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Chapter Title: Consensus, Accuracy, and Completeness of the Earnings Growth Forecasts

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2 Consensus, Accuracy, and Completeness of the Earnings Growth Forecasts

We study in this chapter the nature of the forecasts made by security analysts that were described in chapter 1. To do so we look at three questions: (*a*) To what extent are the forecasts of different analysts similar to each other and to forecasts that might be produced by some explicit, "objective" methods? (*b*) How accurate are the forecasted growth rates when compared with the quantities that were later realized? (*c*) Are the forecasts complete in the sense that they use all information which should have been readily available to the forecasters when they formulated their predictions? This last question is related to whether we can reasonably consider the forecasts to represent "rational" expectations. Relative to many investigations of expectations in other fields,[1] this study is characterized by having comparatively few predictors and by covering predictions made over a period of slightly less than a decade. This is balanced, however, by the study's access to a large number of forecasts from each predictor.

2.1 Importance of a Study of Growth Forecast Accuracy

Financial theorists have emphasized for years the importance of expectational variables in the valuation of common stocks. Accordingly the price of a share should be determined primarily by investors' current expectations about the firm's future performance and profitability, particularly the anticipated growth rate of earnings and dividends per share. Modern financial literature emphasizes the link between anticipated risk

1. A number of studies of anticipations data have been collected by Zarnowitz (1967). Some more recent work on the assessment of expectations or forecasts has been done by Mincer (1969), Pesando (1975), Pearce (1978), and Friedman (1980).

and return; and the capital-asset pricing model, developed by Sharpe (1964), Lintner (1965), and Mossin (1966), has become a widely used approach to security valuation. Central to this approach is expected return, even though its nature has not been stressed. Empirical studies of price-earnings ratios of common stocks (including those described in chapter 4) find that the most important explanatory variables are expectational ones, especially those measuring the anticipated future growth rate of the corporation.[2] Other empirical investigators who have studied the determination of stock-price changes have similarly put heavy emphasis on the importance of variables measuring the growth of the firm. For example, Nerlove (1968) found that two of the most important variables explaining differences in the actual price performance of individual common stocks over both short and long periods were the growth of sales and earnings and the retention of earnings, which is related to future growth. Nerlove's results suggest that growth forecasts are needed in order to predict differential returns from individual common stocks.

This analytical emphasis is matched by efforts in the financial community of security analysts to forecast the future earnings and dividends and to judge the risk levels of the companies they study. Thus financial theorists, practitioners, and empirical researchers all agree on the importance of these expectational inputs in determining the prices of common stocks. A study of growth forecasts would seem to be of critical importance in understanding how capital markets value different securities.

2.2 Agreement among Predictors

The extent to which the different growth-rate projections are in agreement is described and summarized in this section. As chapter 1 explained, the growth forecasts estimated by security analysts are of two types: (*a*) long-run forecasts representing the anticipated average annual rate of growth expected to occur over the next five years, and (*b*) forecasts of earnings per share for the following year. We converted the latter into one-year percentage rates of growth by using the average "normalized" earnings estimates of the analysts as a common base.

Forecasts of long-term growth made by nine predictors were available during the 1961–65 period while eleven forecasters provided short-term growth estimates. However, data were not available from each forecaster in each of the five years, and ten of the eleven forecasters of short-term

2. The classic statement of the anticipations view of the determination of share valuation may be found in Williams (1938). This position is also adopted in the standard textbook in the field, Graham et al. (1962). The emphasis on the importance of earnings growth may also be found in Gordon (1962), Holt (1962), and Malkiel (1963).

growth were different from the forecasters of long-term growth. More limited numbers of forecasts were available for the period 1966–69.

The question of the extent of agreement among predictors is important in the development of the capital-asset pricing model. It has been usual in that literature to assume that all market participants have identical expectations concerning all security returns. Similarly, most economic theories that embody expectations, including most of the "rational expectations" literature, implicitly assume that all participants hold the same expectations. Our data make possible for the first time an examination of this assumption with respect to predictions formed for judging the values of common stocks.

2.2.1 Comparisons of Different Predictions

We start by considering the extent of agreement between each pair of predictors with respect to the relative growth prospects of companies by calculating correlation and rank correlation coefficients. These measures ignore any disagreements concerning the expected overall average rates of growth or concerning dispersion of growth rates among companies.

Table 2.1 gives the correlations among the long-term growth predictions. Below the main diagonals of the table we report the product-moment correlations; we present the Spearman rank correlations above the diagonals. Each correlation is based on all the observations (companies) available for each pair of forecasters. Correlations are calculated in the usual way. The correlation matrix with elements consisting of these separate correlations need not be positive definite. Only results for the

Table 2.1 Agreement among Long-Term Growth Predictors

	1961					
Predictor	1	2	3	6	8	
1	***	.78	.87	.83	.81	
2	.82	***	.67	.58	.74	
3	.95	.79	***	.93	.76	
6	.90	.77	.97	***	.71	
8	.85	.73	.74	.76	***	
	1962					
Predictor	1	2	4	5	6	7
1	***	.78	.75	.39	.73	.70
2	.85	***	.74	.61	.82	.80
4	.89	.82	***	.69	.82	.61
5	.57	.63	.85	***	.72	.44
6	.83	.86	.86	.77	***	.67
7	.84	.86	.83	.67	.82	***

Table 2.1 (continued)

1963							
Predictor	1	2	3	4	5	6	7
1	***	.81	.70	.72	.38	.69	.80
2	.84	***	.81	.76	.54	.75	.82
3	.83	.83	***	.75	.45	.86	.70
4	.85	.76	.89	***	.75	.81	.74
5	.55	.57	.71	.90	***	.76	.57
6	.79	.77	.89	.88	.88	***	.72
7	.88	.85	.83	.83	.66	.76	***

1964									
Predictor	1	2	3	4	5	6	7	8	9
1	***	.79	.73	.71	.76	.77	.63	.77	.66
2	.83	***	.76	.86	.77	.83	.66	.79	.78
3	.90	.91	***	.77	.79	.77	.67	.69	.83
4	.83	.87	.95	***	.62	.77	.49	.69	.61
5	.86	.86	.81	.84	***	.71	.72	.79	.66
6	.76	.79	.77	.85	.86	***	.70	.73	.58
7	.48	.52	.82	.64	.81	.73	***	.62	.66
8	.91	.90	.92	.89	.85	.79	.82	***	.67
9	.81	.89	.93	.81	.83	.63	.76	.88	***

1965									
Predictor	1	2	3	4	5	6	7	8	9
1	***	.72	.63	.64	.74	.75	.52	.78	.53
2	.80	***	.79	.80	.78	.80	.64	.73	.68
3	.84	.89	***	.79	.79	.81	.67	.73	.73
4	.82	.87	.94	***	.72	.79	.82	.67	.71
5	.84	.85	.80	.86	***	.77	.66	.66	.49
6	.78	.77	.79	.87	.83	***	.66	.69	.66
7	.47	.46	.79	.84	.50	.71	***	.49	.62
8	.90	.88	.91	.90	.82	.76	.81	***	.54
9	.90	.88	.97	.95	.90	.88	.92	.91	***

NOTE. Simple correlations in lower left, Spearman rank correlations in upper right.

years 1961 through 1965 are shown because of the limited numbers of forecasters available in later periods. Table 2.2 presents the corresponding figures for the short-term predictors. In the tables the long-term predictors are numbered 1 through 9 while the short-term predictors are designated *A* through *K*. This serves to emphasize that the short- and long-term predictors are not the same.

Tables 2.1 and 2.2 do suggest considerable consensus. The correlations are generally significantly different from zero well beyond conventionally used significance levels. However, the lack of agreement they reveal is substantial and possibly more striking. Agreement tended to be greatest among the long-term predictors, but the average correlation coefficient was only about three-fourths. This suggests that only half the variance in one individual's predictions can typically be "explained" by agreement with those of another. Agreement was substantially less among the short-term predictors. Even ignoring predictor E, which made comparatively few forecasts and showed a tendency toward lower agreement, the average pairwise correlation coefficient was not much above one-half.

No great differences are evident when rank correlations are used rather than product-moment ones. The rank correlations may be aggregated

Table 2.2 **Agreement among Predictors of Short-Term Growth Rates**

1961

Pred.	*A*	*B*	*C*	*D*	*E*	*G*	*H*	*I*	*K*
A	***	.51	.71	.80	.48	.72	.67	.66	.68
B	.67	***	.54	.67	.54	.53	.85	.62	.59
C	.71	.69	***	.61	.41	.52	.49	.55	.52
D	.74	.83	.76	***	.65	.53	.80	.81	.73
E	.48	.45	.39	.83	***	.37	.71	.48	.74
G	.61	.78	.57	.82	.65	***	.35	.62	.54
H	.54	.92	.50	.77	.71	.39	***	.55	.61
I	.71	.79	.70	.81	.48	.78	.63	***	.70
K	.69	.80	.78	.86	.80	.71	.62	.77	***

1962

Pred.	*A*	*B*	*C*	*D*	*E*	*G*	*H*	*I*	*K*
A	***	.68	.57	.56	.15	.33	.81	.69	.51
B	.91	***	.36	.49	.03	.44	.54	.52	.63
C	.43	.71	***	.57	.07	.44	.64	.61	.61
D	.49	.72	.70	***	.26	.34	.44	.62	.54
E	.03	−.04	.15	.12	***	.33	.47	.27	.47
G	.54	.80	.73	.54	.67	***	.56	.55	.35
H	.82	.63	.69	.39	.13	.61	***	.59	.49
I	.75	.76	.77	.49	.13	.74	.74	***	.49
K	.79	.95	.86	.73	.75	.68	.55	.78	***

1963

Pred.	*A*	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*K*
A	***	.69	.53	.56	.27	.62	.62	.81	.67	.70
B	.85	***	.45	.34	.17	.69	.58	.65	.66	.76
C	.55	.57	***	.28	.36	.44	.66	.58	.48	.66
D	.58	.17	.44	***	.26	.67	.48	.65	.55	.55
E	.49	−.03	.25	.53	***	−.25	.53	.33	.49	.41
F	.57	.83	.64	.72	−.29	***	.59	.82	.67	.74
G	.71	.85	.79	.50	.70	.71	***	.70	.64	.75
H	.91	.62	.68	.69	.43	.85	.81	***	.77	.76
I	.74	.88	.61	.64	.68	.80	.73	.88	***	.70
K	.60	.79	.70	.51	.63	.74	.84	.73	.80	***

Table 2.2 (continued)

1964										
Pred.	*A*	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*K*
A	***	.82	.60	.82	.19	.82	.51	.78	.48	.76
B	.89	***	.47	.64	.55	.79	.53	.78	.57	.80
C	.48	.75	***	.49	.81	.50	.45	.55	.43	.78
D	.75	.79	.61	***	.09	.73	.68	.72	.58	.77
E	.25	.31	.25	.17	***	.28	.36	.13	.29	.55
F	.48	.89	.67	.81	.24	***	.49	.71	.55	.68
G	.42	.75	.73	.74	.34	.70	***	.60	.63	.53
H	.91	.81	.72	.82	−.11	.77	.80	***	.70	.62
I	.50	.80	.88	.78	.46	.72	.78	.86	***	.65
K	.54	.88	.89	.85	.52	.80	.62	.75	.85	***

1965											
Pred.	*A*	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*K*
A	***	.84	.69	.51	.53	.71	.65	.82	.65	.72	.71
B	.93	***	.67	.57	.46	.77	.78	.69	.84	.79	.82
C	.47	.80	***	.61	.86	.67	.71	.83	.63	.75	.82
D	−.06	.61	.48	***	.41	.54	.71	.80	.70	.62	.71
E	.53	.76	.85	.54	***	.54	.48	.52	.66	.01	.74
F	.64	.84	.71	.39	.69	***	.64	.80	.78	.92	.88
G	.31	.80	.47	.69	.47	.58	***	.89	.81	.81	.86
H	.86	.86	.89	.85	.50	.82	.83	***	.86	.72	.90
I	.28	.90	.66	.65	.62	.58	.83	.80	***	.60	.86
J	.94	.92	.74	.86	−.01	.97	.87	.84	.85	***	.87
K	.44	.89	.87	.64	.56	.91	.88	.93	.88	.91	***

NOTE. Simple correlation coefficients in lower left, Spearman rank correlations in upper right.

using Kendall's coefficient of concordance (W).[3] Values for this statistic are reported in table 2.3 for selected groups of long- and short-term predictors where substantial overlap occurred in the companies covered. This table reveals on a simultaneous, nonparametric basis much the same results as those shown by the correlations. Agreement certainly is present, but it is far from being complete. Possibly surprisingly, the short-term concordances are typically not much smaller than the long-term ones.

A rather different way of looking at the agreement among predictors is to see how much of the variation in one forecaster's predictions can be associated with those of the other predictors as a group. Doing so sensibly requires use only of the companies for which all the predictors being

3. Kendall's W is a statistic measuring the amount of association among several rankings. It varies between zero (no association) and unity (perfect agreement). It can be expressed as a linear function of all pairwise Spearman rank correlation coefficients. For further discussion, see, e.g., Siegel (1956, pp. 229–38).

Table 2.3 **Kendall's Coefficient of Concordance for Ranks of Companies by Different Predictors**

A. Long-Term Growth

	Predictors				
Year	(1,2,4)	(1,2,5)	(1,2,4,5)	(1,2,4,5,6)	(1,2,4,5,6,7)
1962	.826	.792	.784	.817	.775
1963	.833	.832	.815	.778	.788
1964	.850	.838	.803	.796	.736
1965	.806	.813	.792	.792	.757

B. Short-Term Growth

	Predictors		
Year	(A,B,C)	(A,B,D)	(A,B,C,D)
1961	.734	.798	.762
1962	.787	.776	.736
1963	.641	.736	.629
1964	.781	.886	.776
1965	.797	.790	.738

compared provided forecasts.[4] Only a limited number of the predictors could be included, and even so the number of companies is severely restricted. The statistic we use is the multiple correlation coefficient R for each predictor with the set of other predictors being compared. The results are presented in table 2.4, which also indicates the predictors that were included in the comparisons and the number of observations that were available.

The values of the multiple correlation coefficients are, of course, higher than those of the simple correlations. Even so, among the long-term predictors they also reveal that each predictor still has a considerable amount of variation that is not associated with the predictions of the others. The most noticeable aspect of the short-term predictions is that now the multiple correlation coefficients are more nearly of the same size as those for the long-term predictions. Correspondingly, the increase in the correlation coefficients obtained by proceeding from the simple to the multiple correlations is comparatively greater for the short-term than for the long-term predictions. This finding is not an artifact of the different observations used. When the simple correlations are calculated using only those companies from which the multiple correlations are calculated, the simple correlation coefficients have much the same values as

4. The fact that the correlation matrices in tables 2.1 and 2.2 need not be (and are not always) positive definite means that we cannot sensibly calculate multiple correlations on the basis of the simple correlations calculated for different companies.

Table 2.4 Multiple Correlations of Predictors with Several Others

A. Long-Term Growth

Pred.	1961	1962	1963	1964	1965
1	.88	.92	.93	.94	.89
2	.84	.89	.88	.94	.93
4	***	.96	.95	.91	.94
5	***	.95	.93	.94	.92
6	.85	.87	.95	.92	.91
7	***	.92	.92	.85	.86
8	.83	***	***	***	***
No. observations	22	27	24	77	101

B. Short-Term Growth

Pred.	1961	1962	1963	1964	1965
A	.76	.93	.77	.95	.92
C	.92	.95	.83	.92	.93
D	.98	.89	.82	.93	.96
G	.92	.89	.93	.95	.95
I	.91	.93	.96	.96	.93
K	.90	.92	.94	.96	.96
No. observations	24	29	28	25	26

NOTE. Table entries are multiple correlations of each predictor with the others listed. *** entries not included in the calculations.

those shown in tables 2.1 and 2.2 and the short-term predictors still tend to be less than the long-term predictors.

The reasons for these findings are not entirely clear. The results suggest that roughly as much common information is used in forming the short-term as the long-term forecasts, but that there appear to be greater differences in how various types of information are combined in the short-term than in the long-term forecasts. We shall investigate in section 2.2.4 below the extent to which these associations may represent some common underlying factors.

Correlation coefficients measure only one aspect of agreement. They ignore any differences in the average levels of forecasts. The average forecasts of the different predictors appeared to be of roughly the same magnitude. However, they did tend to differ significantly from each other, even though the averages of different pairs of predictors were calculated from the companies for which both made forecasts. Significant differences also tended to be found when central tendency was measured by the medians of the observations. These differences are in addition to the lack of agreement indicated by the correlation coefficients and concordances, and strongly support the finding of considerable heterogeneity of expectations.

While we have treated long-term and short-term forecasts as being basically different, one might nevertheless suspect that little difference

Table 2.5 **Correlations of Long- and Short-Term Growth Predictions (1965)**

Pred.	1	2	3	4	5	6	7	8	9
A	.17	.09	.51	.18	.26	.30	.38	.60	.35
B	.60	.64	.73	.74	.65	.71	.62	.63	.71
C	.21	.37	.42	.50	.30	.46	.57	.07	.48
D	.29	.37	.54	.52	.27	.28	.38	.27	.60
E	.38	.42	.66	.85	.53	.61	.64	.45	.09
F	.45	.53	.74	.64	.53	.50	.62	.62	.74
G	.43	.35	.61	.51	.57	.55	.57	.58	.69
H	.30	.34	.34	.44	.13	.32	.58	.42	.57
I	.43	.32	.61	.56	.56	.49	.55	.65	.73
J	.65	.72	.77	.77	.70	.71	.76	.60	.71
K	.57	.52	.53	.64	.65	.65	.78	.50	.52

may be evident in practice. This suspicion is strengthened by noting that only one predictor was able to supply both types of forecast in the same year; other predictors formed either short- or long-term forecasts but not both. Correlating the long- with the short-term predictions bears out this supposition only partially, however. The values for 1965 shown in table 2.5 provide a typical example. The correlation coefficients vary considerably among the pairs of predictors; but on average the values are lower than those found among the short-term predictions, and so a fortiori they are lower than those of the long-term predictors. Thus there is little systematic tendency for the long- and short-term predictions to show close associations.

2.2.2 Changes in Predictions

Our data set allows us to observe changes in predictions over time. This permits us to investigate the extent to which each predictor is influenced by the previous forecasts it made. The correlations are shown in table 2.6.

Table 2.6 **Correlations of Predictions over Time**

A. Long-Term Growth Rates

Year	1	2	3	4	5	6	7	8	9
1961/62	.97	.86	***	***	***	.92	***	***	***
1962/63	.95	.96	***	.96	.82	.91	.97	***	***
1963/64	.97	.87	.94	.89	.73	.97	.71	***	***
1964/65	.96	.89	.99	.93	.95	.95	.90	.98	.88

B. Short-Term Growth Rates

Year	*A*	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*K*
1961/62	.28	.45	.40	.12	.45	***	.29	.02	.32	.46
1962/63	.27	.69	.04	.23	.59	***	.37	.13	.28	.61
1963/64	.65	.49	.37	.33	.62	.44	.39	.26	.37	.45
1964/65	.44	.52	.65	.47	.67	.40	.42	.61	.56	.35

For the long-term growth predictions these correlations were quite high, being generally in excess of 0.9. These values tended to be considerably higher than the correlations with the forecasts made by other predictors at the same time; that is, a forecaster of long-term growth tended to be more in agreement with his own prior views than with those of other predictors.

The correlations over time of the short-term predictions also shown in table 2.6 were typically a great deal smaller than those for the long-term predictions, averaging 0.4. Though there were exceptions, particularly in the case of predictor *E*, the pattern found for the long-term predictors that these correlations over time were generally higher than the contemporaneous correlations with other predictors was far less evident.

These findings raise the question of the extent to which forecasters were in agreement with each other about the *changes* in their forecasts. The correlations for the differences of 1965 predictions from the 1964 ones are shown in table 2.7. They reveal a pattern also present in the other years. In these comparisons the correlations were low for the long-term predictions, suggesting that alterations in the expectations were not all based on information common to all or interpreted similarly. Correlations were much higher among the short-term predictions (re-

Table 2.7 **Correlations of Changes of Predictions (1964–65)**

A. Long-Term Growth Rates

Pred.	1	2	3	4	5	6	7	8	9
1	1.00								
2	.22	1.00							
3	.06	.02	1.00						
4	−.09	.25	.02	1.00					
5	.25	.18	.07	.05	1.00				
6	.05	.21	.09	−.01	.27	1.00			
7	.10	−.02	.10	−.12	−.01	.21	1.00		
8	−.10	.18	.03	−.03	−.12	.06	.07	1.00	
9	−.15	−.05	−.26	.19	.04	−.34	.27	.21	1.00

B. Short-Term Growth Rates

Pred.	*A*	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*K*
A	1.00									
B	.81	1.00								
C	.46	.70	1.00							
D	.17	.38	.39	1.00						
E	.52	.77	.47	.22	1.00					
F	.77	.78	.53	.46	.44	1.00				
G	.37	.53	.19	.48	.33	.25	1.00			
H	.67	.40	.50	.33	.25	.53	.53	1.00		
I	.17	.77	.54	.42	.34	.42	.67	.70	1.00	
K	.78	.87	.88	.39	.59	.83	.51	.71	.87	1.00

versing the pattern found for the predictions themselves) and were comparable in magnitude to the correlations of the forecasts themselves shown in table 2.2.

2.2.3 Industrial Classification and the Predictions

One might suspect that the correlations among the predictors reflect little more than consensus concerning the industries that are expected to grow relatively quickly rather than agreement about the relative rates of growth of firms within industries. This possibility was investigated by decomposing the correlation coefficient into two parts, one due to correlation within industries (r_w) after removing correlation of industry averages, and the other due to correlation among the industry means (r_a). That is,

$$r = r_w + r_a, \tag{2.2-1}$$

where

$$r_w = \frac{\sum_{j=1}^{J} \sum_{i=1}^{N_j} (X_{ij} - \bar{X}_j)(Y_{ij} - \bar{Y}_j)}{\left[\sum_{j=1}^{J} \sum_{i=1}^{N_j} (X_{ij} - \bar{X})^2 \sum_{j=1}^{J} \sum_{i=1}^{N_j} (Y_{ij} - \bar{Y})^2 \right]^{1/2}} \tag{2.2-2}$$

and

$$r_a = \frac{\sum_{j=1}^{J} N_j(\bar{X}_j - \bar{X})(\bar{Y}_j - \bar{Y})}{\left[\sum_{j=1}^{J} \sum_{i=1}^{N_j} (X_{ij} - \bar{X})^2 \sum_{j=1}^{J} \sum_{i=1}^{N_j} (Y_{ij} - \bar{Y})^2 \right]^{1/2}}, \tag{2.2-3}$$

with

X_{ij}, Y_{ij} the ith observations in the jth class (industry),
N_j the number of observations in the jth class,
J the number of classes,
$\bar{X}_j$, $\bar{Y}_j$ the averages within the classes, and
$\bar{X}$, $\bar{Y}$ the overall averages.

This decomposition indicated that agreement concerning industry growth rates is not the major factor accounting for the correlations among the forecasts. The values for 1965 are shown in table 2.8. Entries above the diagonal in that table show the values of r_a using the industrial classification obtained from the participating firms. As a comparison with tables 2.1 and 2.2 shows, only a small part of the correlations among the predictions is due to correlations among the industry means, a pattern not specific just to the year for which results are shown.

The decomposition we have just been considering does not yield the partial correlation coefficient holding industrial classification constant

Table 2.8 Industrial Classification and Forecast Agreement (1965)

A. Long-Term Forecasts

Pred.	1	2	3	4	5	6	7	8	9
1	***	.27	.20	.26	.29	.27	.10	.26	.34
2	.77	***	.30	.30	.36	.34	.14	.29	.36
3	.82	.82	***	.41	.31	.32	.25	.31	.51
4	.83	.83	.91	***	.37	.39	.27	.31	.43
5	.81	.78	.69	.79	***	.33	.16	.20	.34
6	.74	.68	.68	.81	.76	***	.16	.28	.39
7	.47	.40	.73	.79	.44	.71	***	.18	.34
8	.87	.84	.88	.88	.78	.69	.77	***	.29
9	.81	.79	.92	.86	.83	.81	.82	.88	***

B. Short-Term Forecasts

Pred.	*A*	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*K*
A	***	.30	.14	.16	.19	.64	.17	.18	.08	.47	.17
B	.86	***	.61	.51	.56	.52	.49	.56	.40	.66	.44
C	.45	.57	***	.34	.42	.33	.25	.33	.15	.38	.33
D	−.19	.27	.33	***	.24	.33	.37	.38	.22	.64	.42
E	.48	.59	.73	.39	***	.29	.37	.01	.21	.02	.11
F	.65	.71	.55	.22	.71	***	.22	.26	.28	.59	.43
G	.22	.57	.36	.51	.26	.50	***	.35	.29	.46	.32
H	.84	.64	.87	.80	.55	.77	.68	***	.15	.64	.41
I	.23	.83	.63	.55	.52	.44	.69	.77	***	.46	.26
J	.90	.57	.54	.82	.04	.73	.87	.58	.69	***	.50
K	.37	.85	.74	.37	.61	.77	.67	.81	.80	.69	***

NOTE. Values of r_a are above diagonal created by asterisks; values of partial correlations holding industry classification constant are below diagonal.

although the numerator of r_w in equation (2.2-2) is the numerator of that partial correlation coefficient. These partial correlations are shown below the main diagonal in table 2.8. Roughly speaking, they are of the same magnitude as the simple correlations of tables 2.1 and 2.2. Especially in the case of the short-term predictions, they vary extensively across the predictors. This finding again suggests that the forecasters are not all following uniform procedures in arriving at their predictions. Although, in principle, part of this variation might arise from the need to use different sets of companies when comparing different pairs of predictors, equally wide variations appeared when only a common set of companies was used for the comparison.

These findings should not be taken to indicate that there is not a large association between the predictions and the industry classification. The values of R^2 obtained by regressing the predictions on industry dummy variables are shown in table 2.9. They indicate that there are very strong and significant associations. This is a particularly striking feature of the long-term predictions where values above 0.9 occur quite often and all

Table 2.9 **Industrial Classification and Forecast Variation: Values of R^2 for Regressing Growth Rates on Industry Dummies**

A. Long-Term Growth

	Predictor								
Year	1	2	3	4	5	6	7	8	9
1961	.42	.88	.89	***	***	.89	***	.85	***
1962	.77	.87	***	.89	.80	.91	.91	***	***
1963	.78	.85	.82	.89	.83	.90	.92	***	***
1964	.80	.85	.91	.83	.85	.86	.66	.91	.90
1965	.82	.88	.90	.87	.86	.87	.64	.92	.83

B. Short-Term Growth

	Predictor										
Year	*A*	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*K*
1961	.36	.68	.67	***	.56	***	.39	.74	.46	***	.62
1962	.27	.35	.32	.24	.60	***	.34	.22	.18	***	.41
1963	.34	.45	.49	.45	.74	.41	.37	.43	.39	***	.55
1964	.48	.63	.32	.40	.62	.64	.34	.66	.30	***	.49
1965	.24	.79	.48	.68	.57	.58	.62	.68	.48	.74	.66

the values for some predictors are above 0.8. Although industry associations are usually less pronounced for the short-term predictions, they are a highly important feature of these forecasts as well.

We conclude that while there exists a high association of forecasts with industry classification, it is not the primary factor accounting for the correlations between predictors. Thus the overall pattern is not one in which forecasters tend to agree on industry effects but not on other across-company variations; instead, they are in at least as much disagreement about industry effects as about other ones.

One may wonder whether correlations among individual forecasters varied over different industry groups. Such variation might indicate that certain industry groups are more difficult to forecast in some *ex ante* sense. The correlations among forecasters tended to be lowest in the "cyclical" industry group and highest for the electric utility companies. These differences were significant for all pairs of predictions considered. Ranking the correlations over industries and then comparing these ranks among predictors showed substantial concordance over the ordering of the correlations.[5]

5. The test for individual pairs of predictions was the likelihood-ratio test. Note that the ranking comparison is not based on independent observations, so a statistical test of the concordance is not appropriate. The hypothesis that the correlations are all zero within industries could, however, be rejected well beyond conventional significance levels.

2.2.4 Factor-analytic Investigation of Agreement

The analysis of the growth-rate expectations by industry classification was partly suggested by the notion that the predictions in part depend on simpler, more basic, and less diverse information than that specific to each firm. Thus it might be supposed that if one knew the fortunes of an industry group, one would know a good deal about the fortunes of each firm in it. One might want to carry this idea further and suppose that the predictions can be regarded as having a strong underlying core of information from which each predictor made its own further adjustments independent of the others. To investigate this hypothesis, we employ the standard factor-analysis model.

a) A Factor Model for Predictions

The basic idea is that each predictor forms its forecasts for the companies surveyed on the basis of the values of a few factors that affect all the companies. Let ϕ_{jk} be the value of the kth factor (out of K) for the jth company. These ϕ_{jk} are assumed to be random variables. The model then supposes that each forecast made by predictor i for company j, g_{ji}, can be expressed as

$$(2.2\text{-}4) \qquad g_{ji} = \sum_{k=1}^{K} \phi_{jk} a_{ki} + e_{ji}.$$

Here the a_{ki} are coefficients which have different values for different predictors but which assume the same values for every company in the forecasts of the ith predictor. The e_{ji} are random variables for which it is assumed that

$$(2.2\text{-}5) \qquad E(e_{ji}) = 0$$

and

$$(2.2\text{-}6) \qquad \begin{aligned} E(e_{ji}e_{mk}) &= \sigma_i^2 \qquad && i = k,\ j = m \\ &= 0 && \text{otherwise.} \end{aligned}$$

The important part of assumption (2.2-6) is that the e_{ji} for different predictors, i and k, are uncorrelated. The assumptions of homoscedasticity and lack of correlation across companies are used to determine the sizes of tests, but they are not a critical requirement for data to exhibit the type of variance-covariance matrix that is characteristic of the common-factor model.

The quantity ϕ_{jk} is interpreted most easily when there is only one of them for each company, that is, when $K = 1$. Then we might think of ϕ_{jk} as representing the (best) forecast that would be made for the company on the basis of commonly available information. The e_{ji} might then be taken to be specific or idiosyncratic information (or for that matter pure guesswork) used by the predictor i. The model assumes that this component of the predictor's forecasts is uncorrelated with the corresponding components of the forecasts of each of the other predictors. The a_{ki} contain the weightings of the two types of information. They could have the same values for each predictor.

When there is more than one factor, we might interpret the model as also reflecting the dependence of earnings on various aspects of the state of the economy, as, for example, real growth, inflation, etc. Different predictors might be in agreement over the extent to which each firm is sensitive to variations in these general conditions, but each might be using different predictions of what economic conditions will obtain. For example, the forecasters may agree that U.S. Steel's earnings growth would be positively influenced by the growth in GNP. Nevertheless, they may differ in their forecasts for U.S. Steel's earnings growth because they do not agree on the growth of GNP. Similarly, all forecasters may agree that an increase in the rate of inflation may depress the earnings for Consolidated Edison but may differ in their inflation forecasts. The a_{ki} now represent the different predictions of generally important economic variables made by the individual forecasters, and the ϕ_{jk} may be interpreted as the extent to which earnings growth depends on the various economic variables.

b) Relation to a Factor Model for Earnings

This interpretation of the model for earnings-growth forecasts complements nicely a related model for earnings growth or, more generally, for returns to securities that is sometimes used in valuation models. We shall see in chapter 3 that a common-factor model has important implications for the structure of security prices. Let x_{jt} be the value of the variable of interest for company j at time t and f_{kt} be the value of the kth factor at time t. (In the security-valuation model x_{jt} initially is the return to security j, but it might instead be earnings growth.) The model for x_{jt} is

(2.2-7) $$x_{jt} = \mu_j + \sum_{k=1}^{K} \gamma_{jk} f_{kt} + \epsilon_{jt},$$

where the f_{kt} might represent national income, inflation, or other generally relevant aspects of the economic environment. The μ_j and γ_{jk} are parameters specific to the firms while now ϵ_{jt} is a random disturbance. A forecast of x_{jt} could sensibly be made by forecasting f_{kt} and then using equation (2.2-7), with ϵ_{jt} taken to be zero. We might therefore consider the parameters μ_j and γ_{jk} to be the factors ϕ_{jk} of the prediction model (2.2-4), while the a_{ki} represent different forecasters' predictions of f_{kt} at a particular time as well as the weighting given to the typical common value of the firm-specific expectation μ_j.

From our previous discussion it may seem unreasonable to assume that the predictors should all know the values of ϕ_{jk} if they cannot even agree on the predicted values of major economic variables. However, the model could be extended to be

$$(2.2\text{-}8) \qquad g_{ji} = \sum_{k=1}^{K} (\phi_{jk} + \eta_{jki})a_{ki} + e_{jk},$$

where the η_{jki} are independent random variables uncorrelated across predictors. Now the ϕ_{jk} can be regarded as an average value held by predictors rather than ones on which all predictors agree implicitly. Since we can write equation (2.2-8) as

$$(2.2\text{-}9) \qquad g_{ji} = \sum_{k=1}^{K} \phi_{jk}a_{ki} + \left(\sum_{k=1}^{K} \eta_{jki}a_{ki} + e_{ji}\right)$$

$$= \sum_{k=1}^{K} \phi_{jk}a_{ki} + e'_{ji},$$

the model (2.2-4) remains formally appropriate provided that (2.2-6) holds for the augmented disturbance e'_{ji}. The theoretical implications for security valuation of diversity of expectations of the form (2.2-8) in the model (2.2-7) will be investigated in chapter 3.

c) Empirical Findings

Only a small number of factors can be identified from data for the limited number of predictors available, especially when the assumption of different variances for different predictors is made in (2.2-6).[6] However, for most years two factors are identifiable since the hypothesis that $K \leq 2$ imposes testable restrictions on the variance-covariance matrices of the predictors.

The major question is whether a common-factor model fits the data at all. Because of the small number of predictors, this amounts to asking whether only two factors can account for the observed correlations between predictors. Rejecting this hypothesis would not necessarily indicate that the model is inappropriate, but could arise from there being a (small) number of additional factors. As the discussion of the interpretation of the ϕ_{jk} indicated, particular interest focuses on the hypothesis that there is only one factor.

6. Identifiability and estimation of the factor-analysis model are discussed by Anderson and Rubin (1956).

Missing observations cause a major problem for the analysis. It is not at all clear that the fact of omission of a company from the list of those for whom a forecaster supplied predictions is a random event unconnected with the values predicted by others. Instead, it may be related to the values of the predictions—or to the extent to which some underlying factor about which there is uncertainty affects the company. As with the calculation of multiple correlation coefficients for table 2.4, it is necessary to base calculations on companies for which each of the included predictors made forecasts. The predictors that could be included and the number of observations are indicated in table 2.10. They are the same as those used in table 2.4.

It is of course quite possible for the model to describe some predictors and not others. No systematic search was made to try to find those predictors (if any) which it might fit; instead, the selection of the predictors included in the analysis was based on there being an overlap in the companies for which predictions were made.

Table 2.10 **Summary of Common-Factor Model**

A. Long-Term Predictions

	1961†	1962	1963	1964	1965
	Contributions of Two Factors to Predictors' Variances				
Pred.					
1	.84	.86	.86	.90	.81
2	.74	.86	.67	.90	.89
4	***	.94	.91	.87	.90
5	***	.97	.91	.89	.86
6	.74	.76	.90	.87	.85
7	***	.89	.97	.98	.98
8	.69	***	***	***	***
No. observations	22	27	24	77	101
	Significance Levels beyond Which Hypothesis Cannot Be Rejected				
No. Factors					
$K \leq 2$	***	.45	.01	.16	.09
$K = 1$	.12	.01	.00	.00	.00

B. Short-Term Predictions

	Contributions of Two Factors to Predictors' Variances				
Pred.	1961	1962	1963	1964	1965
A	.58	.90	.97	.90	.97
C	.84	.93	.55	.82	.87
D	.99	.80	.47	.86	.95
G	.98	.97	.85	.97	.89
I	.82	.86	.99	.94	.85
K	.78	.89	.83	.97	.92
No. observations	24	29	28	25	26

†Only one factor identifiable.

The findings of the (asymptotic) test[7] of the hypotheses are summarized in table 2.10 in terms of the smallest significance levels at which the hypotheses could be rejected.[8] The hypothesis of two factors could not be tested for the 1961 long-term predictions because only four predictors could be analyzed together. In most other cases, particularly among the short-term predictions, the hypothesis could only be rejected at high levels. This includes the long-term predictions in 1964 and 1965 where a

7. The tests are likelihood-ratio ones, in which one assumes that all random quantities have the normal distribution.

8. These quantities are sometimes referred to as "prob-vals." See Wonnacott and Wonnacott (1979).

fairly large number of observations are available. The predictions for 1963, however, provided a strong exception. Expressing these results differently, we find that usually it would be reasonable to ascribe the correlations among predictors to a pair of underlying factors.

The finding of two common factors does not necessarily indicate that there are only two factors present in the behavioral models underlying (2.2-4) and (2.2-7). If the values of a_{ki} for two or more factors (k) were the same for all predictors (i) (e.g., because they do all use the same forecasts of the important economic variables), then the test would aggregate these different factors into a single composite factor. The results just obtained may partly arise because such aggregation provides a sufficiently good approximation that more factors cannot be detected with the modest numbers of observations used.

The hypothesis of only one common factor receives little support from the data. It is rejected strongly except in a couple of instances, one of which is the long-term predictions of 1961, where only four predictors could be included and only one factor can be identified. The finding that one factor is not usually sufficient suggests that the correlations among predictors do not arise from just a single source, and indicates that the model (2.2-7) may be a fruitful way of considering how the forecasting process should be regarded.

d) Importance of the Common Factors

These findings suggest that the agreement among the forecasts of different predictors arises from their dependence on a set of common factors. The extent of this dependence may be summarized by considering the proportion of the variance of the forecasts of each predictor that can be attributed to two factors. Let $\bar{\phi}_k$ and $\bar{g}_i$ be the means of the kth factor and of the ith predictor's forecasts. The factor analysis then provides an estimate of

$$\sum_{j=1}^{J}\left(\sum_{k=1}^{K}(\phi_{jk}-\bar{\phi}_k)a_{ki}\right)^2,$$

which we can divide by $\Sigma_{j=1}^{J}(g_{ji}-\bar{g})^2$ to provide a quantity analogous to R^2. The values of these ratios are shown in table 2.10.

A large part of the variance of the predictors can be ascribed to dependence on the common factors. As table 2.10 reveals, there is a considerable amount of variation in the magnitude of these quantities among predictors and across years. Nevertheless, quite high values do prevail: most entries are above 0.8, values of 0.9 are common, and even values above 0.95 are found. This still leaves considerable diversity of expectations, but does indicate a very solid core of common information. It is worth noting that many of the largest values occur for the short-term predictions.

e) Extension of the Model

These findings spur a number of further investigations. One of the quantities which the factors represent does not seem to be the industry averages. When we analyzed the residuals using different industry means, levels of significance very similar to those of table 2.10 were obtained and models with only one factor still tended to be rejected strongly.

Taking the difference of one year's forecast from the forecast of the preceding year, where the forecasts are expressed by equation (2.2-4), we obtain

$$g_{jit} - g_{jit-1} = \sum_{k=1}^{K} (\phi_{jkt} - \phi_{jkt-1})a_{kit} + \sum_{k=1}^{K} \phi_{jkt-1} \times (a_{kit} - a_{kit-1}) + e_{jit} - e_{jit-1}. \tag{2.2-10}$$

The common-factor model would therefore continue to be appropriate for these differences if only the ϕ_{jk} or the a_{ki} changed. If both changed, the number of common factors would increase beyond the number that could be identified in our data. The three years in which changes in the long-term predictions could be analyzed produced even larger significance levels beyond which the two-factor model could not be rejected than those of table 2.10 for the predictions themselves. It is noteworthy that this was particularly true for the 1962–63 changes and the 1963–64 ones, since the model did not fit the predictions well in 1963. By contrast, the model was usually rejected beyond the 0.10 level with the changes in short-term predictions.

f) Summary of Factor-analytic Investigation

In sum, we find that the factor model (2.2-4) appears to describe well some of the predictions, but not all. Furthermore, some predictors may use the same values of the factors each year, though changing the predicted value of the underlying common variables. When five years of data are available for a predictor, two factors are still identifiable, but only one can be identified when not more than four years are available. Analyzing the long-term growth forecasts of predictors 1, 2, and 6 in this way led in each case to not rejecting at the 0.05 level the hypothesis of two factors. For these predictors and for the others for which only four years were available, the hypothesis of just one factor could be rejected easily. The results for the short-term predictors were similar: the only one for which the two-factor hypothesis could be rejected was *C*. Conditioning on the industry would lead to not rejecting the hypothesis in this case as well as in the others. No support was found for the model with only one factor.

Thus it appears reasonable to conclude that a factor model is consistent with the process by which our predictors have formed their expectations.

The forecasters may first have made predictions of important economic factors such as GNP growth, inflation, etc., and then attempted to estimate how each of these factors would affect each specific company. Disagreements among the forecasters could result either from different predicted values for the factors or from different views concerning how the factors affect specific company results.

2.2.5 Predictions and Past Growth Rates

Comparing the predictions with previous growth rates provides added perspective on the agreement among forecasters. However, past growth rates are not so well defined that their measurement is unambiguous. Instead, a number of different calculations may be made to estimate past growth. Of at least as much relevance as such objective calculations are the perceptions of past growth actually held by forecasters. We were fortunate in having had some of these perceptions supplied to us.

Correlations of eight historical growth rates of earnings per share with each other and with the predictions are shown in table 2.11 for 1963. Four of these past growth rates were supplied by participating firms, though not in all years. They represent the firm's perception of the growth of earnings per share that had occurred in various preceding periods. The other growth rates were calculated as coefficients in the regressions of the logarithms of earnings per share on time over the previous four, six, eight, and ten years. We also investigated with very similar results other measures based on the first differences of the logarithms of earnings per share and on linear trends.

The specific definitions of the eight historical growth rates were:

g_{p1} = four- to five-year historical growth rate supplied by predictor 1,

g_{p2} = eight- to ten-year historical growth rate supplied by predictor 1,

g_{p3} = one-year historical growth rate supplied by predictor 4,

g_{p4} = six-year historical growth rate supplied by predictor 4,

g_{c1} = log-regression trend fitted to last four years,

g_{c2} = log-regression trend fitted to last six years,

g_{c3} = log-regression trend fitted to last eight years,

g_{c4} = log-regression trend fitted to last ten years.

Values for g_{p3} were available only for 1962 and 1963.

The correlations in the first part of table 2.11 are indicative of the problems of assessing growth rates unambiguously. The different percep-

Table 2.11 **Correlations of Past Perceived, Past Calculated, and Predicted Growth Rates (1963)**

	g_{p1}	g_{p2}	g_{p3}	g_{p4}	g_{c1}	g_{c2}	g_{c3}	g_{c4}
				Past Growth				
g_{p1}	1.00							
g_{p2}	.66	1.00						
g_{p3}	.36	.43	1.00					
g_{p4}	.78	.82	.56	1.00				
g_{c1}	.54	.31	.10	.43	1.00			
g_{c2}	.79	.55	.03	.56	.68	1.00		
g_{c3}	.89	.74	.07	.76	.43	.77	1.00	
g_{c4}	.78	.88	.15	.96	.40	.67	.92	1.00
				Predicted Long-Term Growth				
1	.79	.85	.33	.78	.59	.62	.76	.82
2	.69	.73	.41	.75	.53	.52	.65	.68
3	.78	.68	.57	.77	.63	.57	.57	.58
4	.79	.82	.71	.79	.65	.70	.76	.79
5	.59	.56	.75	.75	.37	.25	.17	.26
6	.78	.90	.80	.90	.55	.65	.78	.85
7	.84	.82	.42	.80	.64	.70	.78	.81
				Predicted Short-Term Growth				
A	.15	.36	.62	.51	−.17	−.06	−.02	−.02
B	.43	.50	.65	.46	.44	.37	.37	.46
C	.10	.02	.51	.17	.10	−.13	−.21	−.19
D	.36	.22	.48	.43	−.13	−.01	.08	.06
E	.48	.60	.69	.34	−.15	−.09	.29	.48
F	.64	.50	.62	.64	.15	.46	.33	.29
G	.45	.45	.56	.33	.03	.10	.20	.20
H	−.16	−.07	.55	.32	−.10	−.15	−.35	−.28
I	.41	.45	.54	.45	−.04	.07	.12	.16
K	.36	.39	.62	.51	.06	.07	.32	.36

tions are not more highly correlated with each other than were different predictions, with the correlation being weakest between the one-year perceptions and the longer-term ones. The correlations among the calculated growth rates are of a similar order of magnitude as those among the perceived growth rates, and the same is true of the correlations of the calculated growth rates with the longer-term predictions. Their associations with the one-year perceived growth rates tend to be particularly weak.

The correlations of long-term growth predictions with historical growth rates are generally high. Indeed, they are not much different from those found in comparing the predictions with each other. Among the perceived past growth rates, the correlations are apt to be lowest with g_{p3}, the growth rates perceived to have occurred over the most recent year. For the calculated growth rates, the correlations tended to increase with the length of time over which the growth rates were calculated.[9]

The correlations relating the short-term predictions with the calculated growth rates tend to be considerably smaller and are negative in many cases. Correlations of short-term predictions with the past perceived growth rates tend to be stronger and are particularly so with the one-year past perceived growth. The values, however, are still not very large. Security analysts do not appear to rely simply on historical growth rates in forecasting for the year ahead. It seems more likely that they are also emphasizing a number of important economic factors and their own study of industry and company relationships to these factors.

The comparisons of past with predicted long-term growth rates might suggest that the apparent agreement among the predictors reflects little more than at least some use by all of them of the historic figures. In investigating this possibility, we calculated the partial correlations among the predictions, holding past calculated growth rates, past perceived growth rates, and both sets of growth rates constant. The first two sets of partial correlations were not much smaller than the simple correlations. Holding both sets constant produced partial correlations that were considerably smaller than the simple correlations, though almost all were still significant beyond the 0.05 level. Thus, while a substantial part of the agreement among predictors appears to result from their use of historic growth figures, there is also evidence of similarity in the adjustments that different security analysts tend to make to past growth rates.

We may well ask what is the relationship of the past growth figures to the common-factor model for which we found some support among the predictions. In particular, can we regard these past growth rates as representing one of the factors? The hypothesis that the same factor model applies to the past growth rates and to the predictions could be decisively rejected, partly because the factor hypothesis can be rejected among the past growth rates themselves, both perceived and calculated.

More mixed results were obtained when only one perceived and one calculated growth rate were used with the predictions. When these were used together with the short-term forecasts, significant rejection of the hypothesis of at most three factors occurred in all years except 1965. With the long-term forecasters of table 2.10, the hypothesis would be rejected very strongly in 1963 and 1964 but would be accepted in other years. Again, correlation between the two measures of past growth may be part of the problem. However, using only one past rate, perceived or calcu-

9. This effect was also found when the calculated growth rates were based on either (1) the regression of earnings per share on time or (2) the appropriate root of the ratio of earnings per share at the end of the period to earnings at the beginning.

lated, with but two factors produced again the same sort of ambiguous results.

2.2.6 Predictions and Price-Earnings Ratios

We complete our examination of agreement among various predictions by comparing the forecasts with the price-earnings ratios of the corresponding securities observed at about the times the predictions were being made. By utilizing a normative valuation model (for example, one of those cited in footnote 2), it is possible to calculate an implicit growth rate from the market-determined price-earnings multiple of a security. Thus comparisons of the predictions with the price-earnings ratios may be interpreted as examining the relationship between the forecasts and the growth rates expected by the market.

Correlations with two versions of the price-earnings ratio are shown in table 2.12 for 1965. The prices (P) used were the closing prices for the last day of the year. The earnings were either the actual earnings (E) or the average of the "normalized" or trend-earnings figures ($\overline{NE}$) supplied by the predictors. The correlation coefficients in the table are about the same as those obtained when the forecasts were compared with each

Table 2.12 Correlations of Price-Earnings Multiples and Predictions (1965)

Pred.	P/E	$P/\overline{NE}$
Long-Term		
1	.81	.72
2	.80	.81
3	.81	.60
4	.88	.85
5	.84	.85
6	.91	.83
7	.71	.54
8	.83	.66
9	.87	.78
Short-Term		
A	.31	.31
B	.74	.65
C	.46	.53
D	.31	.17
E	.44	.72
F	.61	.60
G	.47	.46
H	.33	.40
I	.50	.51
J	.58	.65
K	.61	.66

other. The correlations tend to be much higher for the long-term forecasts than for the short-term ones. Since price-earnings multiples should be affected by several variables other than expected growth rates (and so are not simply predictions), this exercise underscores the extent of disagreement among the forecasters.

2.3 The Accuracy of the Predictions

Three approaches are taken to evaluate the accuracy of the predictions. The first involves correlation of predictions and realizations and investigates the extent to which the relative predicted rates of company growth are associated with the relative rates of growth that occurred. This association can be high even if there are major differences between the predicted and realized rates of growth. The second approach to evaluation involves the appraisal of the accuracy of the various forecasts in more absolute terms. The third type of appraisal is a comparison of the forecasts with extrapolation of various previously experienced growth rates.

All comparisons concerned rates of growth rather than the levels of earnings per share in order to avoid misleading scale effects. In particular, all per-share realizations were converted into annual percentage rates of change from the average values of the estimated normalized earnings per share as of the dates the predictions were made. No conversion of the long-term predictions was necessary since all the five-year forecasts were originally recorded as percentage rates of growth, but the short-term forecasts did require conversion, as was described in chapter 1. Although every effort was made to ensure that the predicted and realized values used the same concepts and conventions, small differences may remain.

2.3.1 Correlations of Predictions with Realizations

Correlation coefficients summarizing the forecasting ability of the short-term predictors from 1961 through 1968 are presented in table 2.13. Corresponding figures for the long-term predictors are shown in table 2.14. The goodness of the forecasts was assessed by calculating and presenting Spearman rank correlation coefficients as well as product-moment correlations. We also indicate the number of companies for which forecasts and realizations could be compared.

By and large, the correlations of predicted and realized growth rates are fairly low. Nevertheless, with few, minor exceptions, the correlations are positive and most of them are significantly different from zero. The values tend to be smaller than correlations found with the other predictors, a feature especially of the long-term predictions. On average, the correlations for the long-term predictors are higher than for the short-term ones, although the differences are slight in 1963 and 1964. Except for the 1961 long-term predictions, the averages are below 0.5. They are

Table 2.13 **Correlations of Earnings Growth Forecasts of Security Analysts with Realized One-Year Earnings Growth for the Year Following the Forecast**

Pred. Short-Term (one-year) Forecasts	1961 Predictions			1962 Predictions			1963 Predictions			1964 Predictions			1965 Predictions		
	r	ρ	No.	*r*	ρ	No.	*r*	ρ	No.	*r*	ρ	No.	*r*	ρ	No.
A	.47	.22	109	.18	.21	112	.21	.21	112	.34	.36	111	.33	.42	112
B	.40	.20	63	.41	.25	64	.52	.27	64	.51	.37	62	.58	.39	66
C	.20	.15	106	.03	.11	126	.45	.47	126	.52	.34	128	.43	.40	129
D	.29	.21	186	.03	.06	192	.04	.02	184	.59	.33	115	.15	.24	117
E	.87	.68	30	.63	.39	32	.44	.57	31	.40	.49	35	.55	.57	36
F	***	***	***	***	***	***	.42	.27	74	.44	.28	74	.57	.47	76
G	.49	.24	143	.01	.09	146	.31	.13	166	.33	.14	161	.15	.16	163
H	.25	.30	42	.44	.38	48	.19	.28	55	.63	.35	54	.39	.45	56
I	.56	.20	176	.34	.16	187	.20	.18	191	.34	.24	191	.27	.35	194
J	***	***	***	***	***	***	***	***	***	***	***	***	.44	.28	52
K	.36	.36	87	.29	.25	88	.34	.15	88	.35	.36	87	.54	.43	88
Correlation with no. predictions	−.21	−.60	***	−.73	−.78	***	−.59	−.62	***	−.41	−.76	***	−.55	−.56	***

Pred.	1966 Predictions			1967 Predictions			1968 Predictions		
	r	ρ	No.	*r*	ρ	No.	*r*	ρ	No.
L	***	***	***	***	***	***	.10	−.09	108
M	.14	−.15	165	.10	.05	155	.04	−.08	142
N	.23	.18	154	.28	.21	151	.30	.23	150

NOTE. *r* = correlation coefficient. ρ = Spearman's rho. No. = number of observations.

Table 2.14 **Comparison of Five-Year Earnings Growth Forecasts of Security Analysts with Realizations**

Pred.	1961 Predictions vs. 1961–66 Growth			1962 Predictions vs. 1962–67 Growth			1963 Predictions vs. 1963–68 Growth			1964 Predictions vs. 1964–69 Growth			1965 Predictions vs. 1965–70 Growth		
	r	ρ	No.	*r*	ρ	No.	*r*	ρ	No.	*r*	ρ	No.	*r*	ρ	No.
1	.50	.09	119	.24	.03	175	.21	−.02	173	.27	.18	173	.40	.33	168
2	.33	.16	116	.32	.16	173	.25	.11	171	.35	.33	167	.34	.29	165
3	.80	.41	42	***	***	***	.48	.31	122	.53	.46	67	.33	.15	72
4	***	***	***	.75	.39	57	.75	.46	59	.50	.49	123	.40	.35	121
5	***	***	***	.49	.34	172	.42	.29	172	.68	.28	103	.37	.32	145
6	.55	.21	37	.62	.49	62	.69	.40	37	.43	.30	163	.31	.33	158
7	***	***	***	.57	.37	61	.51	.32	60	.38	.27	173	.42	.36	163
8	.36	.21	60	***	***	***	***	***	***	.66	.57	54	.64	.59	55
9	***	***	***	***	***	***	***	***	***	.40	.22	39	.53	.40	45
Correlation with no. predictions	−.73	−.56	***	−.86	−.78	***	−.87	−.79	***	−.59	−.42	***	−.66	−.31	***

Pred.	1966 Predictions vs. 1966–71 Growth			1967 Predictions vs. 1967–72 Growth			1968 Predictions vs. 1968–73 Growth			1969 Predictions vs. 1969–74 Growth		
	r	ρ	No.	*r*	ρ	No.	*r*	ρ	No.	*r*	ρ	No.
2	.38	.40	112	.10	.23	108	.11	.16	107	.05	.09	118
3	.09	.29	160	.09	.23	148	.14	.14	137	.18	−.12	129
6	.15	.16	162	.36	.33	153	.21	.32	156	***	***	***

NOTE. *r* = correlation coefficient. ρ = Spearman's rho. No. = Number of Observations considerably lower for some of the short-term predictions. The rank correlations furthermore tend to be lower than the product-moment ones.

One pronounced feature of the correlations is an inverse relationship between correlations of predictions with realizations and the number of companies for which predictions are made. As tables 2.13 and 2.14 reveal, the coefficients calculated between the number of companies and the correlations of predictions with realized growth rates are all negative and are generally quite substantial.

These results do not necessarily indicate that those who chose to forecast fewer companies were thereby able to make superior forecasts. Instead, it partly arises from a serious anomaly of our data. The simple correlation coefficients of tables 2.13 and 2.14 probably give a more favorable impression of predictive ability than is justified. Two or three companies in our study turned out to be rapid growers and also reasonably easy to predict. Were these companies omitted, the correlations (especially the product-moment ones) would decline substantially. For example, the correlation coefficients decline quite sharply if IBM, Polaroid, and Xerox are dropped from the sample. The importance of a few outliers in boosting the reported correlation coefficients thus weakens the evidence in favor of superior forecasting ability, since most forecasters did include these more spectacular performers.

2.3.2 Accuracy of the Predictions

Our second approach to the evaluation of the accuracy of the forecasts is based on an inequality coefficient similar to that developed by Theil (1966). This coefficient is given by

$$T = \sum_{i=1}^{N} (P_i - R_i)^2 \Big/ \sum_{i=1}^{N} R_i^2, \tag{2.3-1}$$

Where P_i is the predicted and R_i the realized growth rate for the ith company. This coefficient gives a comparison between perfect prediction ($T = 0$) and a naive prediction of zero growth for all corporations ($T = 1$). Thus the higher the inequality coefficient, the worse the predictions. It is even possible, of course, for the inequality coefficient to be greater than unity. In such a case, the predictor would have done better simply to predict no growth for all companies.

Values of this statistic are shown in table 2.15. They are based on comparisons of the long-term forecasts with the subsequent realized growth rates over five years and the short-term forecasts with the subsequent one-year changes (all adjusted to the same base). Table 2.15 thus employs the same sets of data as do tables 2.13 and 2.14.

Values of the inequality coefficient for the long-term predictions show some tendency to drift upward over the period 1961–66. The nature of the

Table 2.15 Inequality Coefficients for Assessing Accuracy of Predictions

A. Long-Term Forecasts vs. Five-Year Realizations

Pred.	1961–66	1962–67	1963–68	1964–69	1965–70
1	.38	.53	.56	.74	.85
2	.39	.49	.53	.70	.92
3	.28	***	.43	.33	.62
4	***	.22	.21	.53	.94
5	***	.35	.39	.29	.88
6	.32	.39	.43	.67	1.01
7	***	.34	.33	.69	1.04
8	.39	***	***	.40	.81
9	***	***	***	.37	.83
Correlation with no. of predictions	.73	.71	.66	.89	.66

Pred.	1966–71	1967–72	1968–73	1969–74
2	1.17	.90	.64	.63
3	1.36	.96	1.29	.85
6	1.40	.88	.69	***

B. Short-Term Forecasts vs. One-Year Realizations

Pred.	1961–62	1962–63	1963–64	1964–65	1965–66
A	1.11	1.01	.73	.59	1.03
B	.80	.80	.46	.44	.49
C	1.10	1.00	.51	.55	1.26
D	1.41	1.07	.82	.49	.77
E	.16	.36	.37	.47	.52
F	***	***	.60	.49	.49
G	.70	1.24	.66	.75	.88
H	1.61	.79	.72	.36	.66
I	.63	.84	.74	.75	1.17
J	***	***	***	***	.77
K	.81	.73	.56	.57	.50
Correlation with no of predictions	0.49	0.70	0.68	0.90	0.74

Pred.	1966–67	1967–68	1968–69
L	***	***	.97
M	1.09	.97	.95
N	1.37	.91	1.21

statistic is such that given absolute differences between predicted and realized growth are treated more favorably when realized growth is high so that the figures might not be considered fully comparable from one year to the next. However, the change is impressive. In 1966 each of the three predictors which furnished data would have done better (on this criterion) simply to have predicted no growth at all. Subsequently, some improvement did occur. Though much less pronounced than differences between years, considerable variations also exist among predictors. As we already found with the correlations, the inequality coefficients are strongly correlated with the number of companies for which the predictor made forecasts. These correlations are all positive, again indicating that average forecast success tended to weaken as the number of forecasts made increased.

The inequality coefficients for one-year forecasts tended to be weaker than for the long-term ones. Quite commonly, values greater than unity occurred. There was again considerable variation from year to year, but no patterns are evident. Pronounced differences occur between forecasters, but these again are strongly related to the number of forecasts made.

The performance of predictor *E*, especially in the early years, appears to be particularly strong. However, this superiority is largely illusory. Predictor *E* tended to concentrate on large, relatively stable companies, and, we suspect, predictions were made only when there was a priori reason to believe that the forecasts would be reliable. The validity of this conjecture is suggested by observing that all the other forecasters did better for the set of companies for which predictor *E* made forecasts than for the larger set. At the same time, as noted earlier, it was the case that predictor *E*'s forecasts tended to be less correlated with others. This tendency continued when the other correlations were also based on the same limited set of companies.

We may put the general findings into perspective by noting that a naive forecast based on predicting that, for each company, earnings growth would equal the past growth rate of GNP would have given lower inequality coefficients than the short-term forecasts. Such a naive forecast, of course, would not identify any relative differences among companies. On this criterion, the long-term forecasts are slightly stronger than the naive forecast. A naive prediction of average long-term GNP growth tended to produce slightly higher inequality coefficients than our predictors. As we shall see in section 2.4, there was a tendency in the early years for the forecasters to underestimate the realized growth. In later years, however, we did not find any systematic evidence of underestimation of change.

2.3.3 Analysis of the Forecasts by Industrial Category

We can extend the inequality-coefficient analysis to investigate the extent to which errors in prediction were related to (1) errors in predicting the average/growth of the sample firms, (2) errors in predicting the average growth rate of particular industries, and (3) errors in predicting the growth rates of firms within industries. To accomplish this, we decompose the numerator of (2.3-1) into three parts. The first comes from the average prediction for all companies not being equal to the average realization. The second part reflects differences among the average industry predictions not being equal to the corresponding differences among average industry realizations. The third arises from the differences in predictions for the corporations within an industry not being the same as the differences in realizations.

Let P_{kj} and R_{kj} be the predicted and realized growth rates for the kth company ($k = 1, \ldots, N_j$) in the jth industry ($j = 1, \ldots, J$). We can write the numerator of (2.3-1) as

$$\text{(2.3-2)} \qquad \sum_{j=1}^{J}\sum_{k=1}^{N_j}(P_{kj}-R_{kj})^2 = \left[\sum_{j=1}^{J} N_j(\bar{P}-\bar{R})^2\right] + \left[\sum_{j=1}^{J} N_j[(\bar{P}_j-\bar{P})-(\bar{R}_j-\bar{R})]^2\right] + \left[\sum_{j=1}^{J}\sum_{i=1}^{N_j}[(P_{kj}-\bar{P}_j)-(R_{kj}-\bar{R}_j)]^2\right].$$

Here, $\bar{P}_j$ and $\bar{R}_j$ are the averages for the jth industry and $\bar{P}$ and $\bar{R}$ are the overall means. The three terms in square brackets represent the decomposition referred to above. The proportions of T arising from these three sources will be called T^M, T^{BI}, and T^{WI}, respectively, for mean errors, between-industry errors, and within-industry errors.

Failure to forecast industry means (T^{BI}) accounted for only a very small proportion of the inequality coefficient. The main sources of inequality were the within-industry errors. Table 2.16 shows the results for 1963 for the long-term predictors. Similar findings were made for other years and for the short-term predictors.

The correlations of predictions with future growth rates within industries permit us to assess which industries were most difficult to forecast in an *ex post* sense. This difficulty is indicated in table 2.17. To calculate this table, we first ranked each predictor's correlation coefficients between its forecasts and the realizations over the eight industry groups. The industry for which the predictor had the worst correlation (that is, the most difficulty) was given a rank of unity. Table 2.17 presents the sums of the ranks for each industry based on the predictors which furnished enough forecasts to calculate correlation coefficients in each of the industries.[10] If the difficulty rankings for all predictors were identical, the rank totals

10. Only three long-term predictors could be included in 1962, four in 1963, and six in 1964 and 1965. Three short-term predictors were included in 1961 and 1962, and four were included in 1963, 1964, and 1965.

Table 2.16 **Analysis of Forecasts by Industrial Category: 1963 Predictions vs. 1963–68 Actual Earnings**

Pred.	Correlation	T	T^{M}	T^{BI}	T^{WI}	No. of Observations
1	.21	.75	.32	.23	.63	173
2	.25	.73	.31	.20	.62	171
3	.48	.66	.31	.18	.55	122
4	.75	.46	.05	.21	.41	59
5	.42	.62	.12	.17	.58	172
6	.69	.45	.07	.11	.43	37
7	.51	.58	.16	.22	.51	60
g_{p1}	.42	.65	.07	.26	.59	153
g_{p2}	.39	.71	.09	.32	.63	131
g_{p3}	.47	.66	.04	.19	.63	121
g_{p4}	.45	.77	.04	.17	.75	156

would be 4 for the most difficult industry (in years when there were four predictors compared), 8 for the next most difficult, and so on. In this case, the coefficient of concordance (Kendall's W) would be unity. The values of Kendall's W were significantly different from zero beyond the 0.05 level for most of the years as were differences between industries for the correlation coefficients for most of the predictors.[11] These findings indicate that there were industry differences. For the long-term predictions, correlation coefficients between forecasts and realizations tended to be highest in the oil, food and stores, and "cyclical" industries. For the short-term predictions, there was really no industry that was particularly easy to predict compared with the others; that is, prediction performances were uniformly mediocre across industries.

The electric utility industry turned out to be one of the more difficult industries for which to make long-term forecasts. This would come as a distinct surprise to the participating security analysts who claimed at the outset that they had some reservations about their abilities to predict earnings for the metals and other "cyclical" companies, but had confidence that they could make accurate predictions for the utilities.[12] It turned out that the long-term predictions for the utility industry were considerably worse than for the metals and "cyclicals."

In general, we had little success in associating forecasting performance with industry or company characteristics. Forecasting differences between industries were only moderately related to the average realized

11. The latter was tested on the basis of the asymptotic distribution of the correlation coefficient and the assumption that the data were distributed normally.

12. This confidence was also reflected in the fact that for the electric utility industry there was high agreement among the forecasters, whereas agreement was relatively low for the cyclical group.

Table 2.17 **Rank Totals of Correlations of Predictors and Realizations Summed over Predictors**

A. Long-Term Forecasts

Industry	1962 Forecast vs. 1962–67 Earnings Growth	1963 Forecast vs. 1963–68 Earnings Growth	1964 Forecast vs. 1964–69 Earnings Growth	1965 Forecast vs. 1965–70 Earnings Growth	1966 Forecast vs. 1966–71 Earnings Growth	Total
Electrical & electronics	23.0	26.0	29.0	33.0	16.0	127.0
Electric utilities	14.0	19.0	36.0	34.0	21.0	124.0
Metals	14.0	17.0	28.0	28.0	9.0	96.0
Oils	3.0	5.0	8.0	9.0	11.0	36.0
Drugs & specialty chems.	17.0	26.0	34.0	42.0	17.0	136.0
Food & stores	8.0	10.0	16.0	26.0	21.0	81.0
Cyclical	10.0	16.0	22.0	16.0	4.0	68.0
Miscellaneous	19.0	25.0	43.0	28.0	9.0	124.0
Kendall's *W*	.76†	.62†	.59†	.50†	.71†	.46†

B. Short-Term Forecasts vs. One-Year Earnings Growth

Industry	1961	1962	1963	1964	1965	Total
Electrical & electronics	9.0	17.0	24.0	24.0	16.0	90.0
Electric utilities	11.0	20.0	20.0	11.0	12.0	74.0
Metals	5.0	13.0	14.0	27.0	27.0	86.0
Oils	10.0	14.0	16.0	16.0	9.0	65.0
Drugs & specialty chems.	21.0	14.0	26.0	17.0	27.0	105.0
Food & stores	21.0	9.0	4.0	11.0	24.0	69.0
Cyclical	16.0	13.0	17.0	18.0	12.0	76.0
Miscellaneous	15.0	8.0	23.0	20.0	17.0	83.0
Kendall's *W*	.61†	.28	.51†	.33	.53†	.85§

†Significant at .05 level.

industry growth rates over the forecast period or to the variances of earnings about the realized growth rates.[13]

2.3.4 Comparison with Extrapolation of Past Growth

The picture that emerges thus far is one of rather mediocre performance by our sample of forecasters. Short-term forecasting performance may fairly be described as poor; long-term forecasting success was only slightly better. A variety of supplementary tests will help us to buttress these conclusions and to appraise more fully security analysts' ability to forecast.

The record of the forecasters raises the question whether any naive forecasting device based on historical data yields as good forecasts as the painstaking efforts of the security analysts. Several alternative historical growth rates were compared with the predictors' forecasts in order to assess their forecasting abilities better. To do so, we used historical log-linear growth rates for pretax cash earnings per share, the g_c variables already used in section 2.2.5. We also tried various averages of first ratios of cash earnings. In all, almost a dozen different mechanical methods for calculating past earnings growth were used, but none of them was satisfactory. We also examined four past-growth perceptions supplied to us by some of the predictors.

Analyses comparable to those shown in tables 2.13, 2.14, and 2.15 were performed using these past growth rates as predictors. The calculated growth rates were virtually uncorrelated with the one-year realizations, uniformly giving correlation results comparable to the weakest of the short-term forecasts. The only virtue of these predictions was that they gave inequality coefficients that were less than unity. The longer-term past perceived rates gave similar findings. However, the one-year past perceptions were somewhat stronger predictors in the two years in which they were available. Even so, their highest correlation with the realizations was only 0.44.

The past growth rates, calculated or perceived, gave somewhat stronger results when used to predict growth rates over five years. In some instances, they were stronger than some explicit forecasts. This was not, however, generally the case, and on balance the security analysts tended to produce stronger predictions. Again, past perceived growth

13. One might at least expect forecasting difficulty to be related to company risk. To investigate this possibility, the corporations were classified according to the quality ratings supplied by two of the predicting firms. There was a tendency for the correlations to be lowest (and negative) in the poorest-quality grouping, but they did not get systematically higher with quality; the highest correlations tended to occur in the middle groupings. When the corporations were classified by a high, medium, or low price-earnings multiple; or past growth rates of earnings; or future growth rates of earnings, sales, or assets, no pronounced or significant patterns emerged.

rates were stronger predictors than calculated ones. Overall we can conclude that mechanically calculated growth rates are not very effective predictors, tending to be inferior to the predictions of the analyst. This finding is similar to that of Little (1962) for British corporations and of Lintner and Glauber (1972) for U.S. ones that growth does not tend to persist. By contrast, analysts' perceived past growth rates were somewhat effective as predictors for the periods of our study, especially those representing earnings growth over a reasonably long period of time. Indeed, the best of the past perceptions of growth were about as reliable predictors as were the individual analyst's explicit predictions.

We noted earlier that price-earnings ratios may be considered to contain implicit forecasts of earnings growth. When we compared the price-earnings multiple and the multiple calculated on the basis of average estimates of "normalized" earnings per share with realized earnings growth, it was evident that the ratios are generally as good predictors as either forecasts based on historical data or those made by many analysts. To put the point in a different way, there did not seem to be any more information in the predictions themselves than was already impounded in market prices.

2.4 Are the Expectations "Rational"?

A major question to ask of any expectations data is whether they are "rational." Unfortunately, our data are not really suitable for investigating this subject properly. In consequence, the tests that we do conduct are at best only slightly indicative of whether the rational-expectations hypothesis is appropriate. Fortunately, the analyses may be of interest in any case to indicate further features of our data and of the quantities being predicted.

The difficulty with our data for the rational-expectations hypothesis is that they are primarily cross-sectional. Nine years of annual data would be of rather limited use for time-series analysis even if we had data for all our forecasters in all years. However, some predictors were in the sample for only two or three years. Even when a predictor's forecasts were available throughout all the period or most of it, the firm did not cover each of the companies in our sample in all years. In consequence, our data were not suitable for many obvious tests of forecast rationality.

To accomplish any investigation, we shall have to treat the forecasts made for different companies as providing a random sample of forecasts. Such an assumption would also have been implicit in the comparisons made in section 2.3 had formal inferences been drawn from them, but it does not seem to be entirely suitable for our data.

We found earlier in analyzing the forecasts that a model in which earnings varied with a few important quantities, such as perhaps the overall growth of the economy, may provide a useful way of looking at the formation of predictions. Later we shall suggest that a similar model is useful for realizations. All the realizations over a particular period are presumably based on the same values of these key variables. If their realized values differ from the predicted ones, these few failures in predicting the common factors will show up as common elements of the differences of the predictions from the realizations. In particular, each realization may differ in a systematic way from its expected value depending on all information available at the time the forecasts were made. However, a factor analysis involving the realizations and predictions is not sensible since it presumes that the predictors have no ability to forecast the firm-specific variations. That is, forecasters may well have predictive ability beyond their assessment of the common variables.

The second problem is that differences between realizations and forecasts may be correlated across firms, affecting the significance levels and powers of tests. This would also arise from the first problem. There is no obvious a priori structure to impose on such correlations, and we lack observations sufficient to estimate them. Hence we shall have to make the standard cross-sectional assumption of independent residuals.

We can also expect heteroscedasticity to be a problem with cross-section data of the sort we have been using. In other words, we can expect some companies to be harder to predict than others so that residual variances should vary among companies. We have no basis, however, for specifying the form of the heteroscedasticity for Aitken estimation.[14] As a result, we used the ordinary least-squares estimates. To prevent the misleading inferences that may result fron heteroscedasticity, however, we use the variance-covariance matrix suggested by White (1980) in performing our tests. This allows specifically for the effects of heteroscedasticity without requiring us to specify its form.

A critical requirement for considering a forecast to be "rational" in the sense used by Muth (1961) is that the mathematical expectation of the realization conditional on the forecast should be the forecast;[15] i.e., we can express the realized growth over period t ($g_{r,t}$) as

14. Routine use of a quadratic function of the independent variables as an "explanation" of the heteroscedasticity could (and did) produce some negative estimates or tiny positive ones that, if used, would have dominated the Aitken estimates.

15. The criterion is not as simple or straightforward as it often appears. There is a problem with what is being forecast—that is, about the quantity for which an expectation is formed—and this affects the criterion. Explicitly, if the expectations refer to a nonlinear function of the quantity it is assumed is being predicted, then the expected value of the transformed quantity is not usually the transformation of the expected quantity. In our case this is particularly relevant because the five-year growth could be expressed in terms other than the annual rates of growth we use. If the rational-expectations hypothesis holds for the annual rates of growth, it will not hold for the total proportionate increase over five years.

(2.4-1) $$g_{r,t} = {}_t g_{p,t-1} + u_t,$$

where ${}_t g_{p,t-1}$ is the predicted growth rate for period t, made in period $t-1$, and u_t is a random variable with mean zero uncorrelated with ${}_t g_{p,t-1}$. Following Theil (1966) and Friedman (1980), who tested the "rationality" of interest-rate forecasts, we regress the realizations ($g_{r,t}$) on the forecasters' predictions (${}_t g_{p,t-1}$) according to

(2.4-2) $$g_{r,t} = a + b\,{}_t g_{p,t-1} + u_t$$

and investigate the null hypothesis of unbiasedness defined by

(2.4-3) $$H_0\colon (a,b) = (0,1).$$

The results of testing H_0 for the long-term predictors are summarized in table 2.18 in terms of the significance levels beyond which H_0 cannot be rejected. We can reject a finding of unbiasedness in the majority of cases. This is not a uniform pattern, however. Few rejections occurred for the 1964–69 predictions. By contrast, the hypothesis is rejected for all predictors in the 1965–70 comparisons.

The estimates of equation (2.4-2) corresponding to these results are shown in table 2.19. While one cannot ascribe the rejection of hypothesis (2.4-3) simply to one coefficient or the other, the problem seems to involve both coefficients. Rather surprisingly, there is no clear-cut pattern to the rejection. It is not, for instance, the case that the a coefficients tend always to be positive or the b coefficients to be less than unity. Unfortunately, it is not appropriate to aggregate these results over time. The five-year nature of the forecasts and of the realizations means that successive values of u_t may very well be correlated. For this reason also,

Table 2.18 **Significance Levels beyond Which Hypothesis (2.4-3) Cannot Be Rejected**

Pred.	1961	1962	1963	1964	1965
1	.000	.000	.000	.511	.000
2	.000	.000	.000	.059	.000
3	.087	***	.000	.375	.008
4	***	.009	.071	.036	.000
5	***	.001	.024	.419	.000
6	.191	.135	.433	.225	.000
7	***	.064	.098	.311	.000
8	.000	***	***	.021	.000
9	***	***	***	.298	.000

Pred.	1966	1967	1968	1969
2	.000	.000	.034	.015
3	.000	.000	.000	.000
6	.000	.000	.000	***

NOTE. Significance levels are results of asymptotic χ^2 tests allowing for heteroscedasticity.

Table 2.19 **Long-Term Predictors' Estimates of Equation (2.4-2) (standard errors adjusted for heteroscedasticity in parentheses)**

	Predictor					
	2		3		6	
Year	*a*	*b*−1	*a*	*b*−1	*a*	*b*−1
1961/66	.06†	−.20	−.03	.48	−.03	.48
	(.02)	(.34)	(.07)	(.66)	(.07)	(.61)
1962/67	.04†	−.08	****	****	−.05	.79†
	(.01)	(.28)	****	****	(.03)	(.39)
1963/68	.05†	−.32	.03†	.11	−.04	.43
	(.01)	(.27)	(.01)	(.18)	(.03)	(.35)
1964/69	−.01	.34	−.02	.30	−.04	.52
	(.02)	(.25)	(.01)	(.21)	(.02)	(.31)
1965/70	−.04†	.16	−.00	−.26	−.03†	−.19
	(.01)	(.20)	(.01)	(.16)	(.01)	(.17)
1966/71	−.10†	.55	−.03	−.67	−.04	−.49
	(.03)	(.42)	(.03)	(.44)	(.02)	(.25)
1967/72	.03	−.74†	.02	−.73†	−.03	−.18
	(.03)	(.37)	(.02)	(.27)	(.03)	(.39)
1968/73	.05†	−.74†	.05†	−.91†	.02	−.49†
	(.02)	(.31)	(.01)	(.10)	(.02)	(.21)
1969/74	.07†	−.83†	.11†	−1.54†	****	****
	(.02)	(.29)	(.02)	(.29)	****	****
	1		4		5	
	a	*b*−1	*a*	*b*−1	*a*	*b*−1
1961/66	.04	.04	****	****	****	****
	(.08)	(.43)	****	****	****	****
1962/63	.06†	−.44	−.04	.63†	.03†	−.13
	(.02)	(.31)	(.02)	(.23)	(.01)	(.15)
1963/68	.06†	−.49	−.04†	.54†	.03†	−.17
	(.02)	(.30)	(.02)	(.23)	(.01)	(.19)
1964/69	.01	−.35	−.01	.39†	−.03	.35
	(.02)	(.30)	(.01)	(.19)	(.02)	(.29)
1965/70	−.03†	.15	−.05†	.21	−.03†	−.14
	(.01)	(.18)	(.02)	(.22)	(.01)	(.15)
	7		8		9	
	a	*b*−1	*a*	*b*−1	*a*	*b*−1
1961/66	****	****	.06†	−.33	****	****
	****	****	(.02)	(.33)	****	****
1962/67	−.02	.54	****	****	****	****
	(.03)	(.44)	****	****	****	****
1963/68	−.01	.33	****	****	****	****
	(.02)	(.36)	****	****	****	****
1964/69	.00	−.16	−.08†	1.13†	.00	−.19
	(.01)	(.16)	(.03)	(.53)	(.02)	(.26)
1965/70	−.02	−.39†	−.10†	.85†	−.03	−.09
	(.01)	(.16)	(.03)	(.31)	(.02)	(.15)

†Significant at the .05 level.

one would not expect a lack of serial correlation between the u_t to be an implication of rational expectations.

The pattern found for the short-term forecasts is rather different from that found for the longer-term ones.[16] Here not only can the null hypothesis ($a = 0$, $b = 1$) be rejected in most cases, but the individual parts can often be rejected. In particular, the coefficients b tended to be significantly less than unity.

With the short-term predictors, we may now look at whether the residuals are serially correlated. More precisely, under the rational-expectations hypothesis, any predictive information contained in the extent to which the last forecast missed should be incorporated in the forecast. To test both of these aspects of the rational-expectations hypothesis, we ran the regression

$$(2.4\text{-}4) \qquad (g_{r,t} - {}_t g_{p,t-1}) = a + b\,{}_t g_{p,t-1} + c(g_{r,t-1} - {}_{t-1}g_{p,t-2}) + u_t.$$

Under the rational-expectations hypothesis, all three coefficients should be zero.

Table 2.20 reports the results for 1964–65 and for 1965–66. In the first case, the overall hypothesis can be rejected for all predictions, the column headed "sig" indicating the significance level beyond which the hypothesis can be accepted. While the constant often provides by itself the basis for the rejections, the b coefficients also often did not conform to the hypothesis either. The hypothesis that $c = 0$ could not be rejected in most cases. The overall hypothesis fared a bit better in the next year, which is the one most favorable to it, but rejection still occurs in many instances. Rejection now does occur on account of the c coefficients in several instances.

We cannot perform this same test with the long-term predictions because of the five-year gap between forecast and realization. We may, however, ask whether the extent to which the most recent difference between the actual (one-year) rate of growth and the five-year rate of growth predicted in the previous year actually has predictive content. With only two or three exceptions, the hypothesis that this difference had no predictive power could not be rejected at the 0.05 level. The results for both aspects of this interpretation of the rational-expectations hypothesis jointly paralleled those found in table 2.19.

Another important property of rational expectations is that they efficiently incorporate all available information including the information contained in previously realized outcomes. Although we have seen that previous misses sometimes have (*ex post*) additional predictive informa-

16. Unfortunately, the predictors which made forecasts for five consecutive years did not make their forecasts later than 1965.

Table 2.20 Short-Term Predictors' Estimates of Equation (2.4-4) (standard errors adjusted for heteroscedasticity in parentheses)

Pred.	*a*		*b*		*c*		Sig.‡
			1964				
A	.07†	(.02)	−.36	(.20)	.34†	(.08)	.000
B	.05†	(.02)	−.24	(.13)	.20	(.15)	.011
C	.06†	(.02)	−.43†	(.13)	.36†	(.13)	.000
D	.08†	(.01)	−.40†	(.07)	.05	(.09)	.000
E	.03	(.07)	−.22	(.24)	.55	(.30)	.001
F	.04	(.02)	−.17	(.17)	.24	(.20)	.003
G	.13†	(.04)	−.34	(.27)	−.09	(.32)	.000
H	.04	(.04)	.12	(.25)	.07	(.07)	.012
I	.14†	(.05)	−.25	(.15)	−.06	(.24)	.000
K	−.08†	(.02)	.53†	(.21)	.15	(.08)	.000
			1965				
A	.03	(.02)	−.53†	(.14)	.39†	(.13)	.000
B	.00	(.02)	−.22	(.15)	.17	(.19)	.017
C	.23	(.14)	−2.40	(1.32)	−.21	(.30)	.108
D	.07	(.03)	−.70†	(.24)	.12	(.20)	.017
E	.02	(.03)	−.32	(.17)	.28	(.29)	.093
F	.02	(.02)	−.25	(.13)	.11	(.13)	.002
G	.09†	(.02)	−.86†	(.15)	.11†	(.05)	.000
H	.01	(.03)	−.25	(.28)	.13	(.16)	.270
I	.19	(.10)	−1.76	(.91)	.18†	(.07)	.068
K	.01	(.02)	.10	(.18)	.17	(.11)	.132

†Significant at the .05 level.

‡Significance level of hypothesis that all coefficients are zero.

tion with the short-term forecasts, we may wonder whether such information will also lead to subsequent revision of forecasts. Under the rational-expectations hypothesis, the change in a forecast made for a given future time should not be related to errors made prior to the current forecast. Any useful information contained in the forecast error during period $t-2$ should have affected the $t-1$ forecast and should not affect the change in the forecast from period $t-1$ to t.

This notion cannot be applied easily to our data, because successive forecasts are for different times. We may, however, consider the hypothesis that for forecast purposes the short-term growth rate can be considered a parameter following a random walk measured with error and so investigate the usual error-learning hypothesis on a cross-sectional basis. Explicitly, this hypothesis states that the *change* in forecast can be considered a linear function only of the difference of the most recent realization from its forecast value and not of previously observed differences. Specifically, we investigate

$$(2.4\text{-}5) \qquad {}_{t+1}g_{p,t} - {}_{t}g_{p,t-1} = A + B(g_{r,t} - {}_{t}g_{p,t-1}) + C(g_{r,t-1} - {}_{t-1}g_{p,t-2}) + u_t$$

and consider the null hypothesis to be that $C = 0$. In considering this hypothesis, it would not be reasonable to assume that A and B are constant across companies. This would suggest that a random coefficients model may be more appropriate. However, since the major effect of such a specification is to produce heteroscedasticity and since all our inferences already are based on allowing for heteroscedasticity explicitly, our procedures for inference may be considered adequate even in the face of variable coefficients.

Table 2.21 shows the results for the short-term predictors for the three years where it is feasible to pursue the investigation. The estimated coefficient C giving the effect of the error made in the period prior to the previous forecast on the current forecast change generally is not significantly different from zero. Nevertheless, there are many instances in the table, especially in the 1964–65 revision period, where one-period prior forecast errors did appear to influence forecast revisions, a finding inconsistent with the simple error-learning model.[17]

As Table 2.21 also shows, the values of R^2 are generally quite low. Altough part of the variance not accounted for may come from the variation among companies of coefficient B, the general impression is that the error-learning hypothesis is not strong. It remains an open question, however, whether the explanation is that earnings do not follow one of the standard models of expectations formation.

By and large, these results do not seem favorable to the rational-expectations hypothesis. Of course, this may be because of the inappropriateness of testing the hypothesis with cross-section data. To shed further light on this issue, we present, as table 2.22, the average errors of our short-term and long-term forecasters taken as a group. The average errors are measured by the differences between the realization and the average prediction of those forecasters making predictions for the companies in question.

In the early part of our period, both the short- and long-term predictors tended to make forecasts that were too low. Realizations tended to exceed forecasts during most of this early period. This may simply indicate a failure to anticipate the continuation of the extraordinary economic expansion experienced through the period. It may also reflect the underestimation of change frequently found in investigating forecasts and reported by Theil (1966).

In the later period, a similar underestimation of change did not characterize the forecasts. The forecasts were too high in some years, but

17. It should also be noted that in some cases the changes in forecast from year to year were correlated.

Table 2.21 **Short-Term Predictors' Estimates of Equation (2.4-5) (standard errors adjusted for heteroscedasticity in parentheses)**

Pred.	B		C		R^2
			1962–63		
A	.11	(.17)	.03	(.09)	.02
B	.02	(.15)	.09	(.10)	.02
C	.25	(.16)	.11	(.08)	.08
D	.02	(.07)	.01	(.07)	.00
E	−.11	(.12)	−.23	(.16)	.10
G	.02	(.12)	.14†	(.05)	.18†
H	−.13	(.07)	.11†	(.12)	.15†
I	−.04	(.09)	.08	(.06)	.02
K	−.04	(.12)	.09	(.06)	.03
			1963–64		
A	.17†	(.06)	.10	(.05)	.23†
B	.17†	(.08)	.32	(.23)	.23†
C	.46†	(.21)	−.09	(.10)	.19
D	.05	(.30)	.04	(.16)	.01
E	−.07	(.09)	.10	(.19)	.02
G	.10	(.07)	.06	(.05)	.05
H	.09	(.14)	.11	(.08)	.05
I	.08	(.08)	.05	(.05)	.03
K	−.07	(.08)	−.08	(.12)	.03
			1964–65		
A	−.07	(.11)	−.15	(.16)	.06
B	.34†	(.08)	.01	(.06)	.18†
C	.29	(.15)	−.12	(.10)	.15
D	.11	(.10)	−.09	(.09)	.04
E	.09	(.05)	.36†	(.07)	.52†
G	.15†	(.07)	.21†	(.07)	.19†
H	−.14	(.10)	.13†	(.07)	.19
I	.11†	(.04)	.18†	(.05)	.17†
K	−.27	(.19)	.01	(.06)	.10

†Significant at the .05 level.

during others they were too low. The only pattern we found consistently was that in years when the forecasts were too high (low), all forecasters tended to be too high (low).

This latter finding is the sort of pattern we might expect from a few common factors throwing off all forecasts. However, insofar as the continuation of the economic expansion lies behind the results, it does not seem to account for the values of b that were found. We do not find accentuation of forecast differences, which would produce values of b greater than unity in (2.4-2). That is the pattern we might expect if the forecast rankings reflected sensitivity to economic expansion.

Table 2.22 Average Forecast Errors across Sample

Forecast Period	Average Error
Long-Term Forecast	
1966/61	.0450
1967/62	.0321
1968/63	.0300
1969/64	.0014
1970/65	−.0336
1971/66	−.0667
1972/67	−.0308
1973/68	−.0246
1974/69	.0126
Short-Term Forecasts	
1962/61	−.0328
1963/62	.0586
1964/63	.1062
1965/64	.0345
1966/65	.0315
1967/66	−.0841
1968/67	.0441
1969/68	−.0288

A broader, and perhaps the most appropriate, test of expectations rationality is whether forecasters effectively incorporate *all* of the available historical information. To investigate this matter, we asked if there was some combination of historical information and analysts' forecasts that together might be better than using any individual piece of information alone. We asked, *ex post*, how an analyst could have made the best linear one-year prediction for earnings in, say, 1962, given that she had available to her the information now available to us. To deal simply with the problems of missing observations, we concentrate on the average of the available predictions rather than on each individually or some best linear combination of them.

Needless to say, in each year there is some combination of predicted short-term growth, long-term growth, eight- to ten-year historical growth, etc., which would be more highly correlated with realizations than would the predictions of any one forecaster alone. This fact is demonstrated by comparing the seventh column of table 2.23 with the earlier columns. In the earlier columns $\overline{g}_p$ is the average predicted growth and g_{p1} and g_{p2} are the simple historical growth rates defined above. Column 7 shows that using the best linear combination of the predictors plus historical information does improve forecasting ability, although the increase over the average of the predictors is not great. The important question is whether the combination that is calculated to work well in one

Table 2.23 **Correlations of Various Predictions with Realizations (1961–65)**

Forecast Period (1)	Forecast Date (2)	$\overline{g}_p$ (3)	g_{c1} (4)	g_{p1} (5)	g_{p2} (6)	Best Linear Combination of Forecast and Historical Info.: Present Year (7)	Best Linear Combination of Forecast and Historical Info.: Prior Year (8)	P/E (9)
A. Long-Term Forecast								
66/61	61	.5585	.0900	.2436	.3863	.6463	*****	.7129
67/62	62	.5280	.3305	.3511	.3990	.5980	.1409	.5155
68/63	63	.6172	.3802	.4871	.5162	.6533	.5243	.5488
69/64	64	.5814	.1104	.2469	.5026	.6253	.1042	.4829
70/65	65	.4667	−.1099	.1615	.4042	.5797	.4667	.4337
B. Short-Term Forecasts								
62/61	61	.3583	.1886	.1642	.2338	.4694	*****	.5546
63/62	62	.2199	.0028	.0181	.0652	.4407	.2411	.1729
64/63	63	.3197	.3229	.2577	.2638	.5098	.0603	.3598
65/64	64	.3959	−.0823	.1505	.1000	.5403	.0375	.3344
66/65	65	.3773	.1485	.1162	.2042	.4567	.2416	.2524

year will continue to work in a subsequent one. Such is not the case. Instead, the superiority of the linear combination disappears and it is decidedly inferior to the average of the predictors. These correlations are shown in column 8 of table 2.23. Stated differently, there is no combination of analysts' forecasts and historical information that could be used to make better predictions on a consistent basis.[18] This result suggests that there is no systematic relationship between historical and realized growth that is not directly incorporated into the forecasts.[19]

The last column of table 2.23 shows the correlation of the simple price-earnings multiple with the realized growth of earnings. The price-earnings multiple was as good as, and often better than, the average of the analysts' predictions. Since *P/E* multiples are influenced by more than forecasted growth (as will be shown explicitly in chapter 4), this is a surprising result. It suggests that whatever information there is in the forecasts gets assimilated quickly.

Our investigation of the rationality of the forecasts presents mixed results. We were able to reject the major implications of the narrow interpretation of the hypothesis and can be fairly confident that the standard explicit hypothesis of expectations formation is not correct. We cannot, however, reject the broader interpretation of the rational-expectations hypothesis. We found no consistent or coherent pattern indicating that readily available information is not efficiently incorporated in the forecasts, and it appears that any useful information in the forecasts does get rationally included in share prices. To put the point in a different way, there does not seem to be any more information in the predictions themselves than is already contained in market prices.

18. For a similar analysis of interest-rate forecasts, see Friedman (1980, pp. 8, 9).

19. This analysis was done only for five years because of lack of data for later years for g_{p1} and g_{p2}, which were past growth rates as "perceived" by two of our forecasters.