Sigma}$, $(\underline{S} \underline{\Sigma}^{-1})$ is equivalent to an identity matrix of order $(p + q)$. Therefore, the trace of $(\underline{S} \underline{\Sigma}^{-1})$ equals $(p + q)$. The result is $F = 0$ when the recreated covariance matrix $\underline{\Sigma}$ equals the observed covariance matrix $\underline{S}$. The hypothesized model structure represents the process which produced the observed covariance matrix.

Maximum likelihood estimates, efficient for large samples, result if the distribution of (y, x) is multinormal (Joreskog and Sorbom, 1978, p. 3 and Hanushek and Jackson, 1977, pp. 314-316). The procedure to select the estimates that minimize the F function involves taking the derivatives of the F function, with respect to each parameter estimated, and solving this set of simultaneous equations for the values that equate the derivations to zero (Hanushek and Jackson, 1977, p. 315). For a more complete discussion of the estimation procedure see Joreskog in Goldberger and Duncan (1973, pp. 85-112).

Once the maximum likelihood estimates of the parameter have been obtained, the hypothesized model is tested for goodness to fit. The total model is tested to determine its ability to create a covariance matrix, $\underline{\Sigma}$, that replicates the observed covariance matrix, $\underline{S}$. Let H_0 be the null hypothesis representing the total model as specified. The alternative H_1 is that $\underline{\Sigma}$ is any positive definite matrix. The test statistic, NF_0 , is minus twice the logarithm of the likelihood ratio where F_0 is the minimum value of F and N is the sample size. NF_0 is asymptotically distributed as χ^2 with degrees of freedom d ; $d = 1/2 [(p + q)(p + q + 1) - t]$ where t is the total number of independent parameters estimated under H_0 (Joreskog and Sorbom, 1978, p. 14). Appendix

B contains a discussion of the χ^2 difference test for testing alternative model structures.

The hypothesized measurement model will be tested for goodness of fit against the null measurement model. The null measurement model fixes the λ 's equal to zero. It is important to test the hypothesized measurement model. Bentler and Bonnett (1980, p. 604) state, "There may be little point to evaluating a given regression structure if the measurement model is totally inadequate."

This research project estimates the parameters and tests the model as specified. As warranted, the model is respecified and retested using both the χ^2 goodness of fit test and the incremental fit index of Bentler and Bonett (1980, pp. 599-600). This incremental fit index denotes the increase in model fit as measured by the change in the generalized variance explained by the hypothesized model. The results of the parameter estimation and model evaluation of the hypothesized causal model are presented in the following chapter. Respecification of the causal model and the appropriate estimation and retesting are also discussed.

CHAPTER V

Data Analysis

Sample Determination: Time Frame and Firms

The firms studied are calendar year firms listed on the New York Stock Exchange. The accounting data releases studied are for the year ended December 31, 1979. These releases are the announcement of earnings, the annual report issuance, and the submission of the 10-K report. An initial sample of three hundred firms was randomly chosen from firms that made the earnings announcement during February, 1980 and made public the annual report and the 10-K report prior to March 31, 1980. To be included in the data analysis, a sample firm met the following conditions:

1. A firm must have complete requisite data on the Compustat yearly data base for 1978 and 1979.
2. A firm must have complete requisite data on the CRSP monthly return data base for the period January 1, 1975 through March, 1980.
3. A firm must have complete requisite data on the Rapidquote data base for the period January, 1975 through March, 1980.
4. A firm must have filed third quarter, 1978 and 1979 10-Q reports with the Securities and Exchange Commission and the reports must be accessible at the Securities and Exchange Commission Reading Room in Chicago, Illinois.

Of the initial three hundred firms, two hundred and nine met these requirements. The Compustat data base contains quarterly and annual financial accounting data. Return data used to develop market price reactions was found on the New York Stock Exchange return data base developed by the Center for Research in Security Prices at the University of Chicago. Data regarding the number of shares traded was obtained from the Rapidquote data base. Rapidquote is Rapidata's securities data base which

contains current and historical trading, financial, and descriptive information on approximately twelve thousand securities. Appendix C contains a list of the two hundred and nine firms used for this study.

Expectations

The observable cues to be investigated are the expectation errors regarding the financial ratios that measure the underlying financial dimensions. An expectation error is the difference between the expectation of a ratio prior to the release of the accounting data and the realization of that ratio due to the release of the accounting data.

For the expectations of the year end ratios for the 1979 year, the market realizes the data contained in quarterly earnings announcements and quarterly 10-Q reports for the first three quarters. The 10-Q reports must be filed within forty-five days of the end of the quarter. Therefore, the 10-Q report for the third quarter 1979 is made public by the middle of November. The expectations of the annual accounting data items for 1979 are assumed to be a composite of the third quarter data and an estimate of what will happen during the fourth quarter.

For the estimate of the results for the fourth quarter the naive model is used:

$$E(Q_{t=0}) = Q_{t-4}$$

where: Q_t is the accounting data item in the fourth quarter of 1979 and Q_{t-4} is the accounting data item in the fourth quarter of 1978.

Q_{t-4} is determined as the difference between the 1978 annual report and the third quarter report of 1978 for the data item.

The expectation of an annual accounting datum is expressed as:

$$E(Y_{79}) = Q_{t-3} + Q_{t-2} + Q_{t-1} + E(Q_{t=0})$$

$$E(Y_{79}) = Q_{t-3} + Q_{t-2} + Q_{t-1} + Q_{t-4}$$

where: Q_{t-3} is the accounting data item in the first quarter 1979.

Q_{t-2} is the accounting data item in the second quarter 1979.

Q_{t-1} is the accounting data item in the third quarter 1979.

Use of the naive model is supported by previous research. Brown and Kennelly (1972) used this model to develop expectations of earnings. Beaver (1974) used a similar naive model which included a drift term in his study of the information content of the magnitude of unexpected earnings. Foster (1977) presents evidence that this naive model is a good representation of the underlying market process. He found, using this model, a significant association between the sign of the earnings change and the sign of the cumulative average residual.

Market Reactions

Other components of the research framework are the measures of market reaction. The measures used are the monthly cumulative abnormal return, for price reactions, and the monthly cumulative abnormal volume, for volume reactions. The cumulative abnormal return, CAR, is expressed as:

$$CAR = \sum_t^T e_{it}$$

where: $e_{it} = R_{it} - (a + b R_{mt})$

$t = \text{December 1979 through March 1980}$

The cumulative abnormal volume is determined similarly:

$$CAV = \sum_t^T \mu_{it}$$

where: $\mu_{it} = V_{it} - (c + d V_{mt})$

$t = \text{December 1979 through March 1980}$

Three steps are required to obtain each of these measures:

1. Develop the estimation equations:

$\hat{R}_{it} = a + b R_{mt}$ by regressing individual firm monthly returns on the monthly returns of the market for the period January, 1975 through November, 1979.

$\hat{V}_{it} = c + d V_{mt}$ by regressing the monthly percentage of shares traded for an individual firm on the monthly percentage of shares traded for the market for the period January, 1975 through November, 1979.

2. Apply the return and volume estimation equations to estimate the expected returns and volumes for December, 1979 through March, 1980.
3. Sum the residuals from both the returns and the volume estimates to obtain the cumulative abnormal return, CAR, and the cumulative abnormal volume, CAV.

Data Summary

The previous research steps are required to obtain the data to be used for parameter estimation and model testing. An analysis of the data indicated that nine firms needed to be eliminated due to structural changes in the firms. These structural changes involved events such as an increase in debt or mergers with other firms during the test period. The expectation errors associated with these firms were many standard deviations away from the mean and biased both the mean and variance-covariance estimates. Table 6 provides a summary of the data after the outliers were eliminated. Table 7 is the lower left triangle of the correlation matrix for the variables used in this analysis.

Table 6. Summary of Data

=====					
<u>Variable</u>	<u>Description</u>	<u>Mean</u>	<u>Standard Deviation</u>	<u>Minimum</u>	<u>Maximum</u>
Y_1	CAR	.013999	.16773	-.63275	.65240
Y_2	CAV	-.024809	.12613	-.55459	.61413
X_1	expectation error re- garding the current ratio	.011108	.29308	-1.0674	1.0583
X_2	expectation error re- garding the quick ratio	.001999	.20836	-.93942	.88883
X_3	expectation error re- garding the defensive interval	-2.1386	17.734	-52.496	96.588
X_4	expectation error re- garding the debt equity ratio	-.002666	.038727	-.16999	.13996
X_5	expectation error re- garding the long term debt to equity ratio	.001612	.033998	-.11079	.16910
X_6	expectation error re- garding times interest earned	-1.1661	7.0938	-57.936	38.379
X_7	expectation error re- garding rate of return on assets	.004051	.017241	-.072613	.097162
X_8	expectation error re- garding the earnings to sales ratio	.000210	.010824	-.048682	.042475
X_9	expectation error re- garding the primary earnings per share	-.002815	.94573	-3.0700	3.32000
X_{10}	expectation error re- garding the rate of return on common equity	.011448	.07522	-.66535	.32500
X_{11}	expectation error re- garding the asset turnover ratio	.049945	.14935	-.74842	.69866
X_{12}	expectation error re- garding the accounts receivable turnover ratio	.34298	1.6558	-8.1015	7.3380
X_{13}	expectation error re- garding the inventory turnover ratio	.18559	1.0347	-4.5998	3.8010

Table 7. Lower Left Triangle of the Correlation Matrix of the Variables of Analysis

	Market Reactions		Liquidity			Leverage			Profitability				Activity		
	y_1	y_2	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}	x_{11}	x_{12}	x_{13}
y_1	1.000														
y_2	.402	1.000													
x_1	-.129	-.110	1.000												
x_2	-.058	-.051	.844	1.000											
x_3	.137	.104	.045	.253	1.000										
x_4	.110	.084	-.323	-.181	.222	1.000									
x_5	-.071	-.050	.314	.315	.008	.465	1.000								
x_6	.027	.127	.101	.060	.089	-.077	-.007	1.000							
x_7	.130	.061	-.040	-.083	-.075	-.242	-.102	.207	1.000						
x_8	.133	.110	-.147	-.201	.081	-.117	-.125	.069	.795	1.000					
x_9	.223	.260	-.034	-.012	-.009	-.099	-.224	.133	.581	.497	1.000				
x_{10}	-.004	-.001	-.057	-.069	-.042	-.114	-.035	.055	.581	.446	.295	1.000			
x_{11}	-.077	-.069	.090	-.001	-.661	-.084	.049	.006	.171	-.085	.094	.090	1.000		
x_{12}	-.031	-.091	.052	-.098	-.216	-.109	.042	-.008	.284	.100	.144	.109	.323	1.000	
x_{13}	-.044	.002	.087	.206	-.181	-.065	.046	-.079	.086	-.156	.046	-.040	.478	.170	1.000

Confirmatory Analysis of Hypothesized Model

The hypothesized model (Figure 8) depicts a measurement model where there are four underlying financial dimensions. The expectation errors regarding these four dimensions are measured by the expectation errors regarding the common ratios for that dimension. This model hypothesizes that the expectation errors regarding the financial dimensions are causally linked to the market reactions. The specifications for this model are the following:

The prediction model:

$$\begin{aligned}\eta_1 &= \gamma_{11} \xi_1 + \gamma_{12} \xi_2 + \gamma_{13} \xi_3 + \gamma_{14} \xi_4 + \zeta_1 \\ \eta_2 &= \gamma_{21} \xi_1 + \gamma_{22} \xi_2 + \gamma_{23} \xi_3 + \gamma_{24} \xi_4 - \beta_{21} \eta_1 + \zeta_2\end{aligned}$$

and the measurement model:

$$\begin{aligned}x_1 &= \lambda_{11} \xi_1 + \delta_1 & x_8 &= \lambda_{32} \xi_3 + \delta_8 \\ x_2 &= \lambda_{12} \xi_1 + \delta_2 & x_9 &= \lambda_{33} \xi_3 + \delta_9 \\ x_3 &= \lambda_{13} \xi_1 + \delta_3 & x_{10} &= \lambda_{34} \xi_3 + \delta_{10} \\ x_4 &= \lambda_{21} \xi_2 + \delta_4 & x_{11} &= \lambda_{41} \xi_4 + \delta_{11} \\ x_5 &= \lambda_{22} \xi_2 + \delta_5 & x_{12} &= \lambda_{42} \xi_4 + \delta_{12} \\ x_6 &= \lambda_{23} \xi_2 + \delta_6 & x_{13} &= \lambda_{43} \xi_4 + \delta_{13} \\ x_7 &= \lambda_{31} \xi_3 + \delta_7\end{aligned}$$

Appendix D contains the parameter specifications of this model. The Full Information Maximum Likelihood (FIML) estimates, their standard errors, and the corresponding T-values for the parameters of the hypothesized model are presented in Table 8.

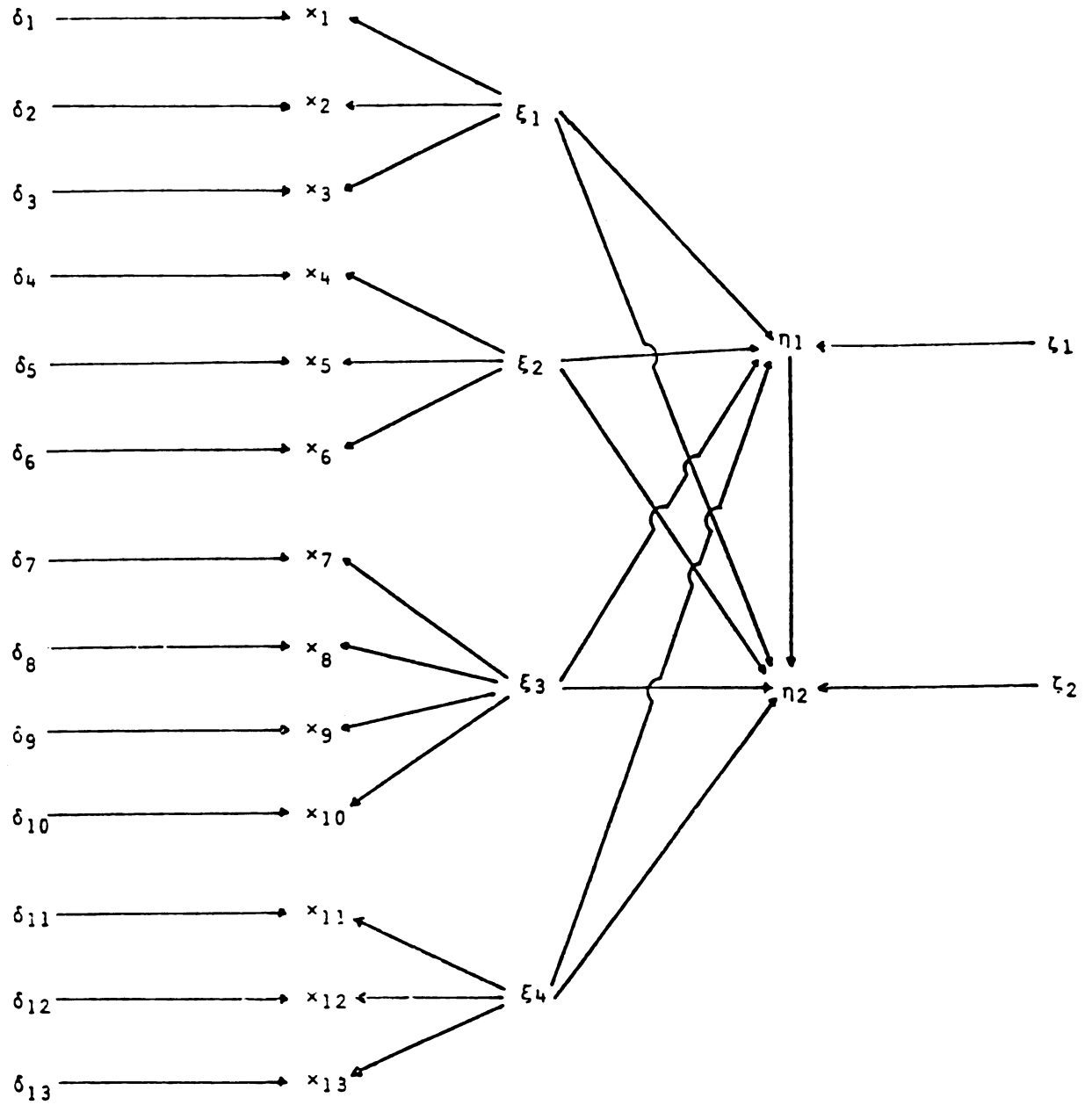


Figure 8. Hypothesized Causal Model

Table 8. Estimates of Parameters for Hypothesized Model

<u>Parameter Number</u>	<u>Estimate</u>	<u>Standard Error</u>	<u>T-Value</u>
1 (λ_{11})	1.007	.059	17.146
2 (λ_{12})	.838	.063	13.349
3 (λ_{13})	.038	.070	.545
4 (λ_{24})	.072	.597	.121
5 (λ_{25})	9.362	76.653	.122
6 (λ_{26})	-.003	.026	-.117
7 (λ_{37})	1.051	.054	19.493
8 (λ_{38})	.755	.062	12.106
9 (λ_{39})	.540	.065	8.268
10 ($\lambda_3 \ 10$)	.550	.065	8.431
11 ($\lambda_4 \ 11$)	.806	.099	8.129
12 ($\lambda_4 \ 12$)	.413	.083	4.981
13 ($\lambda_4 \ 13$)	.569	.087	6.519
14 (β_{21})	-.392	.066	-5.917
15 (γ_{11})	-.114	.071	-1.611
16 (γ_{12})	-.008	.071	-.120
17 (γ_{13})	.143	.070	2.034
18 (γ_{14})	-.122	.088	-1.385
19 (γ_{21})	-.056	.066	-.850
20 (γ_{22})	-.001	.012	-.108
21 (γ_{23})	-.006	.065	-.096
22 (γ_{24})	-.034	.082	-.415
23 ($\sigma_{\xi_1 \xi_2}$)	.057	.470	.121

Table 8. (cont'd)

<u>Parameter Number</u>	<u>Estimate</u>	<u>Standard Error</u>	<u>T-Value</u>
24 $(\sigma_{\xi_1 \xi_3})$	-.007	.066	-.112
25 $(\sigma_{\xi_2 \xi_3})$	.010	.087	.121
26 $(\sigma_{\xi_1 \xi_4})$	.122	.082	1.483
27 $(\sigma_{\xi_2 \xi_4})$	.016	.131	.121
28 $(\sigma_{\xi_3 \xi_4})$	.289	.075	3.851
29 $(\sigma^2 \zeta_1)$	.958	.096	9.938
30 $(\sigma^2 \zeta_1)$	.834	.084	9.970
31 $(\sigma^2 \delta_1)$	-.015	.063	-.236
32 $(\sigma^2 \delta_2)$	.298	.053	5.647
33 $(\sigma^2 \delta_3)$	.999	.100	9.975
34 $(\sigma^2 \delta_4)$	.997	.132	7.573
35 $(\sigma^2 \delta_5)$	-86.366	1435.368	-.060
36 $(\sigma^2 \delta_6)$	1.000	.100	9.975
37 $(\sigma^2 \delta_7)$	-.104	.055	-1.897
38 $(\sigma^2 \delta_8)$	.430	.050	8.546
39 $(\sigma^2 \delta_9)$	.708	.071	10.005
40 $(\sigma^2 \delta_{10})$	.697	.070	9.985
41 $(\sigma^2 \delta_{11})$	.351	.134	2.621
42 $(\sigma^2 \delta_{12})$	.830	.092	9.017
43 $(\sigma^2 \delta_{13})$	.677	.095	7.135

The overall test of model fit, $\chi^2 = 443.3769$ with 77 degrees of freedom, implies a poor fit. However, Bentler and Bonett (1980) point out that the overall chi-square goodness of fit test for comparing a hypothesized model against a general alternative model is insufficient when sample size or degrees of freedom are large. They propose the use of a general null model to provide a reference point for the evaluation of covariance structure models. A null model is a severely restricted model that specifies independence among the variables. For the hypothesized causal structure, the null measurement model specifies no common factors by setting all factor loadings equal to zero.

$$\underline{\Lambda}_{\rightarrow x} = 0$$

The null prediction model specifies no link between the market reaction measures and does not link any of the expectation errors regarding the financial dimensions to the market reactions.

$$\underline{B} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$$

$$\underline{\Gamma} = 0$$

The χ^2 for the null model is 1312.9024 with 105 degrees of freedom. Let C_1 represent the hypothesized causal model and C_0 the null model. The test of model equivalence, a test of the equality of parameters for the two configurations, can be made.

Let H_0 represent the null hypothesis of model equivalence.

$$H_0: C_0 = C_1$$

This can be tested since the difference between the observed χ^2 values for the models is asymptotically distributed as a chi-square, with degrees of freedom equal to the difference in the number of parameters

estimated for the two models.

χ^2 for C_0 is 1312.9024 with 105 degrees of freedom

χ^2 for C_1 is 443.3769 with 77 degrees of freedom

The χ^2 variate for the test of model equivalence is:

$$1312.9024 - 443.3769 = 869.5255$$

$$\text{degrees of freedom: } 105 - 77 = 28$$

The hypothesis of model equivalence is rejected at the $\alpha = .001$ level. This implies that the hypothesized model, C_1 , better represents the true causal configuration than the null model, C_0 .

An index of the amount of information gained in the comparison of the hypothesized model with the null provides additional information about the usefulness of competing models (Bentler and Bonett, 1980, p. 599).

The non-normed fit index,

$$\rho_{C_0C_1} = \left[\frac{\chi^2_{C_0}}{DF_{C_0}} - \frac{\chi^2_{C_1}}{DF_{C_1}} \right] \div \left[\frac{\chi^2_{C_0}}{DF_{C_0}} - 1 \right]$$

represents the increment in fit obtained by using the hypothesized model structure rather than the null model structure.

$$\rho_{C_0C_1} = \left[\frac{1312.9024}{105} - \frac{443.3769}{77} \right] \div \left[\frac{1312.9024}{105} - 1 \right]$$

$$\rho_{C_0C_1} = \frac{12.5038 - 5.7581}{11.5038} = .59$$

The normed fit index is given by:

$$\Delta_{C_0 C_1} = \left[\frac{\chi^2_{C_0}}{N} - \frac{\chi^2_{C_0}}{N} \right] \div \left[\frac{\chi^2_{C_0}}{N} \right]$$

since $\chi^2 = -2$ logarithm of the likelihood ratio - NF

where N = sample size and F is the maximum fit

$$\Delta_{C_0 C_1} = \left[\frac{1312.9024}{200} - \frac{443.3769}{200} \right] \div \left[\frac{1312.9024}{200} \right]$$

$$\Delta_{C_0 C_1} = \frac{6.5645 - 2.2167}{6.5645} = .66$$

The hypothesized model is a significant improvement over the null measurement model. This causal configuration recreates 66 per cent of the generalized variance of the observed variance-covariance matrix. This implies that 34 per cent of the generalized variance is not explained by the hypothesized model.

The parameter estimates and t-values provided in Table 8 indicate that some aspects of the measurement model are inadequate. The expectation error regarding the defensive interval is not a good indicator of the expectation error regarding the liquidity dimension. The expectation error regarding the leverage dimension was not found to be adequately measured by any of the hypothesized indicators. The remainder of the measurement model is quite adequate. The only significant coefficients of the production model are β_{21} and γ_{13} . Abnormal returns are driven by the expectation errors regarding profitability and the abnormal volume is driven by the abnormal returns.

The inadequacy of the hypothesized model may be found in the measurement model, the prediction model, or both. Bentler and Bonett (1980, p. 604) state, "There may be little point to evaluating a given regression structure if the measurement model is totally inadequate." In order to assess the causal model deficiencies which resulted in such a poor fit, an analysis of the measurement model is undertaken.

The hypothesized measurement model is:

$$\begin{array}{ll}
 x_1 = \lambda_{11} \xi_1 + \delta_1 & x_8 = \lambda_{32} \xi_3 + \delta_8 \\
 x_2 = \lambda_{12} \xi_1 + \delta_2 & x_9 = \lambda_{33} \xi_3 + \delta_9 \\
 x_3 = \lambda_{13} \xi_1 + \delta_3 & x_{10} = \lambda_{34} \xi_3 + \delta_{10} \\
 x_4 = \lambda_{21} \xi_2 + \delta_4 & x_{11} = \lambda_{41} \xi_4 + \delta_{11} \\
 x_5 = \lambda_{22} \xi_2 + \delta_5 & x_{12} = \lambda_{42} \xi_4 + \delta_{12} \\
 x_6 = \lambda_{23} \xi_2 + \delta_6 & x_{13} = \lambda_{43} \xi_4 + \delta_{13} \\
 x_7 = \lambda_{31} \xi_3 + \delta_7 &
 \end{array}$$

Figure 9. is a diagram of the hypothesized measurement model. The parameter specifications for each of the matrices of this model are presented in Appendix E.

Estimation of these parameters produced the parameter estimates, standard errors, and t-values in Table 9. The overall test of goodness of fit, $\chi^2 = 419.2233$ with 59 degrees of freedom, indicates the hypothesized measurement model is a poor representation of the structure underlying the observed relationships among the observed exogenous variables, the x 's.

Let M_1 represent the hypothesized measurement configuration and M_0 the null measurement model. The test of model equivalence, a test of

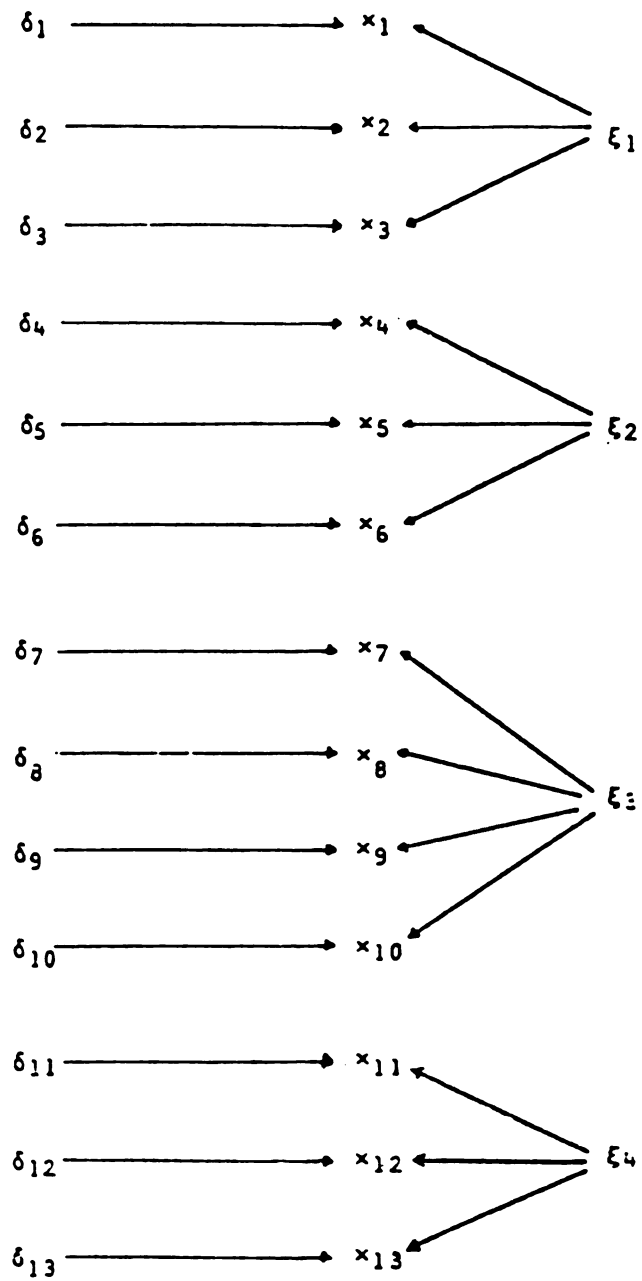


Figure 9. Hypothesized Measurement Model

Table 9. Estimates of Parameters for the Hypothesized Measurement Model

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<u>Parameter Number</u>	<u>Estimate</u>	<u>Standard Error</u>	<u>T-Value</u>
1 (λ_{11})	1.015	.059	17.083
2 (λ_{12})	.864	.063	13.799
3 (λ_{13})	.102	.070	1.453
4 (λ_{24})	.154	.253	.605
5 (λ_{25})	4.463	7.092	.629
6 (λ_{26})	-.013	.026	-.505
7 (λ_{37})	1.079	.054	19.959
8 (λ_{38})	.731	.063	11.693
9 (λ_{39})	.515	.065	7.914
10 (λ_{310})	.527	.065	8.062
11 (λ_{411})	.807	.102	7.897
12 (λ_{412})	.397	.083	4.785
13 (λ_{413})	.579	.089	6.493
14 ($\sigma_{\xi_1\xi_2}$)	.133	.222	.599
15 ($\sigma_{\xi_1\xi_3}$)	.039	.064	.599
16 ($\sigma_{\xi_2\xi_3}$)	.034	.059	.583
17 ($\sigma_{\xi_1\xi_4}$)	.154	.084	1.842
18 ($\sigma_{\xi_2\xi_4}$)	.038	.066	.577
19 ($\sigma_{\xi_3\xi_4}$)	.275	.073	3.752
20 ($\sigma^2_{\delta_1}$)	.017	.059	.292
21 ($\sigma^2_{\delta_2}$)	.284	.052	5.501
22 ($\sigma^2_{\delta_3}$)	.953	.096	9.973
23 ($\sigma^2_{\delta_4}$)	.937	.120	7.822
24 ($\sigma^2_{\delta_5}$)	-18.517	63.364	-.292
25 ($\sigma^2_{\delta_6}$)	1.043	.105	9.976

Table 9. (cont'd.)

<u>Parameter Number</u>	<u>Estimate</u>	<u>Standard Error</u>	<u>T-Value</u>
26 $(\sigma^2\delta_7)$	-.159	.063	-2.527
27 $(\sigma^2\delta_8)$	.451	.052	8.693
28 $(\sigma^2\delta_9)$	.738	.073	10.107
29 $(\sigma^2\delta_{10})$	.732	.073	10.090
30 $(\sigma^2\delta_{11})$	.365	.140	2.616
31 $(\sigma^2\delta_{12})$	.835	.092	9.085
32 $(\sigma^2\delta_{13})$	.668	.098	6.842

the equality of parameters for the two models, can be made. The χ^2 for the null measurement model is 1234.3698 with 78 degrees of freedom.

Let H_0 represent the null hypothesis of model equivalence.

$$H_0: M_0 = M_1$$

The χ^2 variate for the test of model equivalence is:

$$1234.3698 - 419.2233 - 815.1465$$

$$\text{degrees of freedom: } 78 - 59 = 19$$

The hypothesis of model equivalence is rejected at the $\alpha = .001$ level. This implies that the hypothesized model better represents the causal configuration than the null measurement model.

The non-normed fit index,

$$\rho_{M_0 M_1} = \left[\frac{\chi^2_{M_0}}{DF_{M_0}} - \frac{\chi^2_{M_1}}{DF_{M_1}} \right] \div \left[\frac{\chi^2_{M_0}}{DF_{M_0}} - 1 \right]$$

represents the increment in fit obtained by using the hypothesized measurement model structure rather than the null measurement model structure.

$$\rho_{M_0 M_1} = \left[\frac{1234.3698}{78} - \frac{419.2233}{59} \right] \div \left[\frac{1234.3698}{78} - 1 \right]$$

$$\rho_{M_0 M_1} = \frac{15.8252 - 7.1054}{14.8252} = .53817$$

The normed fit index is given by:

$$\Delta_{M_0 M_1} = \left[\frac{\chi^2_{M_0}}{N} - \frac{\chi^2_{M_1}}{N} \right] \div \frac{\chi^2_{M_0}}{N}$$

since $\chi^2 = -2$ logarithm of the likelihood ratio = NF

where N = sample size and F is the maximum fit

$$\Delta_{M_0 M_1} = \left[\frac{1234.3698}{200} - \frac{419.2233}{200} \right] \div \left[\frac{1234.3698}{200} \right] = .66037$$

The hypothesized measurement model is a substantial improvement over the null measurement model. However, the remaining improvement, $1 - \rho_{M_0 M_1} = .41183$ and $1 - \Delta_{M_0 M_1} = .33963$, indicate a more adequate model may be obtained. This implies that the hypothesized measurement model is inadequate from both a statistical and a practical point of view.

Exploratory Analysis of Measurement Models

Given the inadequacy of the hypothesized measurement model an exploratory analysis was undertaken to identify a valid measurement model. To accomplish this the squared correlation matrix was computed and the x variables were aggregated according to concomitant variation. Variables with a high degree of covariation are presumed to be indicators of a common underlying dimension. The squared correlation matrix and the seven identified factors are presented in Table 10.

This new measurement model, M_2 , has seven underlying dimensions. The expectation error for the liquidity dimension is represented by the expectation errors for the current ratio and the quick ratio. The expectation errors regarding the defensive interval, the long term debt to equity ratio, the total debt to equity ratio, and the times interest earned ratio are indicators of themselves. The expectation errors for the ratios measuring profitability and activity remain the same as the hypothesized measurement model. The dimensions are allowed to covary but no indicator is allowed to measure more than one dimension. Figure 10 is a diagram of the measurement model M_2 . The parameter specifications

for the exploratory measurement model M_2 are provided in Appendix F.

Table 11. presents the estimates, standard errors, and t-values for the parameters estimated for M_2 .

Table 10. Squared Correlation Matrix for x Variables

x Variable	7	8	9	10	4	5	2	1	6	3	11	13	12
7	100	93	88	86	-41	-30	-18	-10	35	-18	26	9	49
8	93	100	83	81	-26	-35	-31	-26	26	3	-3	-19	28
9	88	83	100	70	-34	-38	-14	-10	31	-9	18	7	37
10	86	81	70	100	-29	-22	-19	-13	23	-13	18	-2	34
4	-41	-26	-34	-29	100	55	-22	-36	-20	30	-26	-19	-27
5	-30	-35	-38	-22	55	100	50	45	-6	11	6	13	-3
2	-18	-31	-14	-19	22	50	100	96	12	27	0	29	-12
1	-10	-26	-10	-13	-36	45	96	100	17	9	13	27	4
6	35	26	31	23	-20	-6	12	17	100	13	-1	-11	4
3	-18	3	-9	-13	30	11	27	9	13	100	-87	-46	-51
11	26	-3	18	18	-26	6	0	13	-1	-87	100	74	60
13	9	-19	7	-2	-19	13	29	27	-11	-46	74	100	40
12	49	28	37	34	-27	-3	-12	4	4	-51	60	40	100

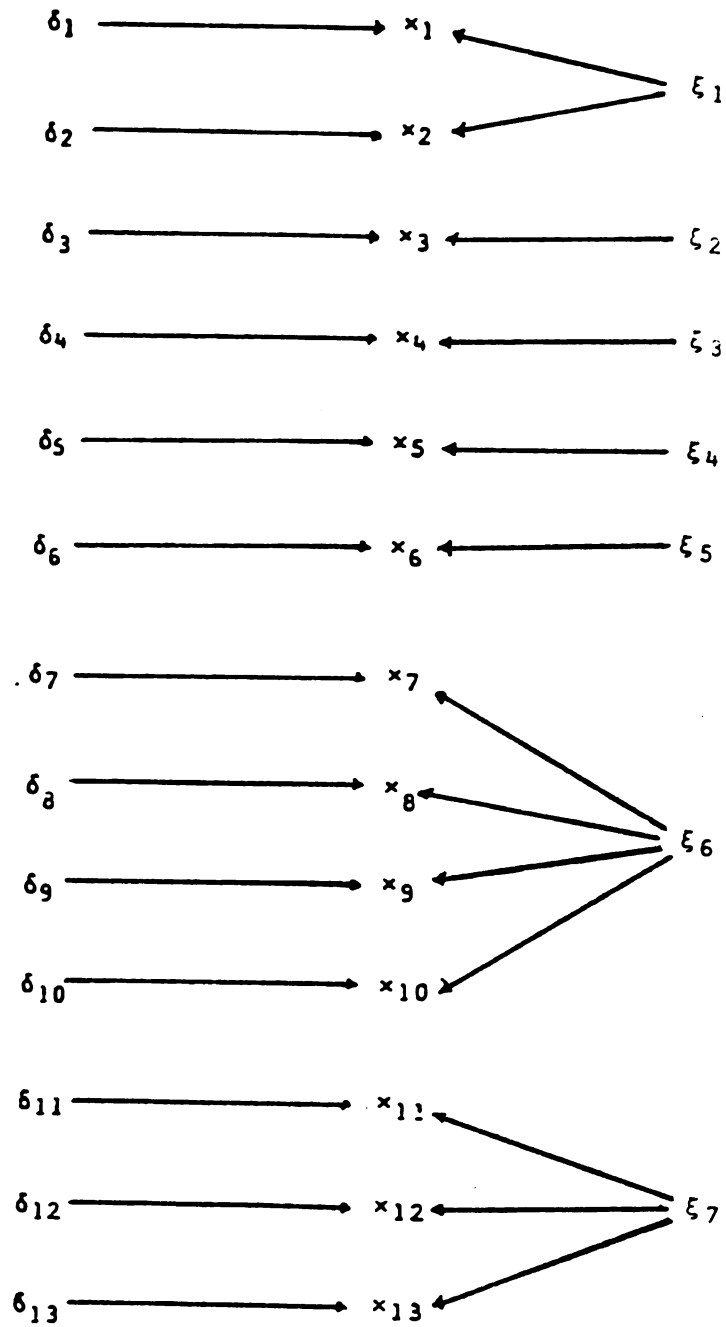


Figure 10. Exploratory Measurement Model M_2

Table 11. Parameter Estimates for Exploratory Measurement Model M_2

<u>Parameter Number</u>	<u>Estimate</u>	<u>Standard Error</u>	<u>T-Value</u>
1 (λ_{11})	.951	.056	16.835
2 (λ_{12})	.888	.059	15.165
3 (λ_{67})	1.047	.053	19.715
4 (λ_{68})	.757	.062	12.241
5 (λ_{69})	.547	.065	8.406
6 ($\lambda_{6\ 10}$)	.552	.065	8.490
7 ($\lambda_{7\ 11}$)	1.115	.083	13.478
8 ($\lambda_{7\ 12}$)	.268	.066	4.054
9 ($\lambda_{7\ 13}$)	.437	.071	6.131
10 ($\sigma_{\xi_1\xi_2}$)	.114	.073	1.562
11 ($\sigma_{\xi_1\xi_3}$)	-.301	.072	-4.197
12 ($\sigma_{\xi_2\xi_3}$)	.222	.073	3.057
13 ($\sigma_{\xi_1\xi_4}$)	.337	.071	4.725
14 ($\sigma_{\xi_2\xi_4}$)	.008	.071	.113
15 ($\sigma_{\xi_3\xi_4}$)	.465	.078	5.948
16 ($\sigma_{\xi_1\xi_5}$)	.095	.073	1.299
17 ($\sigma_{\xi_2\xi_5}$)	.089	.071	1.250
18 ($\sigma_{\xi_3\xi_5}$)	-.077	.071	-1.083
19 ($\sigma_{\xi_4\xi_5}$)	-.007	.071	-.099
20 ($\sigma_{\xi_1\xi_6}$)	-.025	.069	-.365
21 ($\sigma_{\xi_2\xi_6}$)	-.100	.067	-1.494
22 ($\sigma_{\xi_3\xi_6}$)	-.246	.067	-3.691
23 ($\sigma_{\xi_4\xi_6}$)	-.075	.067	-1.118
24 ($\sigma_{\xi_5\xi_6}$)	.216	.067	3.237

Table 11. (cont'd.)

<u>Parameter Number</u>	<u>Estimate</u>	<u>Standard Error</u>	<u>T-Value</u>
25 ($\sigma_{\xi_1 \xi_7}$)	.049	.065	.754
26 ($\sigma_{\xi_2 \xi_7}$)	-.598	.073	-8.173
27 ($\sigma_{\xi_3 \xi_7}$)	-.066	.063	-1.050
28 ($\sigma_{\xi_4 \xi_7}$)	.039	.063	.620
29 ($\sigma_{\xi_5 \xi_7}$)	.015	.063	.240
30 ($\sigma_{\xi_6 \xi_7}$)	.161	.059	2.729
31 ($\sigma^2 \delta_1$)	.096	.041	2.346
32 ($\sigma^2 \delta_2$)	.212	.041	5.221
33 ($\sigma^2 \delta_3$)	0	.100	0
34 ($\sigma^2 \delta_4$)	0	.100	0
35 ($\sigma^2 \delta_5$)	0	.100	0
36 ($\sigma^2 \delta_6$)	0	.100	0
37 ($\sigma^2 \delta_7$)	-.096	.050	-1.918
38 ($\sigma^2 \delta_8$)	.427	.049	8.736
39 ($\sigma^2 \delta_9$)	.701	.070	10.029
40 ($\sigma^2 \delta_{10}$)	.696	.069	10.021
41 ($\sigma^2 \delta_{11}$)	-.243	.159	-1.533
42 ($\sigma^2 \delta_{12}$)	.928	.092	10.055
43 ($\sigma^2 \delta_{13}$)	.809	.084	9.674

The test for goodness of fit, $\chi^2 = 204.1125$ with 48 degrees of freedom, implies that M_2 does not completely fit the data.

Let: M_0 be the null measurement model

M_1 is the priori hypothesized measurement model

M_2 is the seven factor exploratory measurement model

The test of model equivalence, $M_1 = M_2$, is:

$$\chi^2 = 419.2233 - 204.1125 = 215.1108$$

$$DF = 59 - 48 = 11$$

The null hypothesis of model equivalence is rejected at $\alpha = .001$ level.

The incremental fit indices of M_2 to M_0 are:

$$\rho_{M_0 M_2} = \frac{15.8252 - 4.2523}{14.8252} = .7806$$

$$\Delta_{M_0 M_2} = \left[\frac{1234.3698}{200} - \frac{204.1125}{200} \right] \div 6.1718 = .8346$$

The incremental fit indices of M_2 to M_1 are:

$$\rho_{M_1 M_2} = \frac{7.1054 - 4.2523}{14.8252} = .1924$$

$$\Delta_{M_1 M_2} = \left[\frac{419.2233}{200} - \frac{204.1125}{200} \right] \div 6.1718 = .1742$$

These results indicate that the seven factor exploratory model is a better model than the hypothesized measurement model. However, a more adequate representation seems feasible.

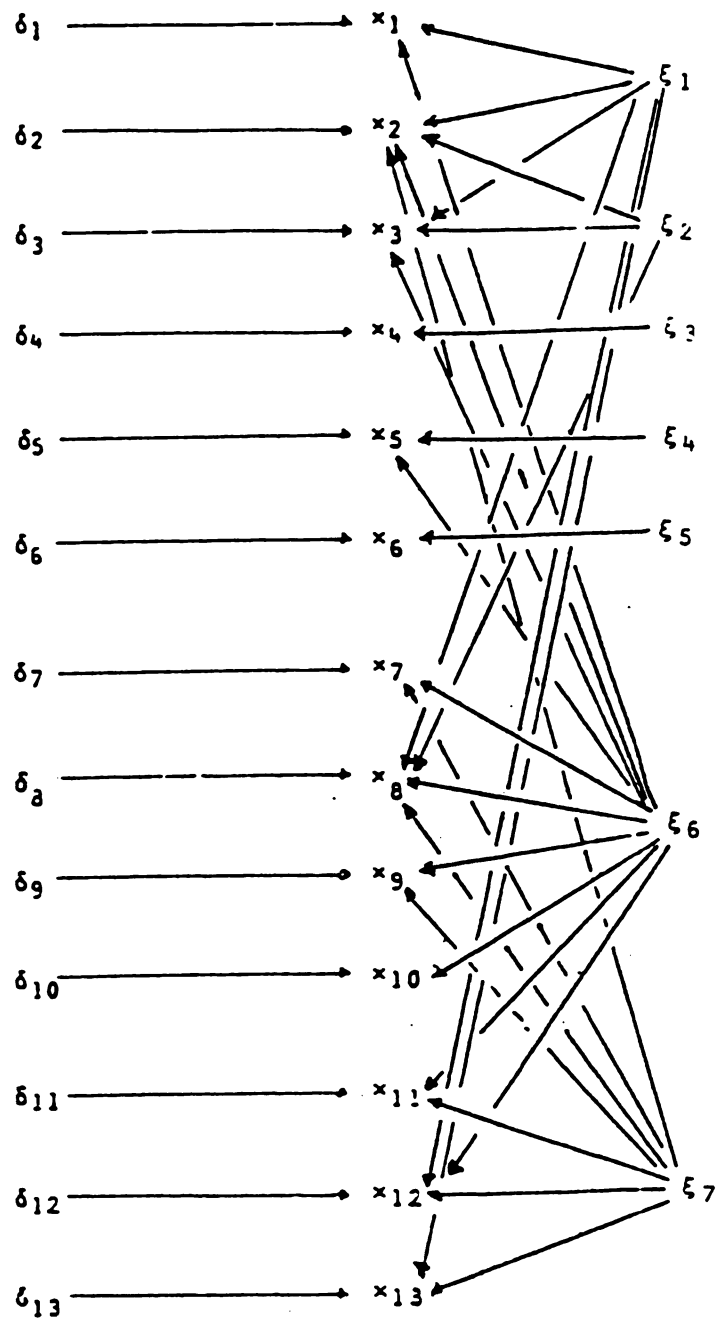
An analysis of the observed correlation matrix and iterative model building produced the following measurement model. Attempts to specify

additional factors resulted in either insignificant factor loadings or under-identification of the model. This exploratory measurement model consists of seven factors or dimensions in which indicators load on more than one dimension. This exploratory measurement model, M_3 , is:

$$\begin{aligned}
 x_1 &= \lambda_{11} \xi_1 + \lambda_{71} \xi_7 + \delta_1 \\
 x_2 &= \lambda_{12} \xi_1 + \lambda_{22} \xi_2 + \lambda_{62} \xi_6 + \lambda_{72} \xi_7 + \delta_2 \\
 x_3 &= \lambda_{13} \xi_1 + \lambda_{23} \xi_2 + \lambda_{63} \xi_6 + \delta_3 \\
 x_4 &= \lambda_{34} \xi_3 + \delta_4 \\
 x_5 &= \lambda_{45} \xi_4 + \lambda_{65} \xi_6 + \delta_5 \\
 x_6 &= \lambda_{56} \xi_5 + \delta_6 \\
 x_7 &= \lambda_{67} \xi_6 + \lambda_{77} \xi_7 + \delta_7 \\
 x_8 &= \lambda_{18} \xi_1 + \lambda_{28} \xi_2 + \lambda_{68} \xi_6 + \lambda_{78} \xi_7 + \delta_8 \\
 x_9 &= \lambda_{69} \xi_6 + \lambda_{79} \xi_7 + \delta_9 \\
 x_{10} &= \lambda_{610} \xi_6 + \delta_{10} \\
 x_{11} &= \lambda_{611} \xi_6 + \lambda_{711} \xi_7 + \delta_{11} \\
 x_{12} &= \lambda_{112} \xi_1 + \lambda_{612} \xi_6 + \lambda_{712} \xi_7 + \delta_{12} \\
 x_{13} &= \lambda_{113} \xi_1 + \lambda_{713} \xi_7 + \delta_{13}
 \end{aligned}$$

where: $\lambda_{12} = \lambda_{23} = \lambda_{34} = \lambda_{45} = \lambda_{56} = \lambda_{67} = \lambda_{711} = 1.0$

Figure 11. is a diagram representation of the exploratory measurement model M_3 .



where: $\sigma_{\xi_1 \xi_2} = \sigma_{\xi_2 \xi_5} = \sigma_{\xi_1 \xi_7} = \sigma_{\xi_3 \xi_7} = \sigma_{\xi_4 \xi_7} = 0$

(Some of the factors are allowed to covary and some are constrained to be orthogonal.)

Figure 11. Exploratory Measurement Model M_3

The χ^2 test of goodness of fit is 91.3119 with 40 degrees of freedom.

Let M_3 be the seven factor, multiple loadings exploratory measurement model. The test of equivalence between the seven factor model M_2 and the seven factor multiple loadings model M_3 is:

$$H_0: M_2 = M_3$$

$$\chi^2 = 204.1125 - 91.3119 = 112.8006$$

$$DF = 48 - 40 = 8$$

H_0 is rejected at the $\alpha = .001$ level.

The incremental fit indices are:

$$\rho_{M_0 M_3} = \left[\left[\frac{1234.3698}{78} \right] - \left[\frac{91.3119}{40} \right] \right] \div \left[\frac{1234.3698}{78} \right] - 1 = .91$$

$$\Delta_{M_0 M_3} = \left[\left[\frac{1234.3698}{200} \right] - \left[\frac{91.3119}{200} \right] \right] \div \left[\frac{1234.3698}{200} \right] = .93$$

$$\rho_{M_1 M_3} = \left[\frac{7.1054 - 2.2827}{14.8252} \right] = .33$$

$$\rho_{M_2 M_3} = \left[\frac{4.2523 - 2.2827}{14.8252} \right] = .13$$

$$\Delta_{M_1 M_3} = \left[\frac{2.0961 - .4566}{6.1717} \right] = .27$$

$$\Delta_{M_2 M_3} = \left[\frac{1.0205 - .4566}{6.1718} \right] = .09$$

These indices indicate that M_3 is a better representation than either M_1 or M_2 . However, the inability to interpret this model makes it much less desirable than M_2 .

Exploratory Analysis of Prediction Models

In order to evaluate the prediction or structural model, an exploratory analysis based on the measurement models previously discussed is conducted. The measurement models, M_2 and M_3 of the previous section are taken as given and the structural parameters are estimated and the prediction model evaluated.

Exploratory Analysis of Prediction Models Based on the Measurement Model M_2

The measurement model M_2 is a seven factor nonmultiple loading model where the factors are allowed to covary. Given this measurement model the prediction model is investigated. The first model investigated links all seven of the dimensions to each of the market reactions and does not link the market reactions directly. This exploratory prediction model, P_1 , is depicted in Figure 12. It causally links the expectation errors for the seven dimensions of M_2 to the market reaction measures. It is presumed that all causal factors have been included and the prediction errors are not allowed to covary. The parameter specification for the prediction model are provided in Appendix G. The estimates, standard errors, and t-values for the structural parameters are provided in Table 12.

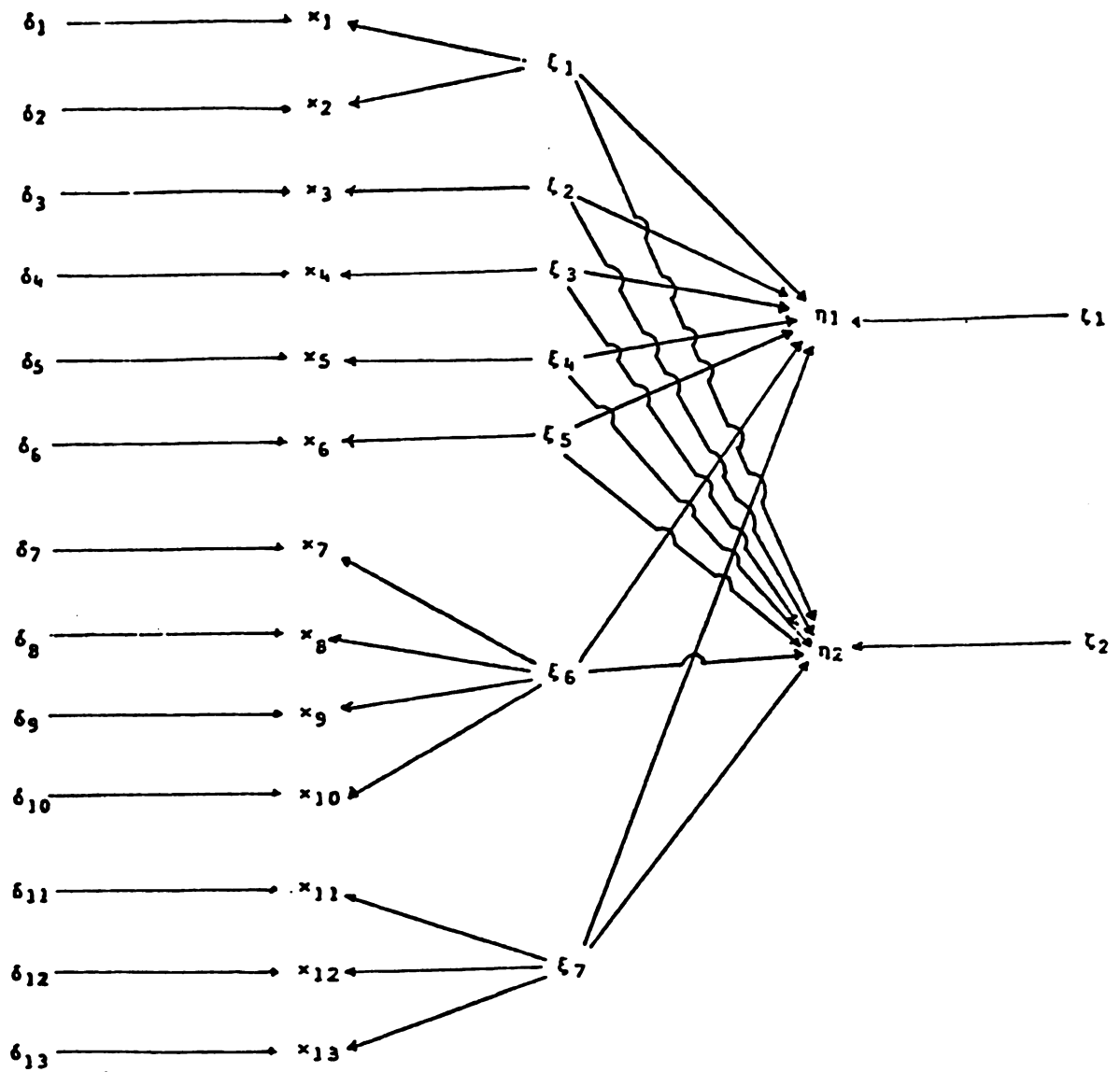


Figure 12. Exploratory Prediction Model P_1

Table 12. Parameter Estimates for Prediction Model P_1

<u>Parameter Number</u>	<u>Estimate</u>	<u>Standard Error</u>	<u>T-Value</u>
10 (γ_{11})	-.024	.111	-.218
11 (γ_{12})	.116	.097	1.186
12 (γ_{13})	.184	.128	1.431
13 (γ_{14})	-.139	.117	-1.189
14 (γ_{15})	-.002	.071	-.022
15 (γ_{16})	.157	.072	2.176
16 (γ_{17})	-.002	.074	-.026
17 (γ_{21})	-.066	.108	-.610
18 (γ_{22})	.077	.095	.813
19 (γ_{23})	.099	.120	.827
20 (γ_{24})	-.073	.111	-.660
21 (γ_{25})	.128	.073	1.757
22 (γ_{26})	.025	.072	.345
23 (γ_{27})	-.007	.074	-.099
45 ($\sigma^2\epsilon_1$)	.933	.094	9.977
46 ($\sigma^2\epsilon_2$)	.956	.096	9.967

The χ^2 goodness of fit is 253.4780 with sixty-one degrees of freedom. Respecification of the exploratory prediction model P_1 to include a causal link between the volume and price reactions is undertaken. This exploratory prediction model, P_2 , is depicted in Figure 13. The parameter specifications are provided in Appendix H. Table 13 provides the parameter estimates, standard errors, and t-values for the exploratory prediction model P_2 .

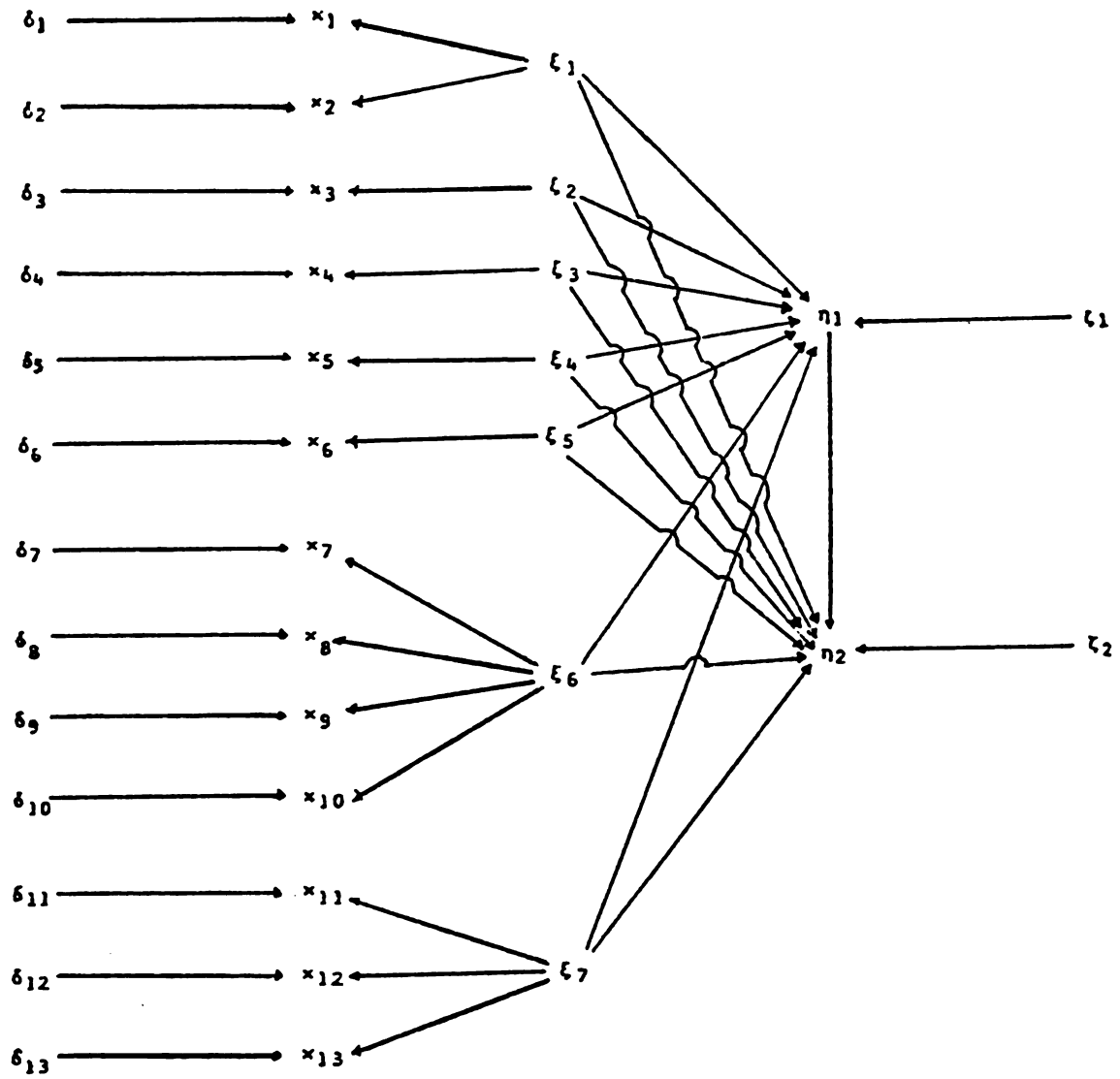


Figure 13. Exploratory Prediction Model P_2

Table 13. Parameter Estimates for Prediction Model P_2

<u>Parameter Number</u>	<u>Estimate</u>	<u>Standard Error</u>	<u>T-Value</u>
10 (β_{21})	-.387	.066	-5.842
11 (γ_{11})	-.028	.107	-.265
12 (γ_{12})	.116	.095	1.230
13 (γ_{13})	.175	.120	1.455
14 (γ_{14})	-.132	.110	-1.198
15 (γ_{15})	-.001	.071	-.019
16 (γ_{16})	.154	.071	2.175
17 (γ_{17})	-.003	.074	-.037
18 (γ_{21})	-.058	.095	-.610
19 (γ_{22})	.033	.085	.391
20 (γ_{23})	.025	.102	.248
21 (γ_{24})	-.016	.096	-.172
22 (γ_{25})	.128	.068	1.897
23 (γ_{26})	-.034	.065	-.514
24 (γ_{27})	-.007	.067	-.100
46 ($\sigma^2 \zeta_1$)	.935	.094	9.992
47 ($\sigma^2 \zeta_2$)	.817	.082	9.972

The χ^2 value associated with this model is 222.0590 with 60 degrees of freedom.

The test of equivalence between these two prediction models based on M_2 is:

$$H_0: P_1 = P_2$$

$$\chi^2 = 253.4780 - 222.0590 = 31.419$$

$$DF = 61 - 60 = 1$$

The hypothesis of model equivalence, H_0 , is rejected at the $\alpha = .001$ level. The incremental fit indices due to the structural parameter relating CAR to CAV are:

$$\rho_{P_1 P_2} = \left[\left[\frac{253.4780}{61} \right] - \left[\frac{222.0590}{60} \right] \right] + \left[\frac{276.3264}{75} - i \right] = .1692$$

$$\Delta_{P_1 P_2} = \left[\left[\frac{253.4780}{200} \right] - \left[\frac{222.0590}{200} \right] \right] + \left[\frac{276.3264}{200} \right] = .1137$$

Given this incremental fit and the t-value of -5.842 for β_{21} it is apparent that this causal link is quite important.

In order to explore the respecification of the prediction model an analysis of the degree of multicollinearity is necessary. The correlations among the estimates for the parameters of the P_2 prediction model are provided in Table 14. Collinearity is present and it is expected since the measurement model employed is oblique. A comparison of the highly correlated estimates with the correlations among the variables upholds the observed collinearity. The effect of the multicollinearity is to make interpretation of the individual coefficients difficult. Causal paths of correlated variables will be deleted by only allowing one path to exist for a pair of correlated variables. Exploratory analysis of other prediction models will incorporate this specification.

Table 14. Lower Left Triangle of Parameter Estimates Correlation Matrix for Prediction Model P₂

	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
θ_{21}	γ_{11}	γ_{12}	γ_{13}	γ_{14}	γ_{15}	γ_{16}	γ_{17}	γ_{21}	γ_{22}	γ_{23}	γ_{24}	γ_{25}	γ_{26}	γ_{27}	
1.00															
γ_{11}	1.00														
γ_{12}	-.004	1.00													
γ_{13}	.003	-.423	1.00												
γ_{14}	-.000	.691	-.464	1.00											
γ_{15}	.001	-.680	.360	-.736	1.00										
γ_{16}	-.001	-.056	-.103	.015	.008	1.00									
γ_{17}	.004	.226	-.098	.307	-.187	-.195	1.00								
γ_{21}	.004	-.260	.579	-.251	.183	-.045	-.151	1.00							
γ_{22}	-.026	.016	-.015	.020	-.018	.001	.006	-.010	1.00						
γ_{23}	.095	-.016	.026	-.019	.016	-.002	-.006	.019	-.383	1.00					
γ_{24}	.106	.023	-.021	.032	-.027	.001	.010	-.014	.646	-.407	1.00				
γ_{25}	-.087	-.019	.017	-.027	.025	-.001	-.008	.011	-.637	.301	-.696	1.00			
γ_{26}	.003	.001	-.002	.001	-.001	.000	.002	-.002	-.062	-.104	.015	.010	1.00		
γ_{27}	.134	.005	-.005	.008	-.007	.001	-.002	-.003	.189	-.053	.283	-.157	-.200	1.00	
γ_{28}	.004	-.010	.017	-.013	.010	-.002	-.003	.013	-.225	.551	-.205	.139	-.044	-.129	1.00

Through iterative building of a prediction model using the M_2 measurement model an optimal prediction model was found. The optimal configuration provided the lowest χ^2 value given the degrees of freedom. In this prediction model the price reaction is driven by the expectation errors regarding the profitability dimension, the total debt to equity ratio, and the long term debt to equity ratio. The volume reaction is driven by the price reaction and the expectation error regarding the times interest earned ratio. Figure 14 depicts this exploratory prediction model, P_3 . The parameter specifications for this prediction model are provided in Appendix I and the parameter estimates are provided in Table 15.

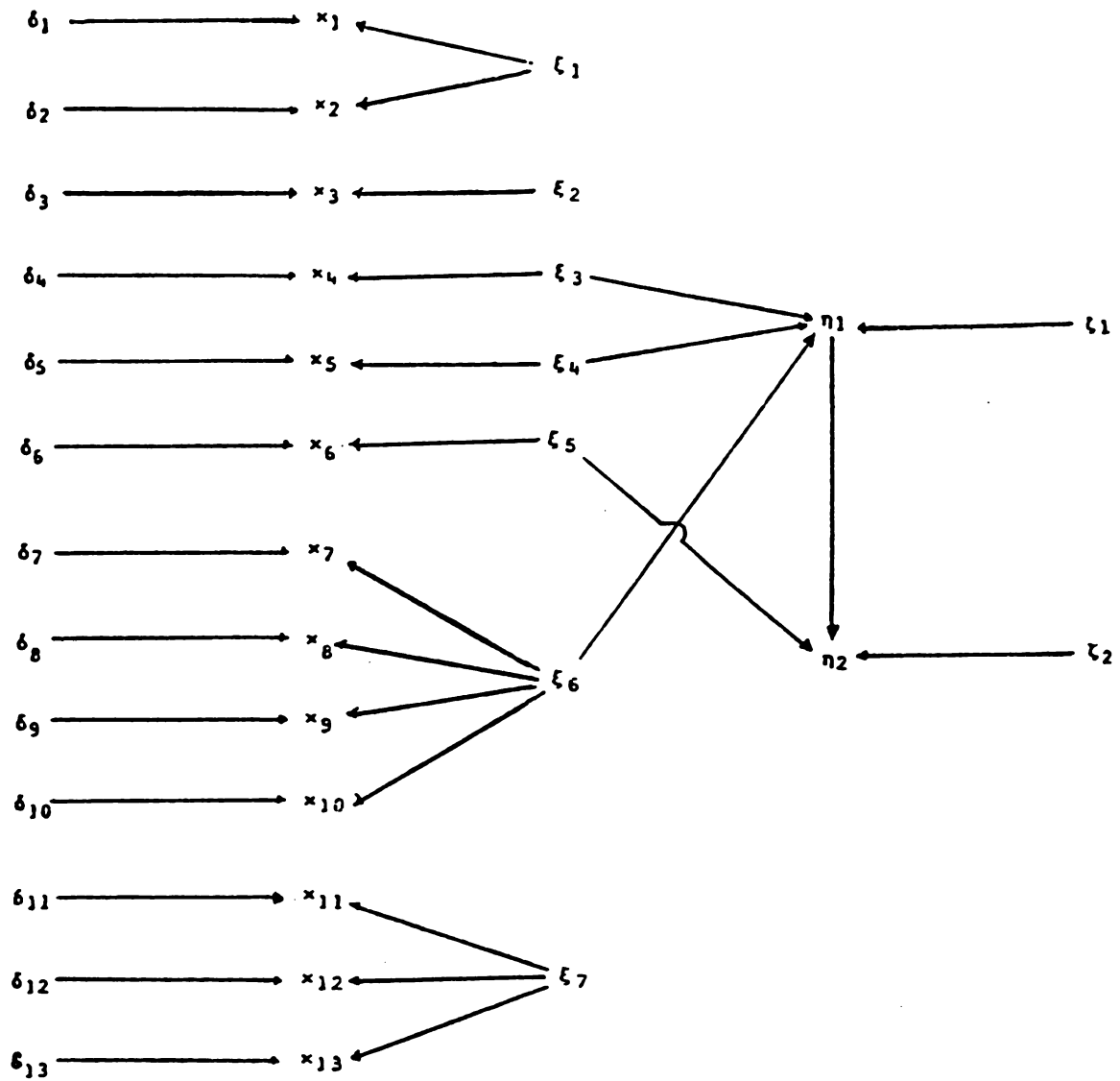


Figure 14. Exploratory Prediction Model P_3

Table 15. Parameter Estimates for Prediction Model P_3

<u>Parameter Number</u>	<u>Estimate</u>	<u>Standard Error</u>	<u>T-Value</u>
10 (β_{21})	-.399	.064	-6.195
11 (γ_{13})	.233	.088	2.649
12 (γ_{14})	-.170	.084	-2.033
13 (γ_{16})	.156	.068	2.280
14 (γ_{25})	.116	.065	1.774
36 ($\sigma^2 \zeta_1$)	.945	.095	9.963
37 ($\sigma^2 \zeta_2$)	.825	.083	9.974

The χ^2 value associated with this model is $\chi^2 = 226.4839$ with 70 degrees of freedom.

The test of model equivalence between this prediction model and the null prediction model is:

$$H_0: P_0 = P_3$$

$$\chi^2 = 276.3264 - 226.4839 = 49.8425$$

$$DF = 75 - 70 = 5$$

The hypothesis of model equivalence is rejected at the $\alpha = .001$ level.

The incremental fit indices comparing this prediction model to the null prediction model are:

$$\alpha_{P_0 P_3} = \left[\left[\frac{276.3264}{75} \right] - \left[\frac{226.4839}{70} \right] \right] \div \left[\frac{276.3264}{75} - 1 \right] = .1672$$

$$\Delta_{P_0 P_3} = \left[\left[\frac{276.3264}{200} \right] - \left[\frac{226.4839}{200} \right] \right] \div \left[\frac{276.3264}{200} \right] = .1803$$

A test of model equivalence between prediction models P_2 and P_3 resulted in the failure to reject the null hypothesis of equivalence. The incremental fit indices comparing the total models (measurement model M_2 and the prediction models, P_1 , P_2 or P_3) against the total null model are:

$$\rho_{N_0 P_1} = \frac{1312.9024}{105} - \frac{253.4780}{61} \div \frac{1312.9024}{105} - 1 = .7257$$

$$\Delta_{N_0 P_1} = \frac{1312.9024}{200} - \frac{253.4780}{200} \div \frac{1312.9024}{200} = .8069$$

$$\rho_{N_0 P_2} = \frac{1312.9024}{105} - \frac{222.0590}{60} \div \frac{1312.9024}{105} - 1 = .7652$$

$$\Delta_{N_0 P_2} = \frac{1312.9024}{200} - \frac{222.0590}{200} \div \frac{1312.9024}{200} = .8309$$

$$\rho_{N_0 P_3} = \frac{1312.9024}{105} - \frac{226.4839}{70} \div \frac{1312.9024}{105} - 1 = .8057$$

$$\Delta_{N_0 P_3} = \frac{1312.9024}{200} - \frac{226.4839}{200} \div \frac{1312.9024}{200} = .8275$$

Exploratory Analysis of Prediction Models Based on the Measurement Model M_3

The measurement model M_3 is a seven factor oblique model in which the indicators load on multiple factors. Through iterative modelling a model with the lowest χ^2 value relative to the number of degrees of freedom was constructed. Since this prediction model is based on the uninterpretable measurement model M_3 a description of the model is not possible. Figure 15 is a diagram of the model. The parameter specifications for the prediction model P_4 are provided in Appendix J.

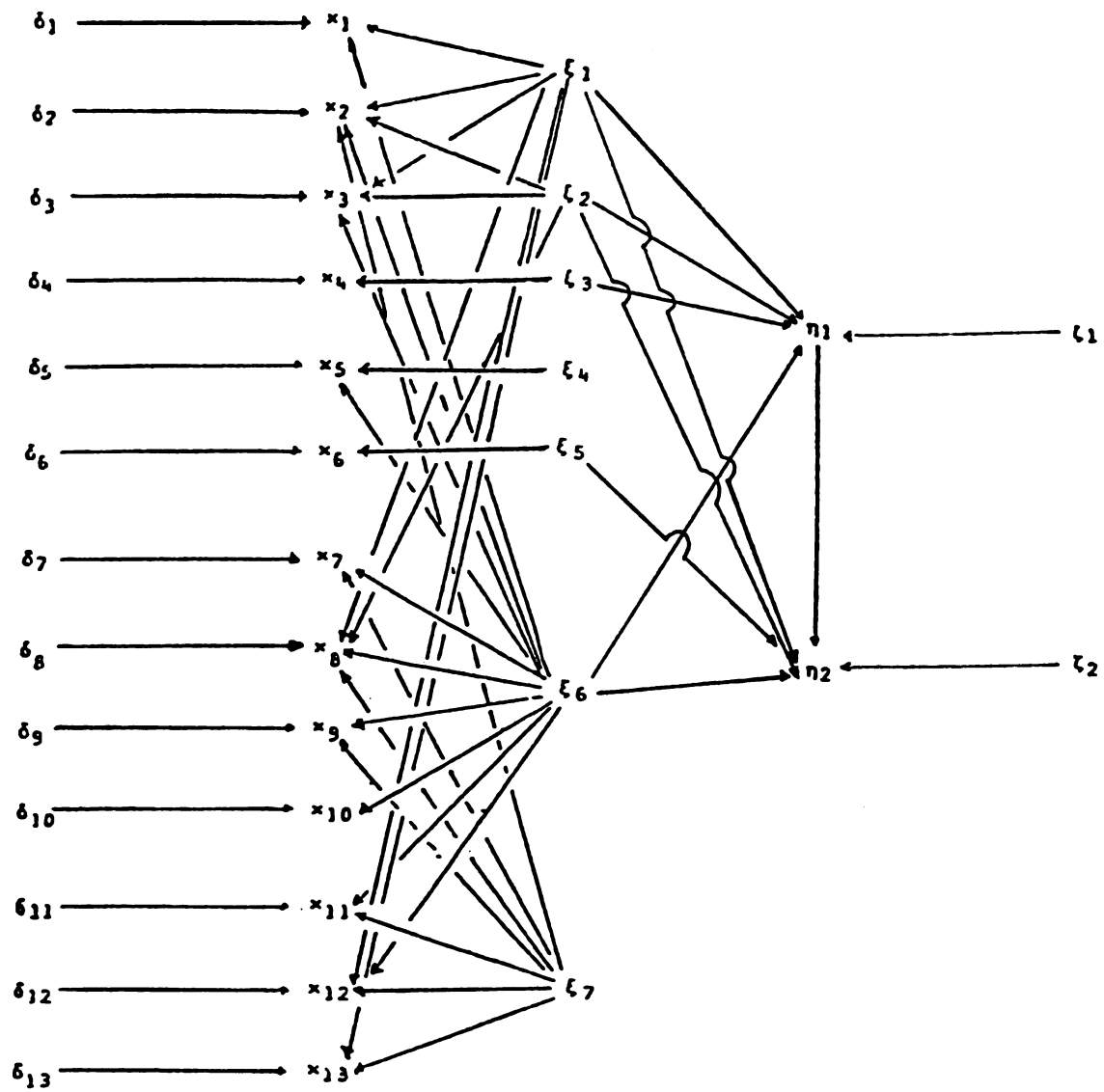


Figure 15. Exploratory Prediction Model P_4

The parameter estimates, standard errors, and t-values are presented in Table 16.

Table 16. Parameter Estimates for Prediction Model P_4

<u>Parameter Number</u>	<u>Estimate</u>	<u>Standard Error</u>	<u>T-Value</u>
17 (β_{21})	-.397	.065	-6.092
18 (γ_{11})	-.010	.036	-.275
19 (γ_{12})	.151	.092	1.649
20 (γ_{13})	.119	.078	1.537
21 (γ_{16})	.039	.100	.389
22 (γ_{21})	-.005	.032	-.147
23 (γ_{22})	.055	.082	.667
24 (γ_{25})	.123	.067	1.836
25 (γ_{26})	-.067	.088	-.770
47 ($\sigma^2 \zeta_1$)	.955	.095	10.012
48 ($\sigma^2 \zeta_2$)	.823	.082	9.979

This model has a χ^2 value of 114.3288 with 59 degrees of freedom. The test of equivalence between this prediction model and the null prediction model is rejected at the $\alpha = .001$ level.

$$H_0: P_{oo} = P_4$$

$$\chi^2 = 163.5489 - 114.3288 = 49.2201$$

$$DF = 68 - 59 = 49.220$$

The associated incremental fit indices are:

$$\rho_{P_{oo} P_4} = .3326$$

$$\Delta_{P_{oo} P_4} = .3009$$

The incremental fit indices between the total null model and this total model (measurement model M_3 and prediction model P_4) are:

$$\rho_{N_0 P_4} = \frac{1312.9024}{105} - \frac{114.3288}{59} \div \frac{1312.9024}{105} - 1 = .9185$$

$$\Delta_{N_0 P_4} = \frac{1312.9024}{200} - \frac{114.3288}{200} \div \frac{1312.9024}{200} = .9129$$

Interpretation of Exploratory Analysis of Prediction Models

The exploratory analysis of prediction models P_2 , P_3 and P_4 indicates a very significant causal link between abnormal volume and abnormal returns. Also a strong link between the expectation errors regarding profitability and abnormal returns is evident. The prediction model P_3 results indicate the usefulness of the long term debt to equity ratio, the debt to equity ratio, and profitability data.

The failure of P_4 to find any significant causal paths other than β_{21} is not a surprise. The underlying measurement model employed allows the expectation errors to load on multiple financial dimensions. Although this provides a better measurement model, the interpretation of the measurement model is difficult and the usefulness of the implied factors is negligible in the market. Even though the measurement model M_3 is a better fit the prediction model implies that the market does not find the measurement model to be useful.

Analysis Assuming Fixed X

Since the fit of a structural model depends on the measurement model employed, a poor measurement model produces a poor fit of the total model and makes interpretation of the structural coefficients very difficult.

The inability to find an adequate measurement model configuration is not surprising given the results of the Stevens (1973) and Johnson (1979) studies presented in Chapter II. One expects to encounter some difficulty in developing a measurement model if the indicators load on multiple factors. Another mode of analysis, often employed in econometrics, which ignores the problem of an inadequate measurement model is to treat the x variables as fixed. This means that each x is treated as a single measure of a particular ξ . The coefficient relating x to ξ , λ , is fixed at 1.00 and no measurement error exists.

$$\underline{\lambda}_x = \underline{1} \text{ and } \underline{\theta}_\delta = \underline{0}$$

The total model consists only of a structural or prediction model,

$$\underline{\beta} \underline{\eta} = \underline{\Gamma} \underline{\xi} + \underline{\zeta}$$

since there is no measurement model.

For this study, treating x as fixed implies that the expectation errors regarding the financial ratios are not multiple indicators of the expectation errors for the four underlying financial dimensions. Instead each expectation error regarding a ratio is treated as the expectation error regarding a unique attribute of the firm.

A number of models were developed, estimated, and tested. Fourteen of these models are presented. Fixed X - Model 1 is a saturated causal model where the market reactions are driven by all of the expectation errors regarding the ratios. Figure 16 is a diagram of this model. Figure 17 is a diagram of the Fixed X - Model 2. This model has the price reaction driven by the volume reaction and the expectation errors regarding the defensive interval, the debt to equity ratio, the rate of return on assets, the earnings to sales ratio, primary earnings per share,

and the rate of return on common equity. The prediction errors are also allowed to covary.

The Fixed X - Model 3 configuration has the market reactions driven by the expectation errors of the ratios for liquidity, leverage, and profitability. The volume reaction is linked to the price reaction. Figure 18 represents a diagram of this configuration. Figure 19, a diagram of the Fixed X - Model 4 configuration, has the price reaction driven by the expectation errors regarding the defensive interval, the total debt to equity ratio, the rate of return on assets, the earnings to sales ratio, primary earnings per share, and the rate of return on common equity. The volume reaction is causally linked to the expectation errors for the times interest earned ratio, the rate of return on assets, and primary earnings per share. The Fixed X - Model 5 configuration adds a causal link where the volume reaction is driven by the price reaction to the Fixed X - Model 5 configuration. This model is presented in Figure 20.

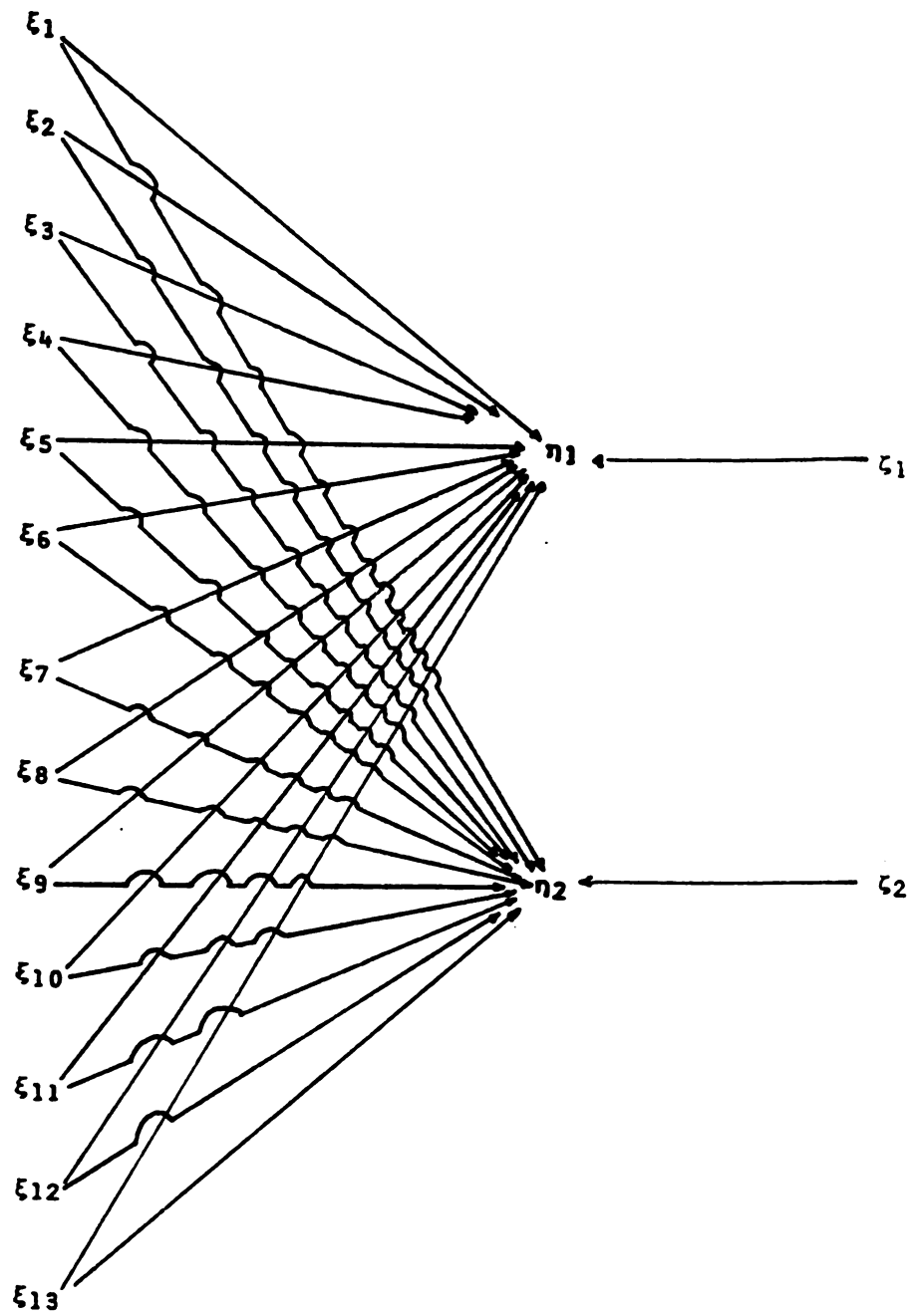


Figure 16. Fixed X - Model 1

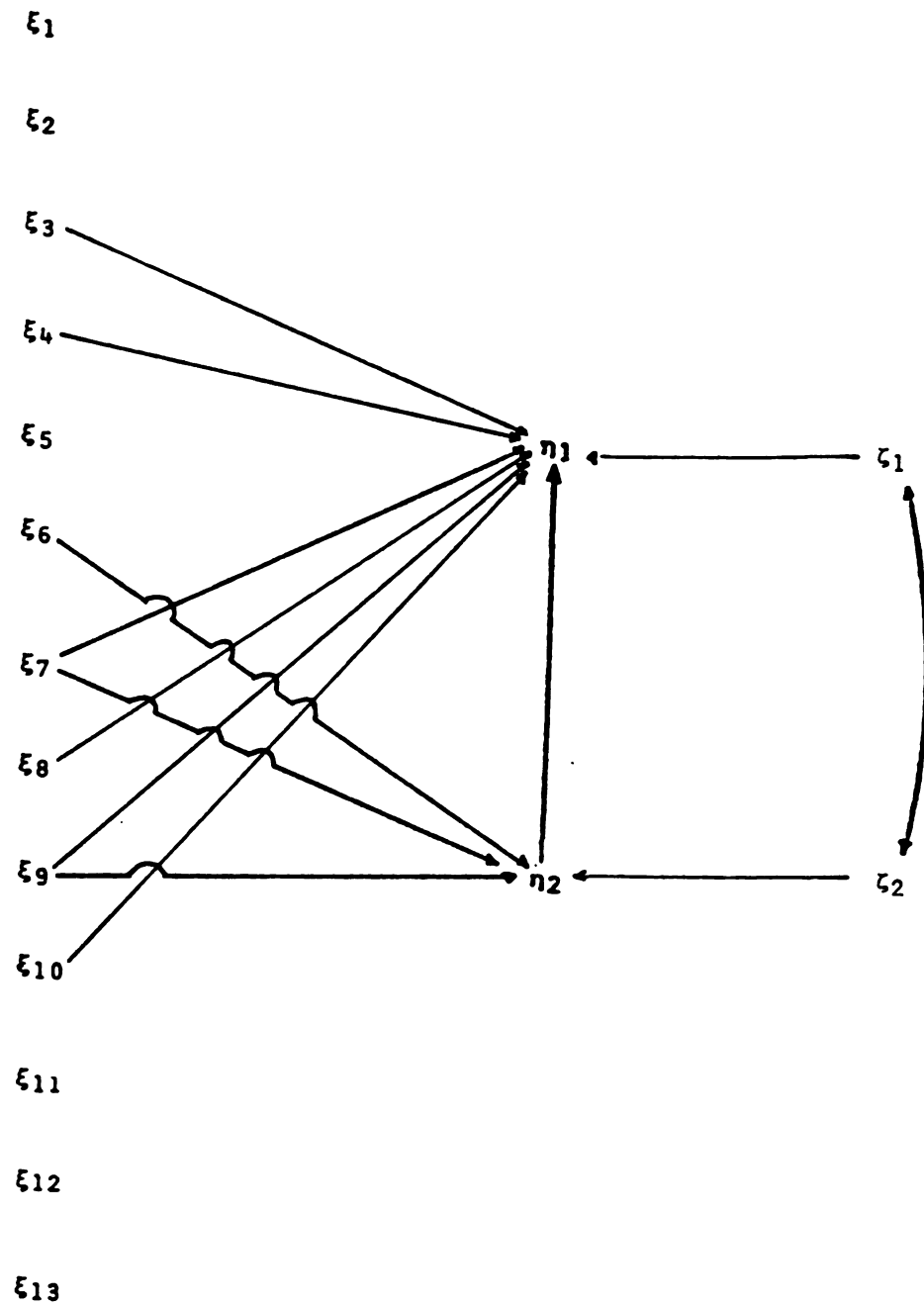


Figure 17. Fixed X - Model 2

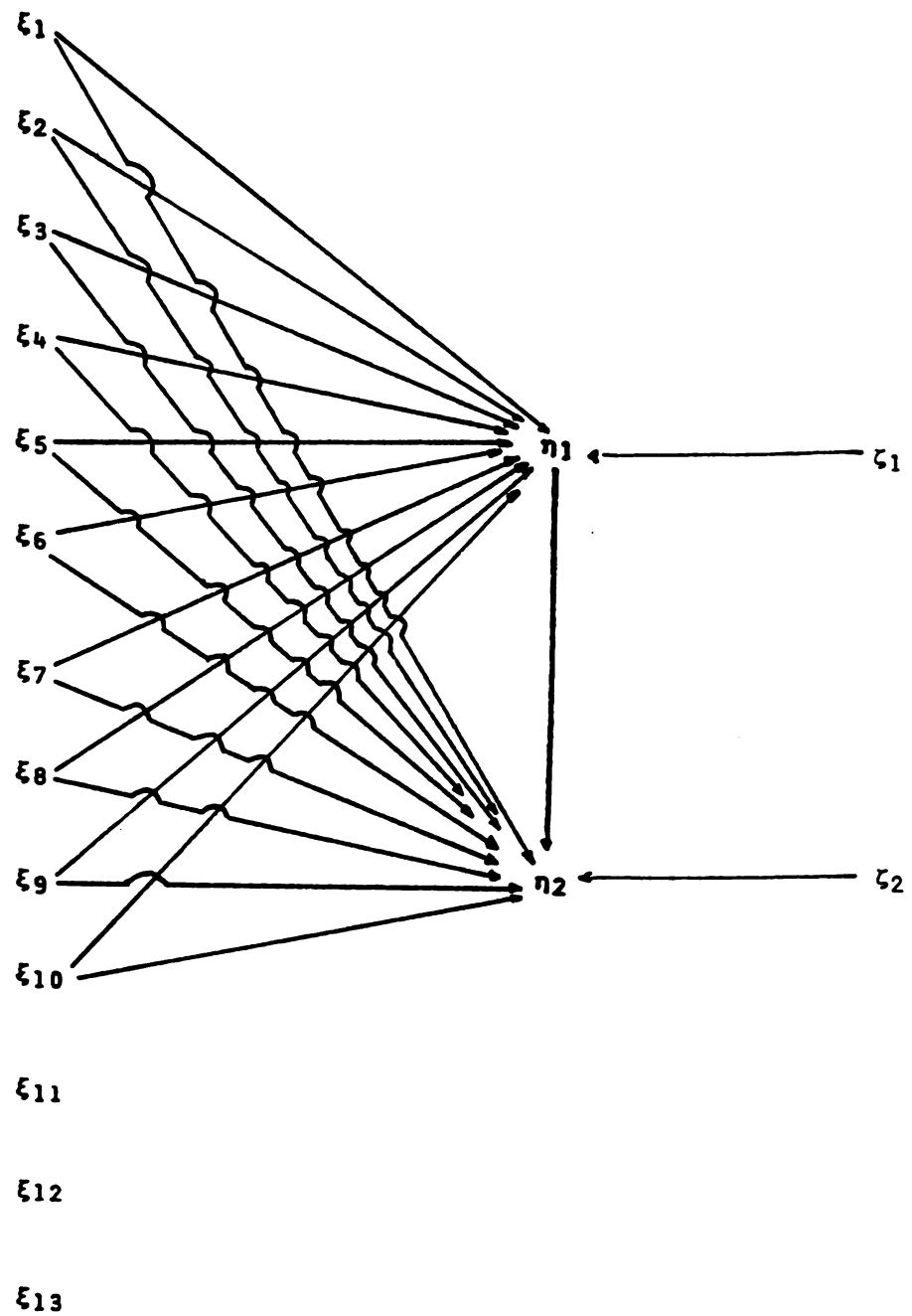


Figure 18. Fixed X - Model 3

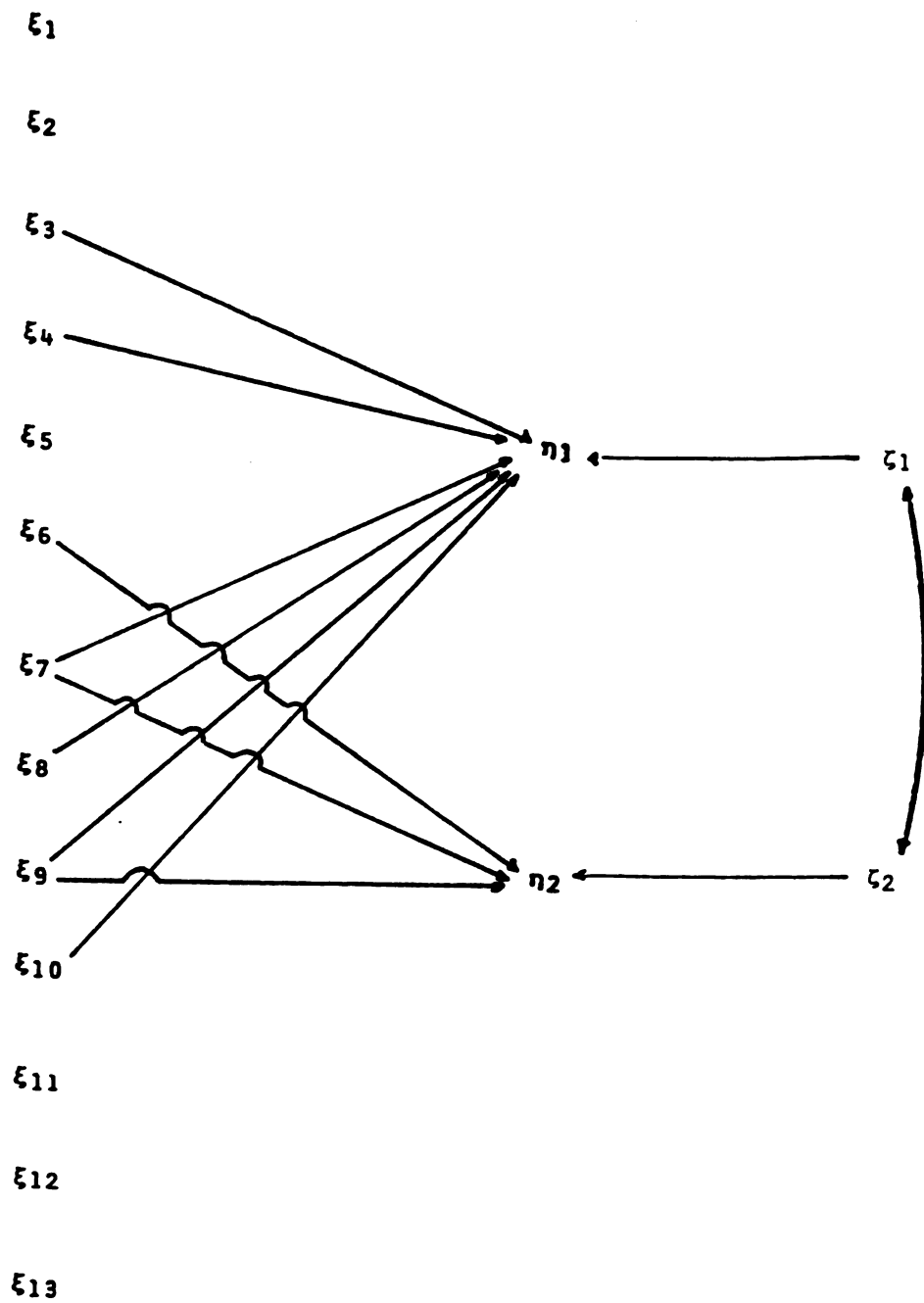


Figure 19. Fixed X - Model 4

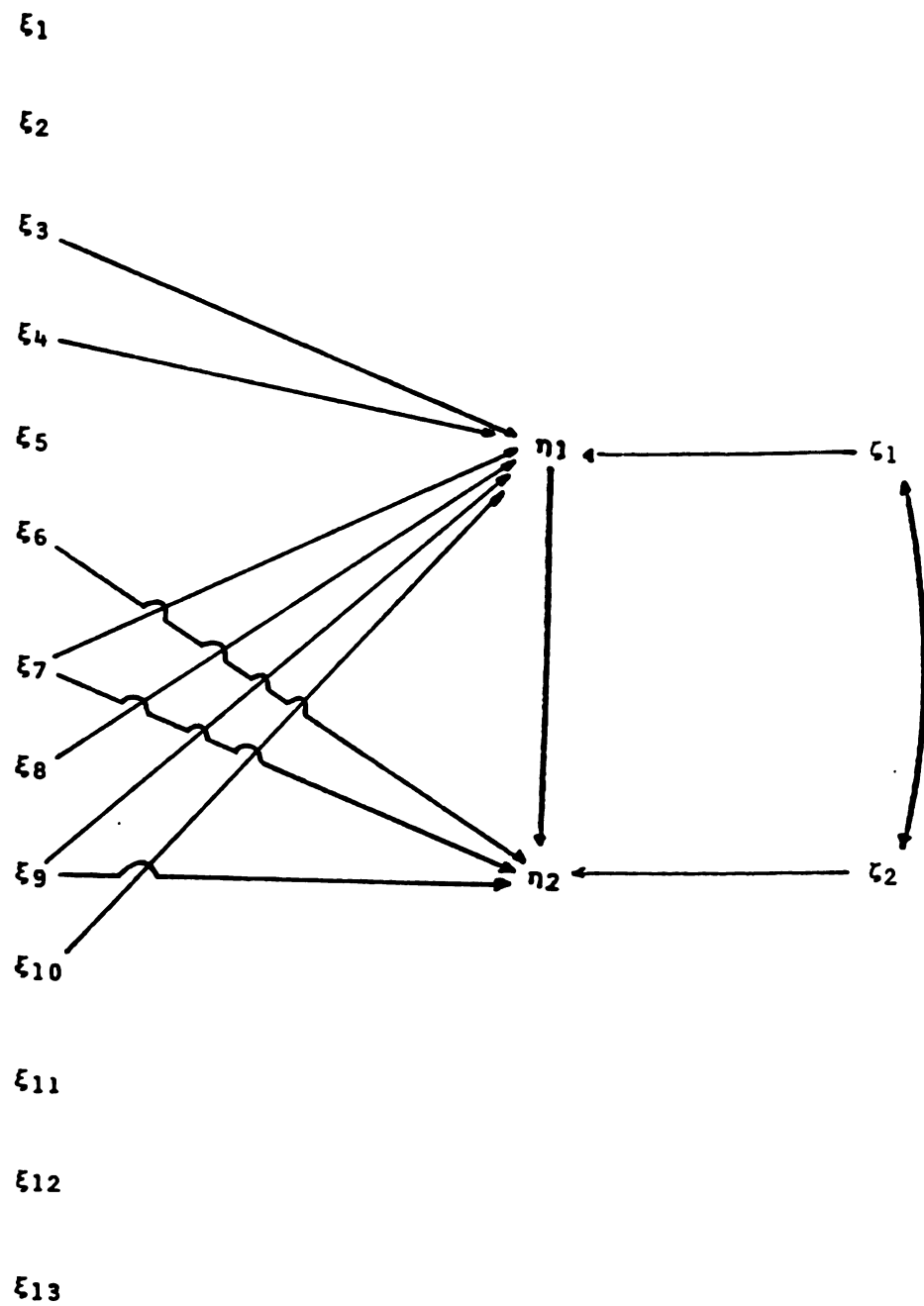


Figure 20. Fixed X - Model 5

The Fixed X - Model 6 causal configuration adds reciprocal causality to the previous model. This model is diagrammed in Figure 21. The next model, Fixed X - Model 7 diagrammed in Figure 22, drops the reciprocal causality of the previous model and has price reactions driving the volume reactions.

The Fixed X - Model 8 configuration has the price reaction driven by the expectation errors regarding the defensive interval ratio, the debt to equity ratio, the rate of return on assets, primary earnings per share, the rate of return on common equity, the asset turnover ratio, the accounts receivable turnover ratio, and the inventory turnover ratio. The volume reaction is driven by the price reaction as well as the expectation errors concerning the current ratio, the times interest earned ratio, the rate of return on assets, the earnings to sales ratio, primary earnings per share, the asset turnover ratio, the accounts receivable turnover ratio, and the inventory turnover ratio. This model is presented in Figure 23.

In Model 9 the volume reaction is driven by the price reaction and the expectation errors for the current ratio, the times interest earned ratio, the rate of return on assets, the earnings to sales ratio, primary earnings per share, and the inventory turnover ratio. The price reaction is driven by the expectation errors concerning the defensive interval, the debt to equity ratio, the rate of return on assets, the rate of return on common equity, and primary earnings per share. The prediction errors covary. This model is presented in Figure 24. The Fixed X - Model 10 configuration deletes the covariation among the prediction errors and allows reciprocal causation among the market reactions. Figure 25 presents this model. The next model, Fixed X - Model 11 eliminates the causal link from the volume reaction to the price reaction of the previous model. Figure 26 represents this model.

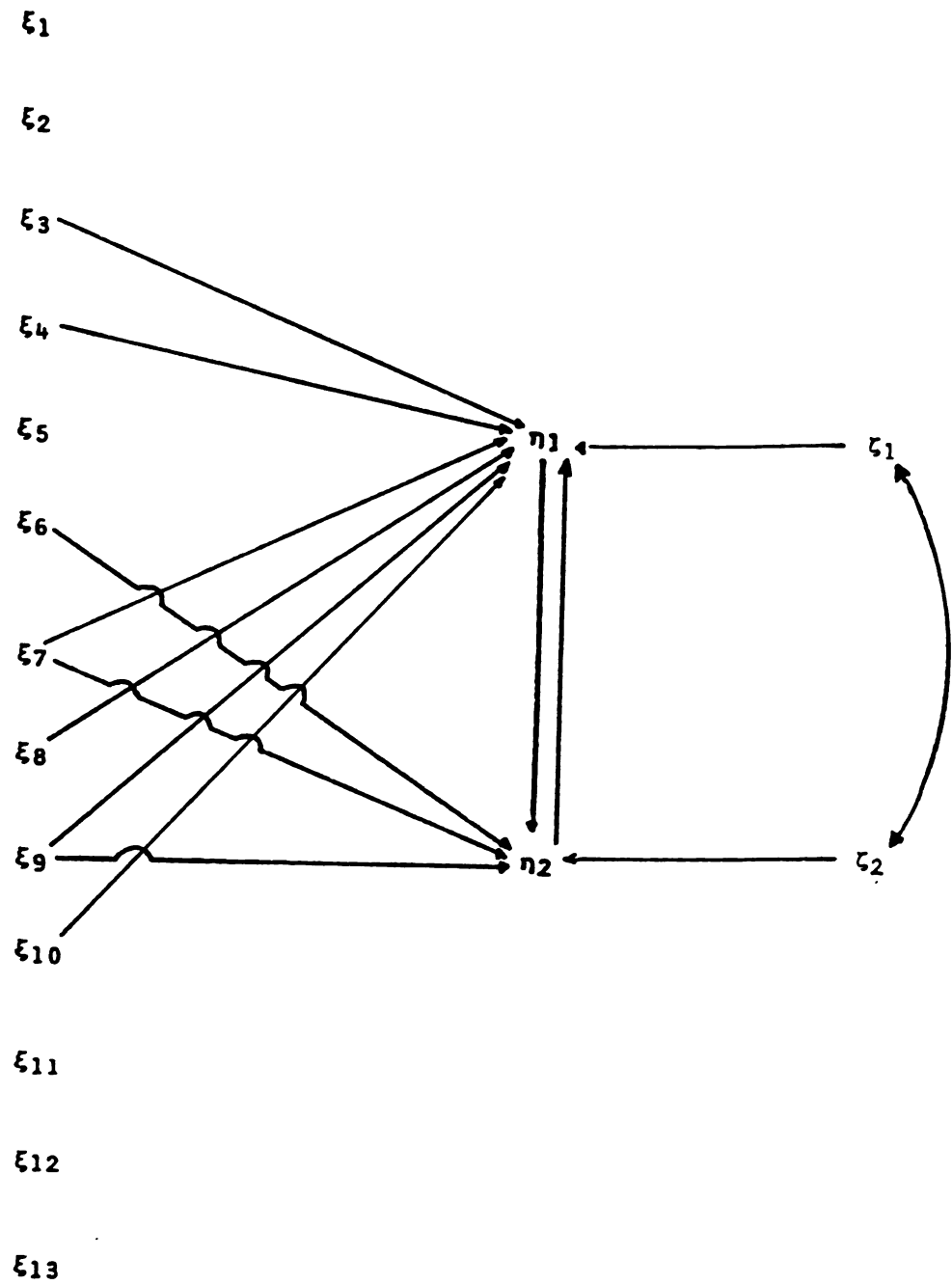


Figure 21. Fixed X - Model 6

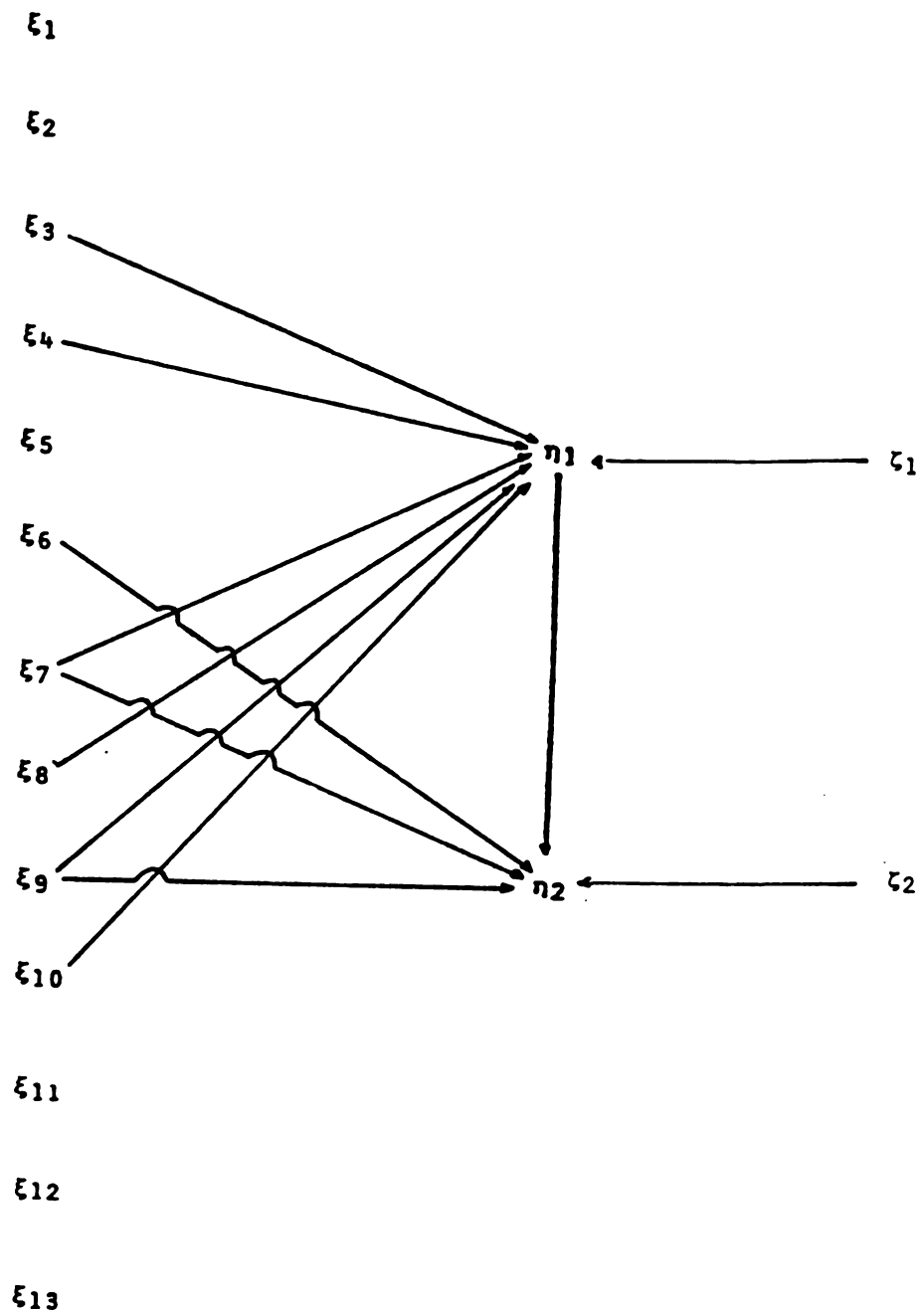


Figure 22. Fixed X - Model 7

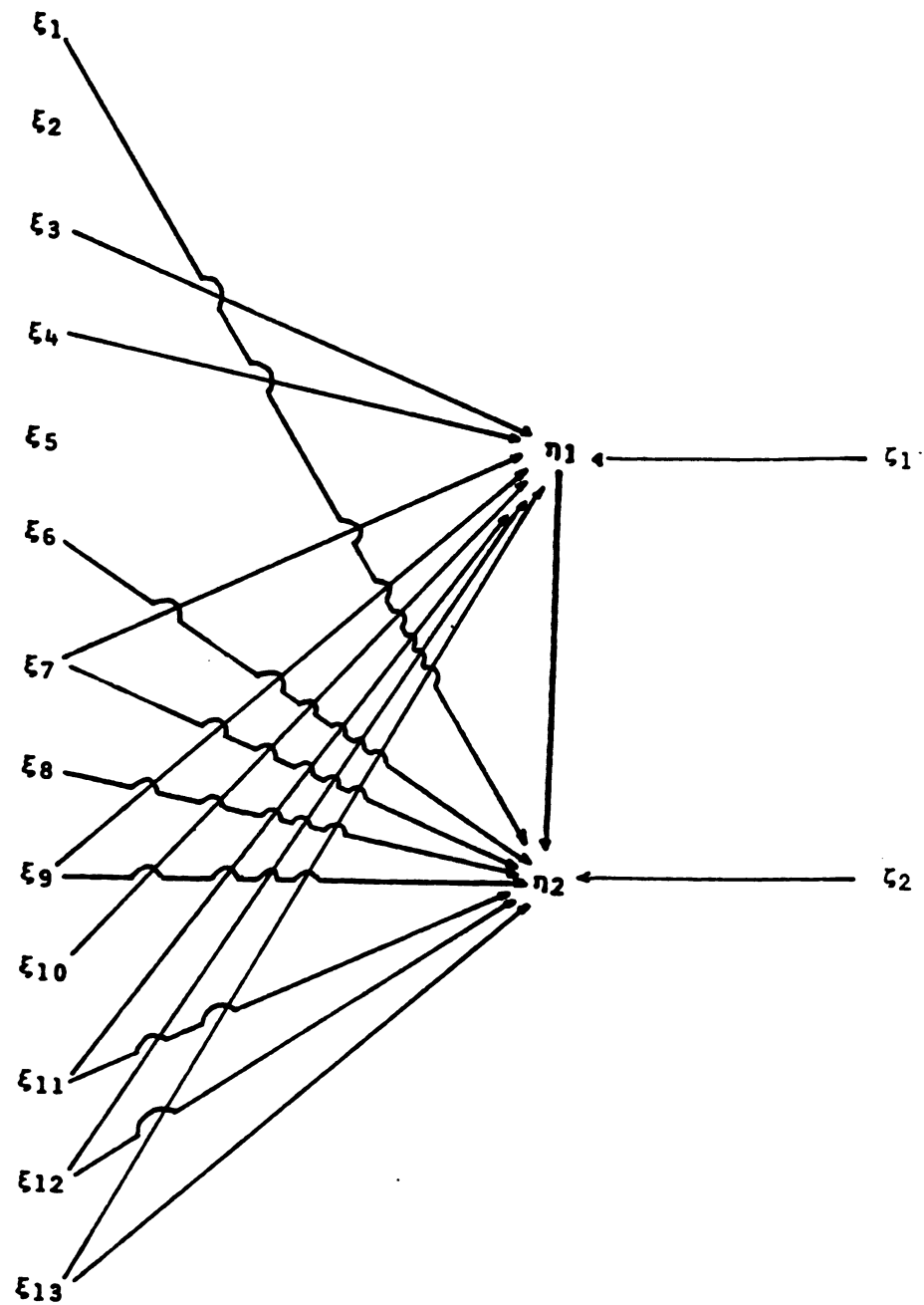


Figure 23. Fixed X - Model 8

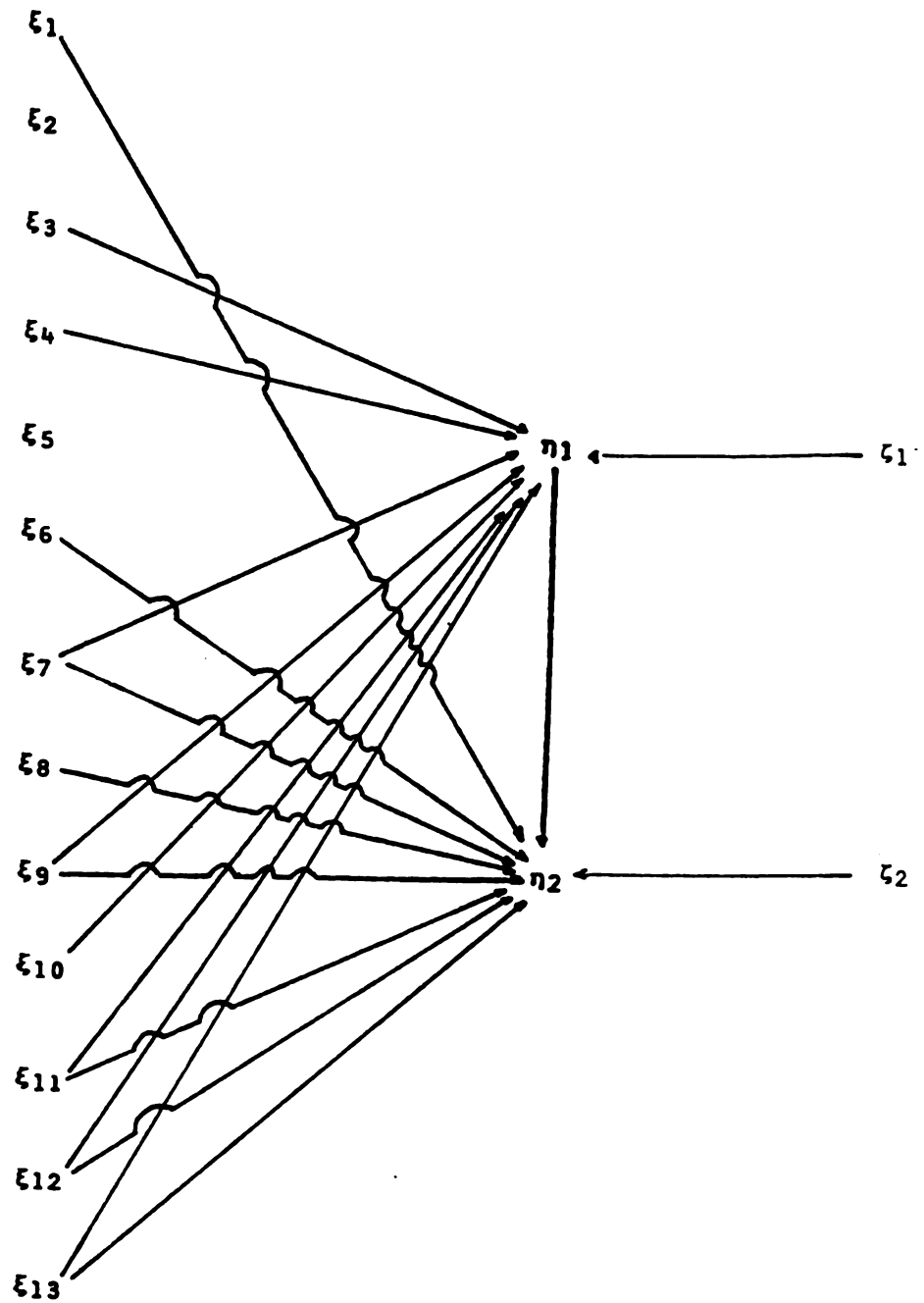


Figure 23. Fixed X - Model 8

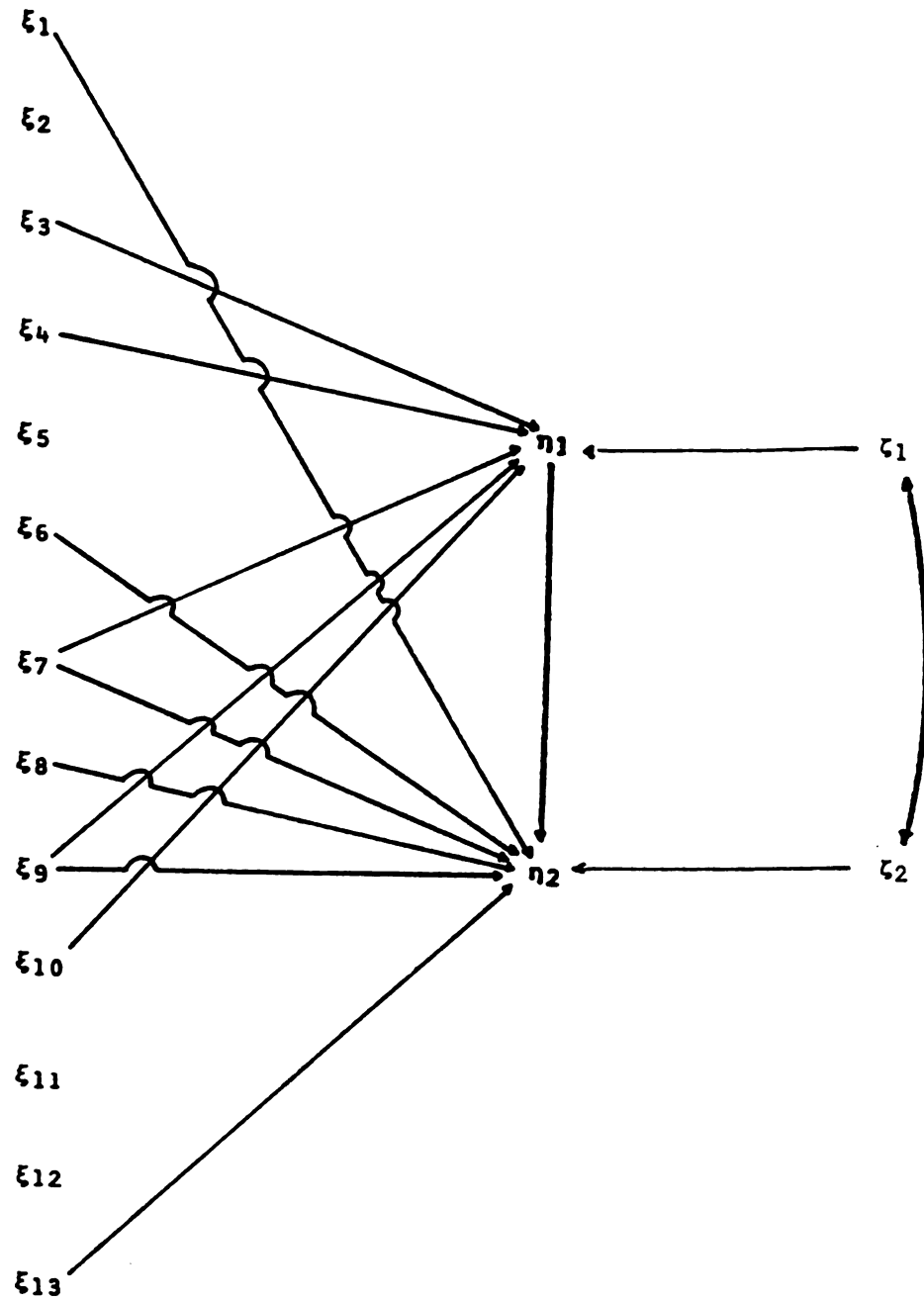


Figure 24. Fixed X - Model 9

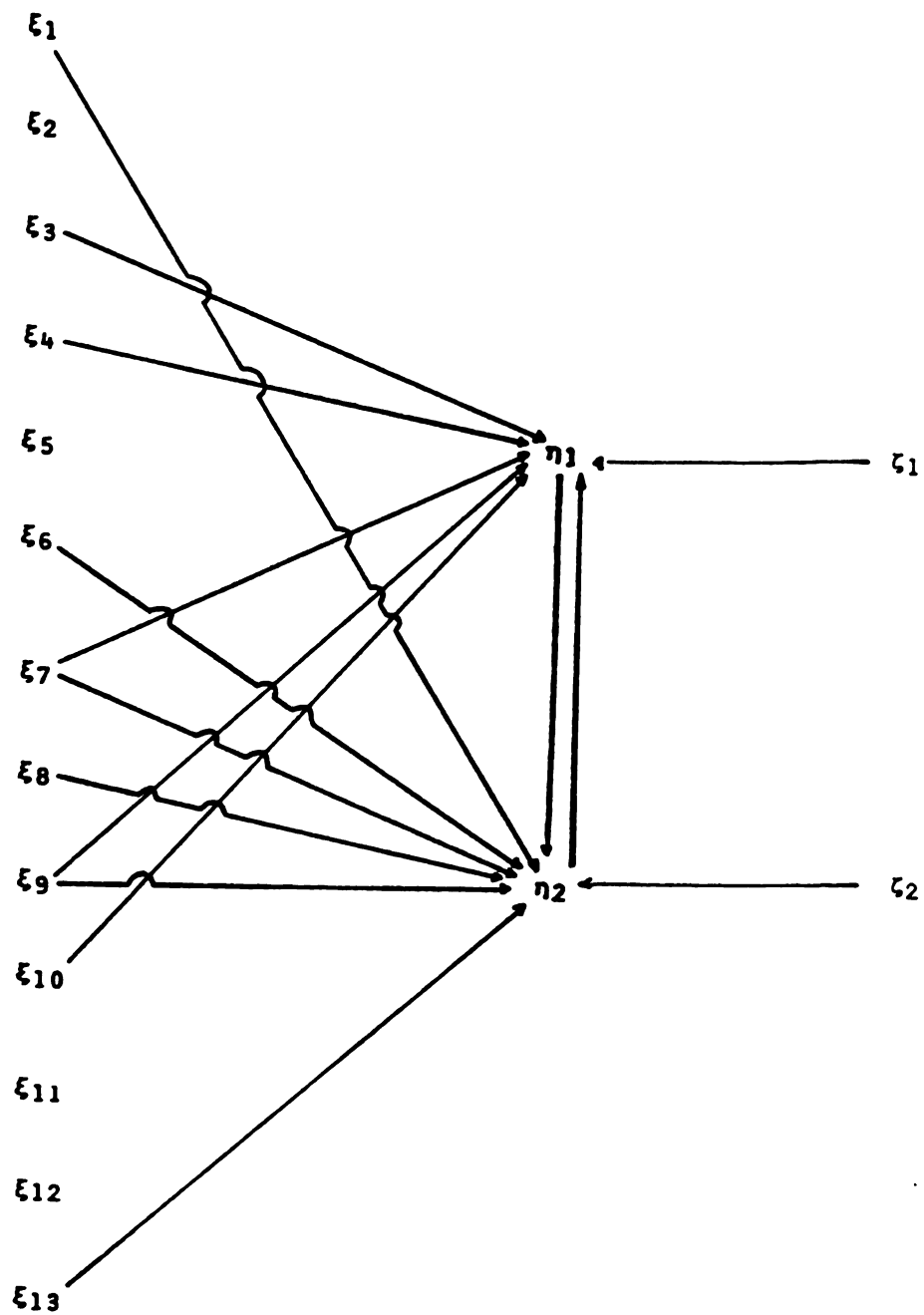


Figure 25. Fixed X - Model 10

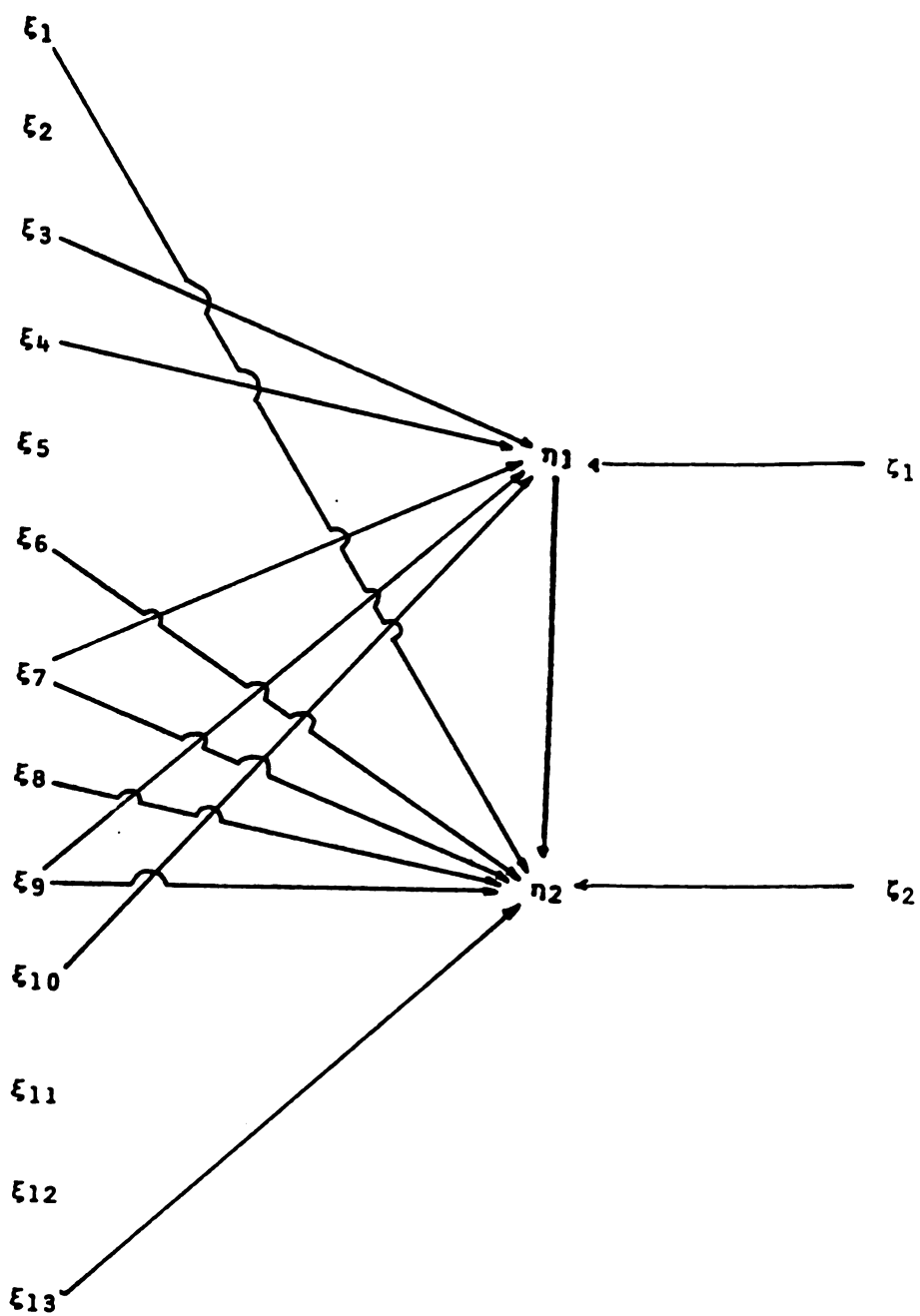


Figure 26. Fixed X - Model 11

The next causal configuration, Fixed X - Model 12, does not have covariance among the prediction errors. The volume reaction is driven by the price reaction and the expectation errors of the times interest earned ratio, the rate of return on total assets, the earnings to sales ratio, primary earnings per share, and the inventory turnover ratio. The price reaction is driven by the expectation errors for the current ratio, the defensive interval, the debt to equity ratio, the rate of return on total assets, primary earnings per share, and the rate of return on common equity. Figure 27 is a diagram of this model.

Figure 28 is a diagram of the Fixed X - Model 13 causal configuration. This model has the price reaction driven by the expectation errors for the current ratio, the defensive interval, the debt to equity ratio, the rate of return on total assets, primary earnings per share, and the rate of return on common equity. The volume reaction is dependent on the price reaction and the expectation errors for the current ratio, the times interest earned ratio, the rate of return on assets, the earnings to sales ratio, primary earnings per share, the rate of return on common equity, and the inventory turnover ratio. The next model, Figure 29, is a saturated model in which the market reactions depend on all of the expectation errors and the volume reaction is dependent upon the price reaction.

Table 17 presents the t-values associated with the structural coefficient estimates for these fourteen models. The χ^2 value and the degrees of freedom for each model are provided as well as the p level of significance for the overall test of model fit. Also, the proportion of variation in the endogenous variables accounted for in each equation for the various models is given. The p level provides the probability of obtaining a χ^2 value larger than the value obtained, assuming the hypothesized model holds.

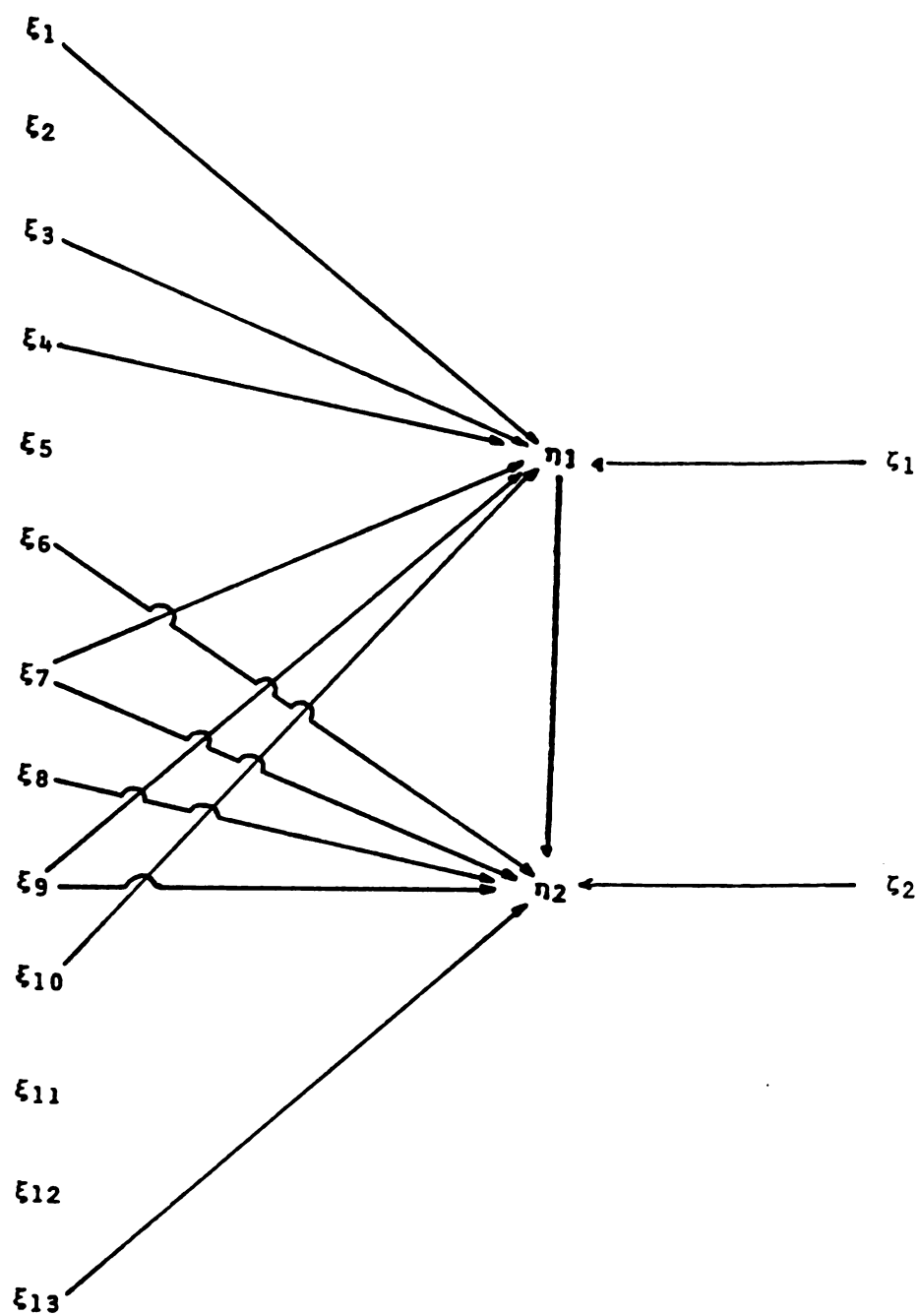


Figure 27. Fixed X - Model 12

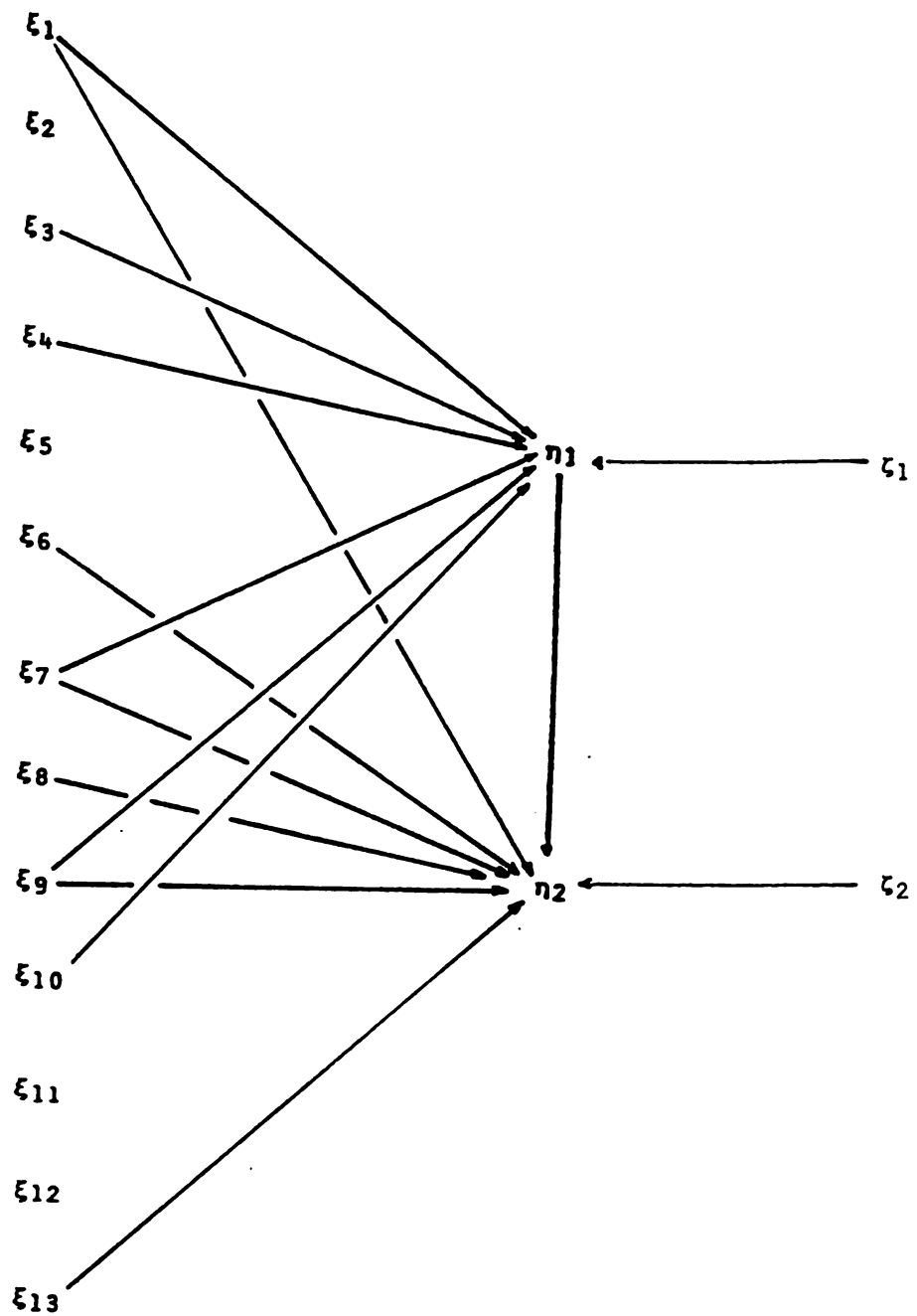


Figure 28. Fixed X - Model 13

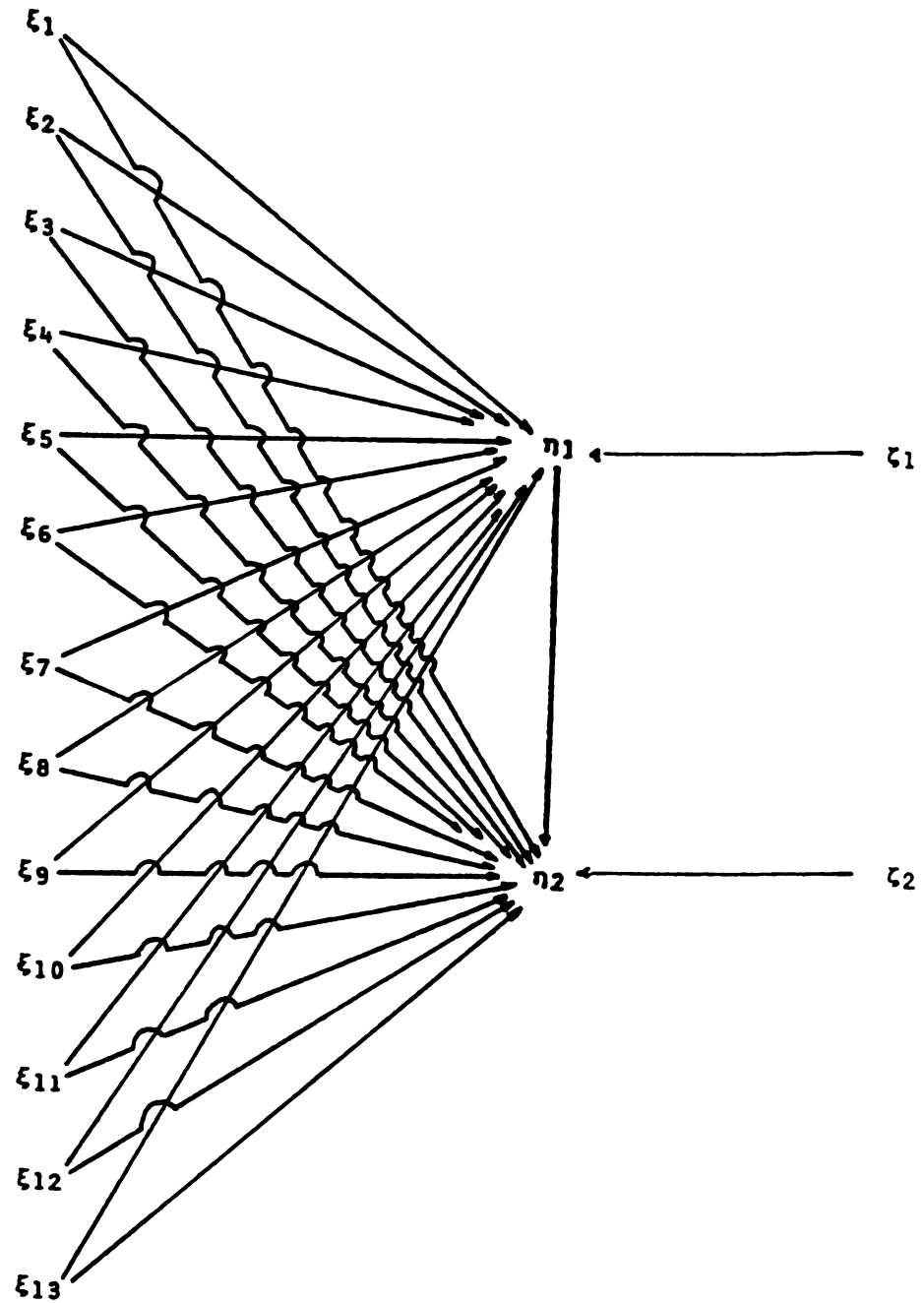


Figure 29. Fixed X - Model 14

Table 17. T-Values of Parameter Estimates for Structural Models Assuming Fixed X

Model	θ_{21}	θ_{12}	γ_{11}	γ_{12}	γ_{13}	γ_{14}	γ_{15}	γ_{16}	γ_{17}	γ_{18}	γ_{19}	γ_{110}	γ_{111}	γ_{112}	γ_{113}	γ_{21}	γ_{22}	γ_{23}
1.	-	-	-.826	.375	1.041	1.061	-.496	-.408	1.437	-.680	2.114	-1.597	.198	-.817	-.746	-.843	.009	.567
2.	-	.327	-	-	1.534	1.384	-	-	.809	-.628	1.146	-1.367	-	-	-	-	-	-
3.	-.5348	-	-.869	.413	1.385	1.146	-.582	-.180	1.083	-.309	2.087	-1.417	-	-	-	-1.086	.443	.186
4.	-	-	-	-	1.497	1.396	-	-	1.134	-.572	2.488	-1.342	-	-	-	-	-	-
5.	-1.799	-	-	-	1.636	1.717	-	-	.685	.197	2.409	-1.248	-	-	-	-	-	-
6.	-1.979	.635	-	-	1.594	1.646	-	-	.570	.076	1.793	-1.256	-	-	-	-	-	-
7.	-5.632	-	-	-	1.662	1.674	-	-	.923	-.115	2.422	-1.349	-	-	-	-	-	-
8.	-5.450	-	-	-	1.067	1.647	-	-	1.386	-	2.398	-1.464	.068	-.926	-.456	-.978	-	-
9.	-1.247	-	-	-	1.691	1.673	-	-	1.142	-	2.420	-1.322	-	-	-	-.975	-	-
10.	-1.702	.207	-	-	1.645	1.628	-	-	1.060	-	1.724	-1.302	-	-	-	-.905	-	-
11.	-5.564	-	-	-	1.675	1.671	-	-	1.154	-	2.419	-1.346	-	-	-	-1.001	-	-
12.	-5.666	-	-1.447	-	1.851	1.048	-	-	1.051	-	2.430	-1.398	-	-	-	-	-	-
13.	-5.523	-	-1.447	-	1.851	1.048	-	-	1.051	-	2.430	-1.398	-	-	-	-.994	-	-
14.	-5.381	-	-.827	.376	1.041	1.060	-.496	-.407	1.435	-.678	2.114	-1.596	.198	-.817	-.746	-.585	-.135	.210
Model	γ_{24}	γ_{25}	γ_{26}	γ_{27}	γ_{28}	γ_{29}	γ_{210}	γ_{211}	γ_{212}	γ_{213}	$\sigma^2_{\epsilon_{12}}$	χ^2	D.F.	p level	Unadjusted R^2 -Equation 1	Unadjusted R^2 -Equation 2		
1.	-.014	.585	1.872	-1.438	.958	3.855	-.271	-.099	-.981	.852	-	27.0363	1	.000	.108	.130		
2.	-	-	1.666	-1.885	-	4.059	-	-	-	-	.858	11.7964	16	.757	.087	.093		
3.	-.441	.768	2.103	-2.167	1.208	3.223	.189	-	-	-	-	3.2960	6	.771	.102	.233		
4.	-	-	1.916	-1.909	-	4.056	-	-	-	-	4.810	11.9249	17	.815	.087	.092		
5.	-	-	1.756	-1.971	-	1.916	-	-	-	-	-.702	9.5660	16	.889	.089	.169		
6.	-	-	1.780	-1.997	-	2.148	-	-	-	-	-.323	9.5522	16	.891	.090	.184		
7.	-	-	1.810	-2.036	-	3.267	-	-	-	-	-	9.9806	17	.904	.090	.217		
8.	-	-	2.187	-2.134	1.314	3.196	-	-.389	-.712	1.263	-	3.7209	10	.949	.095	.237		
9.	-	-	2.240	-2.539	1.524	2.265	-	-	-	1.152	-.157	5.7206	14	.973	.089	.231		
10.	-	-	2.269	-2.588	1.577	2.554	-	-	-	1.188	-	5.7090	14	.973	.047	.232		
11.	-	-	2.282	-2.603	1.591	3.176	-	-	-	1.158	-	5.7445	15	.984	.090	.234		
12	-	-	2.197	-2.682	1.749	3.151	-	-	-	1.124	-	4.6487	15	.995	.099	.230		
13.	-	-	2.281	-2.603	1.591	3.177	-	-	-	1.158	-	3.6627	14	.997	.099	.234		
14	-.418	.814	2.158	-2.075	1.282	3.283	.316	-.181	-.737	1.195	-	0	0	1.000	.108	.240		

(Model is Just Identified)

(Model is Just Identified)

The overall test of goodness of fit indicates that Model 13 recreates a correlation matrix $\underline{\Sigma}$ that best matches the observed correlation matrix $\underline{S}$ at the $p = .9972$ level. Tests of model equivalence indicate that Models 1, 2, and 4 are equivalent, Models 5, 6, and 7 are equivalent, and Models 3, 9, 10, 11, 12, and 13 are equivalent. The hypotheses of model equivalence are rejected for other comparisons.

Interpretation of the structural coefficients and the significance of causal links of a model are dependent upon the collinearity of the exogenous variables. Analysis of the matrix of correlations for the coefficients of the saturated model (Model 14) indicates some problems. Appendix K contains the lower left triangle of the correlation matrix of the coefficient estimates for Model 14. However, elimination of one variable from each pair of collinear variables is provided in Model 13. The structural coefficients of Model 13 relating the abnormal returns to the expectation errors regarding various financial ratios are presented in Table 18.

Table 18. Parameter Estimates for Price Reaction Links for Fixed X - Model 13

Cue	Coefficient	Standard Error	T-Value
Current Ratio	-.105	.072	-1.447
Defensive Interval	.129	.070	1.851
Total Debt/Equity Ratio	.080	.076	1.048
Return on Assets	.105	.100	1.051
Primary Earnings per Share	.202	.083	2.430
Rate of Return on Common Equity	-.116	.083	-1.398

While indicating that some information cues other than profitability are linked to market price reactions, the most significant coefficient is the link pertaining to primary earnings per share. The sign of this

coefficient is as expected. Good news, a positive forecast error, results in a positive abnormal return. For the other coefficients, the signs are meaningless given the magnitudes of the standard errors.

The estimates of the structural coefficients linking the market volume reactions to the financial ratio expectation errors for the Fixed X - Model 13 are presented in Table 19.

Table 19. Parameter Estimates for Volume Reaction Links for Fixed X - Model 13

=====			
Cue	Coefficient	Standard Error	T-Value
Current Ratio	-.064	.064	-.994
Times Interest Earned	.150	.066	2.281
Return on Total Assets	-.314	.120	-2.603
Earnings to Sales Ratio	.182	.114	1.591
Primary Earnings per Share	.247	.078	3.177
=====			

The abnormal volume reaction is most significantly linked to cues regarding profitability. Although the times interest earned ratio is classified as a measure of leverage it can be deemed a profitability indicator.

The signs of the coefficients linking abnormal volume to the expectation errors regarding times interest earned and primary earnings per share are as expected. Good news regarding these items results in increased trading. The sign of the coefficient between the expectation error of the return on total assets is negative and is not as expected. This implies that good news is accompanied by a decrease in trading and bad news results in increased trading. Although there is no apparent reason for this relationship, data items involving the balance sheet tend to have negative coefficients. Another reason for the negative coefficient may be that the return on total assets does not specifically relate

to a beneficial or detrimental position for the equity holder. The effect on equity of a change in the return on total assets is conditioned upon changes in the debt structure of the firm. Therefore the signal may be ambiguous to the stockholder.

The most significant causal link is the coefficient relating abnormal volume reactions to abnormal price reactions. The estimate is $-.355$ with a standard error of $.064$. The associated t -value is -5.523 which is significant at the $\alpha = .0000002$ level.

Since the parameter linking CAV to CAR has a negative sign its actual link is positive since the equation formulation for the model includes $-\beta_{21}$ on the right hand side. Abnormal volume of a positive nature results when positive abnormal returns occur.

Given a specific causal model, the association between an exogenous and an endogenous variable can be decomposed into multiple components. The total association or implied slope is the zero-order correlation between the two variables (Alwin and Hauser, 1975, p. 39). This total association is made up of the total causal effect and the noncausal component. The noncausal component represents association between variables due to non-modeled common causes, collinearity among explanatory variables, and any unanalyzed correlation. The total effect indicates the change in an endogenous variable induced by a change in an exogenous variable. Comprising the total effect are the direct effect and the indirect effect. The direct effect is the associated path coefficient. Indirect effects are the parts of a total effect due to an intervening variable. Table 20 presents the results of an effect analysis based on Model 13.

An analysis of the effect analysis indicates that the relationship between Y_1 and Y_2 is modeled very well. Overall, the level of noncausal

Table 20. Results of Effect Analysis on Fixed X - Model 13

IMPLIED CORRELATIONS AND SLOPES															
	X ₁	X ₂	X ₃	X ₄	X ₅	X ₆	X ₇	X ₈	X ₉	X ₁₀	X ₁₁	X ₁₂	X ₁₃	Y ₁	Y ₂
Y ₁	-.1295	-.0736	.1372	.1104	-.0466	.0369	.1301	.1487	.2233	-.0040	-.0749	.0042	-.0147	1.0004	.4091
Y ₂	-.1105	-.0684	.0810	.0734	-.0801	.1308	.0608	.1153	.2600	-.0211	-.0396	-.0250	.0250	.4091	1.0004
TOTAL EFFECTS															
Y ₁	-.1050	-	.1290	.0800	-	-	.1050	-	.2020	-.1160	-	-	-	-	-
Y ₂	-.1013	-	.0458	.0284	-	.1500	-.2767	.1320	.3187	-.0412	-	-	.0790	.3550	-
DIRECT EFFECTS															
Y ₁	-.1050	-	.1290	.0800	-	-	.1050	-	.2020	-.1160	-	-	-	-	-
Y ₂	-.0640	-	-	-	-	.1500	-.3140	.1820	.2470	-	-	-	.0790	.3550	-
INDIRECT EFFECTS															
Y ₁	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Y ₂	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NONCASUAL COMPONENTS															
Y ₁	-.0245	-.0736	.0082	.0304	-.0466	.0369	.0251	.1487	.0213	.1120	-.0749	.0042	-.0147	1.0000	.4071
Y ₂	-.0093	-.0584	.0352	.0450	-.0801	-.0192	.3375	-.0667	-.0587	.0201	-.0396	-.0250	-.0667	.0540	1.0000

components is quite sufficient except for two instances. The direct effect of X_7 on Y_2 is largely overstated in a negative fashion. This seems to be caused by multicollinearity among X_7 and X_8 . The coefficient relating X_{10} to Y_1 also is overstated and results in a fairly large noncausal component.

Empirical Conclusions

For the original hypothesized causal configuration, the results indicate that only the profitability data is useful to the investor and results in a price reaction. None of the financial dimensions are directly linked to the volume reaction. Instead, it seems to be driven by the abnormal returns. The interpretation of these results must be made in light of the inadequate overall fit of the model.

Exploratory analyses of the measurement model provides insight into the poor fit of the model configuration. Numerous measurement models were investigated; an adequate fitting model was found but its configuration was not interpretable. Using the measurement models developed through the exploratory analysis various prediction models were constructed, estimated, and tested. These results indicate that profitability information is most useful to the market as a whole however leverage data is also significantly linked to abnormal returns. The abnormal volume reaction is driven by the abnormal returns.

By treating each ratio as an individual aspect of the firm the problems associated with the measurement model were eliminated. A number of various prediction models were estimated and tested. These results (Table 17) indicate that the abnormal return reaction is driven by the expectation error regarding earnings per share. The abnormal volume reaction was found to be significantly linked to the expectation errors

regarding times interest earned, return on total assets, and earnings per share. This indicates that the individual market participants use more information than the market as a whole. Congruent with the other models, the most significant parameter was the causal link between abnormal trading and abnormal returns.

The results overwhelmingly provide evidence that abnormal volume reactions are driven by abnormal returns. This upholds the hypothesis that the market does not adjust prices due to individual investors making shifts in their portfolios but individual investors may make shifts in their portfolios due to changes in the price of a security. An analysis of Fixed X - Model 6 (Table 17) indicates that the link going from abnormal returns to abnormal volume (β_{21}) is significant and the link going from abnormal volume to abnormal returns (β_{12}) is not significant.

The relationship between abnormal volume and abnormal price is a positive link. Positive abnormal returns drive positive abnormal trading whereas negative abnormal returns result in negative abnormal trading. Good news (positive expectation errors) regarding earnings per share results in both positive abnormal returns and positive abnormal trading. This result, based on a four month reaction period, provides additional insight into the relationship between abnormal returns and abnormal trading. Previous research, Beaver (1968), Kiger (1972), and Morse (1981) analyzed returns and volume on an aggregate level. They did not examine the relationships between abnormal returns and abnormal volume for the individual securities studied.

CHAPTER VI

Summary, Conclusions, and Implications

Summary

Previous research has determined that accounting information, in particular earnings, is used by investors and possesses information content. Using the abnormal performance research paradigm this project investigated cue usage resulting from the announcement of earnings and the issuance of financial statements. The information cues investigated consisted of:

current ratio

quick ratio

defensive interval

debt to equity ratio

long term debt to equity ratio

times interest earned

rate of return on total assets

earnings to sales ratio

primary earnings per share

rate of return on stockholder's equity

total asset turnover

accounts receivable turnover

inventory turnover

These cues represent four underlying dimensions of a firm. These dimensions are liquidity, leverage, profitability, and activity. Simultaneous equations techniques were used to estimate the parameters and test a hypothesized causal configuration developed in Chapter III.

The hypothesized model consists of two components; a measurement model and a structural model. The measurement model hypothesized that the expectation errors regarding the financial ratios are multiple indicators of the expectation errors for the corresponding financial dimensions. Presuming each dimension to be useful to the investor, the structural model causally linked each dimension's error to measures of abnormal return and abnormal volume.

A test of model fit indicated that the model was not an adequate representation of the underlying process. Further analysis indicated that the measurement model was misspecified. A number of measurement model configurations were investigated but none were found adequate. The measurement model was eliminated and each ratio was treated as a specific attribute of the firm.

A saturated structural model linking each of the ratios to market reactions was estimated and tested. Further exploratory analysis was conducted and a representative model was found. This model had a very high level of fit ($p = .9972$).

Throughout the various causal configurations analyzed the most important cue was the primary earnings per share datum. Other profitability measures as well as measures of liquidity and leverage were found to be significant. This indicates that investors may utilize other data but earnings per share is most important. It is also consistent with the common stock valuation models. The traditional form of valuation is to discount the future earnings stream. For an individual share of stock, the important parameter is earnings per share. Employment of this type of valuation model by the market would suggest that earnings per share data is useful. The results of this study uphold the usefulness of earnings per share data.

The most important causal link driving a volume reaction is the abnormal price reaction. This link was found to be the most significant parameter in most of the model configurations.

Conclusions

The conclusions drawn from this study are threefold. The expectation errors of the financial ratios do not seem to be indicators of the expectation errors of the four financial dimensions of a firm. Instead, each ratio seems to represent a unique attribute to the firm. Second, while liquidity, leverage, and profitability information is useful to the investor, the most important financial datum is the earnings per share figure. The third conclusion is abnormal returns play a very important role in the causal configuration for abnormal volume. In the saturated model, the abnormal return accounted for eleven per cent of the variation in abnormal volume when a saturated model without this link had an r^2 of only thirteen per cent.

Assuming abnormal trading activity is an indicator of degree of consensus within the market regarding an information event, a very unique relationship is evident. "Good news" regarding earnings per share is accompanied by a positive abnormal return and positive abnormal trading volume. "Bad news" regarding earnings per share results in a negative abnormal return and negative abnormal trading volume. The signs of the price reaction by the market are as expected. However, the accompanying trading activity implies that "bad news" is interpreted with a high degree of consensus. "Good news" is not interpreted with a high degree of consensus and abnormal volume indicates this lack of consensus. An asymmetric process regarding the interpretation of information is implied by these results.

Implications

The results of this study have two major implications. In the realm of policy setting this study contributes to the understanding of accounting as an information system and the interaction of that system with investors. For the most part, profitability information seems to have the most significant use by investors. The primary earnings per share datum was most important. This upholds the emphasis that has been placed on the income statement by policy making boards. There are two plausible explanations regarding why the market fails to use information cues regarding liquidity, leverage and activity to the same extent as the profitability cues. One explanation is that the quality of the accounting information from the balance sheet may be inadequate due to the standard setting emphasis on the income statement. The second possible reason may be that the other cues do not have a stochastic relationship with future cash flows which is necessary for a cue to have any potential usefulness (See Chapter II .

The results of this project also have implications to research on abnormal returns and abnormal volume. When abnormal returns are investigated, the use of the earnings per share cue is required. More flexibility is allowed for volume studies since profitability cues other than earnings per share are used by investors.

An analysis of the standard errors associated with the structural coefficients linking abnormal returns and abnormal volume to the expectation errors for primary earnings per share indicates that the standard error is larger for the former. This implies that a more rigorous test of information content or cue usage results from using abnormal returns. However, in instances where the effect of the cue is expected to be weak the use of abnormal volume is advocated. In the fourteen models estimated,

where x is fixed, the proportion of variation accounted for is always higher for abnormal volume. This indicates that volume is a more sensitive measure of market reaction to information events.

Investigations of abnormal volume reactions due to the announcement of earnings should include the causal link between abnormal volume and abnormal returns. Given the significant link between abnormal volume and abnormal price the direct effect of a cue on volume could be insignificant but the indirect effect, through the abnormal return and its link to abnormal volume, significant. The results of the effect analysis reported in Chapter V indicate this composition of direct and indirect causal links.

This research project has demonstrated that simultaneous exploration of both price and volume reactions is fruitful. Given the relationship between abnormal volume and abnormal returns, a simultaneous approach is warranted.

Recommendations for Future Research

In studies of cue utilization using the abnormal performance index research paradigm one assumes that the expectation models employed are valid representations of the underlying investor process. Failure to find significant evidence of cue utilization may be symptomatic of an invalid expectation model. Therefore, future replication of this study using other expectation models could ascertain the degree to which the results of this study are contingent on the expectation model employed.

Other financial variables not included in this study could be explored as well as other dimensions. Improvement of the measurement model is recommended for future research.

This project used a four month reaction period which incorporates more noise into the reaction measures. An approach which would eliminate

some of the noise would be to shorten the reaction periods around the release of the financial data.

APPENDICES

Appendix A

LISREL terminology

Types of Variables

η (eta)	Dependent (endogenous) variable: true (i.e., unobserved)
ξ (xi)	Independent (exogenous) variable: true (i.e., unobserved)
y	Indicator of dependent variable (observed)
x	Indicator of independent variable (observed)
ϵ	Measurement error in observed dependent variable
δ	Measurement error in observed independent variable
ζ	Sources of variance in η not included among the ξ 's

Counts

m	Number of true dependent variables
n	Number of true independent variables
p	Number of observed dependent variables
q	Number of observed independent variables

Data-oriented Matrices

$\underline{S}$	$(p+q \times p+q)$, Variance-covariance matrix among the observed independent and dependent variables (or correlation matrix)
$\underline{\Sigma}$ (sigma)	$(p+q \times p+q)$, Model-generated estimates of variances and covariances among observed independent and dependent variables

Basic Parameter Matrices

$\underline{\Lambda}_y$ (lambda)	$(p \times m)$, Matrix of regression coefficients (λ 's) relating true dependent variables to observed dependent variables
$\underline{\Lambda}_x$ (lambda)	$(q \times n)$, Matrix of regression coefficients (λ 's) relating true independent variables to observed independent variables

<u>B</u> (beta)	(m x m), Matrix of regression coefficients interrelating true dependent variables
<u>Γ</u> (gamma)	(m x n), Matrix of regression coefficients (Y's) relating true independent variables to true dependent variables; indicates direct effect
<u>Φ</u> (phi)	(n x n), Variance-covariance matrix among true independent variables (or correlation matrix)
<u>Ψ</u> (psi)	(m x m), Variance-covariance matrix among zeta variables (or correlation matrix)
<u>Θ_ε</u> (theta)	(p x p), Variance-covariance matrix among epsilon variables (or correlation matrix)
<u>Θ_δ</u> (theta)	(q x q), Variance-covariance matrix among delta variables (or correlation matrix)

Supplementary Parameter Matrices

<u>C</u>	(m x m), Variance-covariance matrix among true dependent variables
<u>D</u>	(m x n), Matrix of regression coefficients for reduced form of structural equations--i.e., coefficients which relate each true dependent variables to true independent variables, giving direct and indirect effects combined

Appendix B

χ^2 test in the analysis of covariance structures (Bentler and Bonett, 1980)

Let M_k be a more restrictive model than M_t . In general, the function $L(\theta)$ is related to the logarithm of the likelihood function of the observations via

$$L^*(\theta) = -n L(\theta)/2 + c$$

where c is independent of θ . (See Joreskog: Psychometrika, 1967, 32, 443-482).

Let $L^*(\theta_k)$ be the maximum of $L^*(\theta)$ under M_k ; let $L^*(\theta_t)$ be the maximum of $L^*(\theta)$ under M_t . Thus

$$L^*(\theta_k) \leq L^*(\theta_t)$$

since the maximum under a space of restricted range cannot exceed the maximum under a space of less restricted range.

Consequently,

$$\log \lambda = L^*(\theta_k) - L^*(\theta_t)$$

is negative, with $0 < \lambda \leq 1$.

To test the null hypothesis of model equivalence ($H_0: \theta_k = \theta_t$), $(-2 \log \lambda)$ is asymptotically distributed as a chi square variate.

The degrees of freedom is the difference in the number of parameters estimated under M_t and M_k . This test is a test of the equality of the parameters under the two models. Since the free parameters in θ_k are a subset of the free parameters in θ_t , various applications of the test can be constructed.

The null hypothesis associated with model comparisons has an alternative form. The alternative is that the covariance matrices

generated by the parameter vectors are equivalent under the M_k and M_t structural models. The significance test is the same as previously described.

Appendix C

Sample Firms

ACF Industries
Alaska Interstate
Alpha Portland
Allen Group
Amax
Amerada Hess
American Cyanamid
American District Telephone
American Water Works
AMETEX
AMF
Ampco Pittsburgh
Armada Corp.
Asarco
Avon
Ball Corp
Baxnes Group
Becker Industries
Bell & Howell
Bemis
B.F. Goodrich
Big Three Inds.
Blair, John
Bliss Laughlin
Boeing
Borg Warner
Baxter Travenol Labs.
Braniff
Brockway Glass
Brunswick
Burndy
Codence Industries
Carlisle
Callahan Mining
Capital Cities Communications
CBS
Charter
Cheseborough Pond
Chrysler
Cluett Peabody
Coca Cola, NY
Colgate Palmolive
Combustion Engineering
Conrac
Continental Group
Conwood
Cooper Industries
Cordura
CPC Industries
Crouse Hinds

Crown Cork and Seal
Cummins
Curtis Wright
Dennison Dentsply
DeSoto
Dexter
Diamond International
Drehold
DiGiorgio
Donnelly
Dorsey
Dow Chemicals
Eaton
Easco
EG&G
Emhart
Fairchild Industries
Federal Mogul
Federal Signal
Fieldcrest Mills
Fischer Scientific
FMC
Ford Motor
Fort Howard Paper
Foster Wheeler
Fruehauf
GATX
Gateway Industries
General Dynamics
General Motors
Genearl Signal
Genstar
G.F. Business Equipment
Giddings Lewis
Gifford Hill
Gillette
Ginas
Gleason Works
Goodyear Tire
Greyhound
Grumman
Gulf Research and Chemical
Hanna Mining
Harcourt Brace & Jovanovich
Hazeltime
Heileman Brewing
Hershey
Hesston
Homestake Mining
Host

Hospital Corp. of America	Robins, A.H.
Hudson Bay Mining	Rubbermaid
I.C. Industries	Ryder System
Illinois Tool Works	Saint Joe Minerals
Inexco Oil	Schaefer, F.M.
Ingredient Technology	Scheving Plough
International Flavors	Schlitz
I.U. International Corp.	Sealed Power
Johnson & Johnson	Searle, G.D.
Jorgensen, Earle	Sherwin Williams
Kane Miller	Signal
Kellogg	Signode
Kerr McGee	Simmonds Precision
Kennecott Copper	Smith International
Knight Ridder	Southland
Lamson Sessions	Southwest Industries
Lenox Lilly, Eli	SPS Technologies
Lionel	Standard Brands
LTV Corp.	Stanley Works
Lynch Communications	Stone Container
Masco	Sun Chemical
McNeil Corp.	Sunstrand
MEI Corp.	Swank
Melville	Sybron
Mesta Machine	Teleprompter
Mirro	Thiokol
Mohasco	Thomas & Betts
Mohawk Rubber	Thomas Industries
Monarch Machine Tool	Time, Inc.
Moore McCormack	Times Mirror
Morrison Knudson	Transway International
Munsingwear	TRW
Myers	Tyler Corp.
Nashua	UMC Industries
National Can	United Refining
National City Lines	United Technologies
National Gypsum	Upjohn
North American Coal	U.S. Industries
North American Phillips	VF Corporation
Northrop	Wallace Murray
Norton	Warner Communications
Nucor	Warner Lambert
Oak Industries	Wayne Gossard
Oakite Products	Wean Limited
Occidental Petroleum	Wheelabrator Frye
Ogden	Whirlpool
Phelps Dodge	White Motor
Pitney Bowes	Witco Chemical
Porter	Wrigley
Potlatch	WR Grace
Reichhold Chemical	
Revere Copper & Brass	
Revlon	
Robertson, H.H.	

Appendix D

Parameter specifications for hypothesized model

$\underline{\Lambda}_x$	ξ_1	ξ_2	ξ_3	ξ_4
x_1	1	0	0	0
x_2	2	0	0	0
x_3	3	0	0	0
x_4	0	4	0	0
x_5	0	5	0	0
x_6	0	6	0	0
x_7	0	0	7	0
x_8	0	0	8	0
x_9	0	0	9	0
x_{10}	0	0	10	0
x_{11}	0	0	0	11
x_{12}	0	0	0	12
x_{13}	0	0	0	13

$\underline{\beta}$
0
14
0

$\underline{\Gamma}$
15
16
17
18
19
20
21
22

$$\begin{array}{c}
 \begin{array}{cccc}
 & \varepsilon_1 & \varepsilon_2 & \varepsilon_3 & \varepsilon_4 \\
 \varepsilon_1 & \left[\begin{array}{c} 0 \\ 23 \\ 24 \\ 26 \end{array} \right] & & & \\
 \varepsilon_2 & & \left[\begin{array}{c} 0 \\ 25 \end{array} \right] & & \\
 \varepsilon_3 & & & \left[\begin{array}{c} 0 \\ 28 \end{array} \right] & \\
 \varepsilon_4 & & & & \left[\begin{array}{c} 0 \end{array} \right]
 \end{array}
 \end{array}
 \quad
 \begin{array}{c}
 \underline{\Psi} \\
 \left[\begin{array}{cc} 29 & \\ 0 & 30 \end{array} \right]
 \end{array}$$

$$\begin{array}{c}
 \begin{array}{cccccccccccccccc}
 & \begin{array}{c} \theta \\ -\delta \end{array} & x_1 & x_2 & x_3 & x_4 & x_5 & x_6 & x_7 & x_8 & x_9 & x_{10} & x_{11} & x_{12} & x_{13} \\
 x_1 & \left[\begin{array}{c} 31 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{array} \right] & & & & & & & & & & & & & \\
 x_2 & & \left[\begin{array}{c} 32 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{array} \right] & & & & & & & & & & & & \\
 x_3 & & & \left[\begin{array}{c} 33 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{array} \right] & & & & & & & & & & & \\
 x_4 & & & & \left[\begin{array}{c} 34 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{array} \right] & & & & & & & & & & \\
 x_5 & & & & & \left[\begin{array}{c} 35 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{array} \right] & & & & & & & & \\
 x_6 & & & & & & \left[\begin{array}{c} 36 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{array} \right] & & & & & & & & \\
 x_7 & & & & & & & \left[\begin{array}{c} 37 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{array} \right] & & & & & & & & \\
 x_8 & & & & & & & & \left[\begin{array}{c} 38 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{array} \right] & & & & & & & & \\
 x_9 & & & & & & & & & \left[\begin{array}{c} 39 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{array} \right] & & & & & & & & \\
 x_{10} & & & & & & & & & & \left[\begin{array}{c} 40 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{array} \right] & & & & & & & & \\
 x_{11} & & & & & & & & & & & \left[\begin{array}{c} 41 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{array} \right] & & & & & & & & \\
 x_{12} & & & & & & & & & & & & \left[\begin{array}{c} 42 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{array} \right] & & & & & & & & \\
 x_{13} & & & & & & & & & & & & & \left[\begin{array}{c} 43 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{array} \right]
 \end{array}
 \end{array}$$

Appendix E

Parameter specifications for hypothesized measurement model

Λ_x	ξ_1	ξ_2	ξ_3	ξ_4
x_1	1	0	0	0
x_2	2	0	0	0
x_3	3	0	0	0
x_4	0	4	0	0
x_5	0	5	0	0
x_6	0	6	0	0
x_7	0	0	7	0
x_8	0	0	8	0
x_9	0	0	9	0
x_{10}	0	0	10	0
x_{11}	0	0	0	11
x_{12}	0	0	0	12
x_{13}	0	0	0	13

Φ	ξ_1	ξ_2	ξ_3	ξ_4
ξ_1	0			
ξ_2	14	0		
ξ_3	15	16	0	
ξ_4	17	18	19	0

[illegible]

Appendix F

Parameter specifications for measurement model M_2

$\underline{\Lambda}_x$	ξ_1	ξ_2	ξ_3	ξ_4	ξ_5	ξ_6	ξ_7
x_1	1	0	0	0	0	0	0
x_2	2	0	0	0	0	0	0
x_3	0	(1.0)	0	0	0	0	0
x_4	0	0	(1.0)	0	0	0	0
x_5	0	0	0	(1.0)	0	0	0
x_6	0	0	0	0	(1.0)	0	0
x_7	0	0	0	0	0	3	0
x_8	0	0	0	0	0	4	0
x_9	0	0	0	0	0	5	0
x_{10}	0	0	0	0	0	6	0
x_{11}	0	0	0	0	0	0	7
x_{12}	0	0	0	0	0	0	8
x_{13}	0	0	0	0	0	0	9

$\underline{\Phi}$	ξ_1	ξ_2	ξ_3	ξ_4	ξ_5	ξ_6	ξ_7
ξ_1	0						
ξ_2	10	0					
ξ_3	11	12	0				
ξ_4	13	14	15	0			
ξ_5	16	17	18	19	0		
ξ_6	20	21	22	23	24	0	
ξ_7	25	26	27	28	29	30	0

$\underline{\Theta}_\delta$

Appendix G

Parameter specifications for prediction model P_1

	ξ_1	ξ_2	ξ_3	ξ_4	ξ_5	ξ_6	ξ_7
Equation 1	10	11	12	13	14	15	16
Equation 2	17	18	19	20	21	22	23

	Equation 1	Equation 2
Equation 1	45	
Equation 2	0	46

Appendix H

Parameter specifications for prediction model P_2

<u>β</u>		η_1	η_2					
Equation 1	$\begin{bmatrix} (1.0) \\ 10 \end{bmatrix}$							
Equation 2		(1.0)						
<u>Γ</u>		ξ_1	ξ_2	ξ_3	ξ_4	ξ_5	ξ_6	ξ_7
Equation 1	$\begin{bmatrix} 11 & 12 & 13 & 14 & 15 & 16 & 17 \\ 18 & 19 & 20 & 21 & 22 & 23 & 24 \end{bmatrix}$							
Equation 2								
<u>Ψ</u>		Equation 1	Equation 2					
Equation 1	$\begin{bmatrix} 46 \\ 0 \end{bmatrix}$							
Equation 2			47					

Appendix J

Parameter specifications for prediction model P_4

$\underline{\beta}$		η_1	η_2					
Equation 1	$\left[\begin{array}{c} 1.0 \\ 17 \end{array} \right]$		$\left[\begin{array}{c} \\ 1.0 \end{array} \right]$					
Equation 2								
$\underline{\Gamma}$		ξ_1	ξ_2	ξ_3	ξ_4	ξ_5	ξ_6	ξ_7
Equation 1	$\left[\begin{array}{c} 18 \\ 22 \end{array} \right]$	19	20	0	0	21	$\underline{\begin{array}{c} 0 \\ 0 \end{array}}$	
Equation 2		23	0	0	24	25		
$\underline{\Psi}$		Equation 1	Equation 2					
Equation 1	$\left[\begin{array}{c} 47 \\ 0 \end{array} \right]$		$\left[\begin{array}{c} \\ 48 \end{array} \right]$					
Equation 2								

Appendix K

Lower left triangle of correlation matrix for coefficients of saturated model: Fixed X - Model 14

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	γ_{21}	γ_{11}	γ_{12}	γ_{13}	γ_{14}	γ_{15}	γ_{16}	γ_{17}	γ_{18}	γ_{19}	γ_{110}	γ_{111}	γ_{112}	γ_{113}	γ_{21}	γ_{22}	γ_{23}	γ_{24}
γ_{21}	1.000																	
γ_{11}	-.000	1.000																
γ_{12}	.000	-.792	1.000															
γ_{13}	-.000	.122	-.392	1.000														
γ_{14}	.000	.351	.043	-.332	1.000													
γ_{15}	-.000	-.258	-.137	.286	-.696	1.000												
γ_{16}	-.000	-.110	.111	-.170	.028	-.026	1.000											
γ_{17}	.000	.116	-.081	.010	.225	-.136	-.297	1.000										
γ_{18}	-.000	-.108	.201	-.134	-.029	-.018	.246	-.734	1.000									
γ_{19}	-.000	.003	-.150	.106	-.239	.373	-.037	-.298	-.067	1.000								
γ_{110}	-.000	.043	-.018	-.035	.013	-.034	.118	-.416	.102	.049	1.000							
γ_{111}	.000	-.093	-.064	.650	-.270	.188	-.094	-.118	.083	.023	-.063	1.000						
γ_{112}	-.000	-.218	.294	-.131	.064	-.105	.131	-.250	.189	-.048	.033	-.183	1.000					
γ_{113}	-.000	.256	-.266	-.117	.086	-.059	.156	-.203	.708	.015	.156	-.403	-.038	1.000				
γ_{21}	-.058	-.000	.000	-.000	-.000	.000	.000	-.000	.000	.000	.000	.000	-.000	-.000	1.000			
γ_{22}	-.027	.000	-.050	.000	-.000	.000	-.000	.000	-.000	.000	-.000	.000	-.000	.000	-.792	1.000		
γ_{23}	.074	-.000	.000	-.000	.000	-.000	.000	.000	-.000	-.000	-.000	-.000	.000	-.000	.117	-.389	1.000	
γ_{24}	.075	-.000	-.000	.000	-.000	.000	-.000	.000	-.000	-.000	-.000	.000	-.000	-.000	.343	.047	-.375	1.000
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	γ_{21}	γ_{11}	γ_{12}	γ_{13}	γ_{14}	γ_{15}	γ_{16}	γ_{17}	γ_{18}	γ_{19}	γ_{110}	γ_{111}	γ_{112}	γ_{113}	γ_{21}	γ_{22}	γ_{23}	γ_{24}
γ_{25}	-.033	.000	.000	-.000	.000	-.000	.000	.000	.000	-.000	.000	-.000	.000	.000	.233	-.136	.282	-.686
γ_{26}	-.029	.000	-.000	.000	-.000	.000	-.000	.000	-.000	.000	-.000	.000	-.000	-.000	-.108	.110	-.172	.026
γ_{27}	.101	-.000	.000	-.000	-.000	.000	.000	-.000	.000	-.000	.000	.000	.000	.000	.110	-.077	.017	.231
γ_{28}	-.048	.000	-.000	.000	.000	.000	-.000	.000	-.000	.000	-.000	-.000	-.000	-.000	-.105	.200	-.137	-.032
γ_{29}	.148	-.000	.000	-.000	.000	-.000	-.000	.000	-.000	-.000	-.000	-.000	.000	-.000	-.003	-.145	.110	-.225
γ_{210}	-.112	-.000	-.000	.000	-.000	.000	.000	.000	.000	.000	-.000	.000	-.000	.000	.050	-.021	-.043	.004
γ_{211}	.014	.030	.000	-.000	.000	-.000	.000	.000	-.000	-.000	.000	-.000	.000	.000	-.094	-.063	.649	-.769
γ_{212}	-.058	.000	-.000	.000	-.000	.000	-.000	.000	-.000	.000	-.000	.000	-.000	.000	-.213	.292	-.135	.059
γ_{213}	-.053	-.000	.000	.000	-.000	.000	-.000	.000	-.000	.000	-.000	.000	-.000	-.000	.258	-.267	-.121	.081
	19	20	21	22	23	24	25	26	27									
	γ_{25}	γ_{26}	γ_{27}	γ_{28}	γ_{29}	γ_{210}	γ_{211}	γ_{212}	γ_{213}									
γ_{25}	1.000																	
γ_{26}	-.025	1.000																
γ_{27}	-.139	-.298	1.000															
γ_{28}	-.016	.247	-.743	1.000														
γ_{29}	.314	-.041	-.278	-.093	1.000													
γ_{210}	-.030	.121	-.423	.107	.031	1.000												
γ_{211}	.148	-.094	-.116	.032	.025	-.064	1.000											
γ_{212}	-.105	.132	-.255	.191	-.056	.069	-.183	1.000										
γ_{213}	-.037	.158	-.209	.210	.007	.161	-.403	-.035	1.000									

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