WHAT DO ECONOMISTS KNOW?

An Empirical Study of Experts' Expectations

by

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Econometric Research Program
Research Memorandum No. 260

March 1980

Abstract

For more than three decades, economic columnist Joseph A. Livingston has canvassed a panel of economists twice a year, eliciting their six-month and twelve-month forecasts for more than a dozen key variables. This study analyzes whether the experts' predictions are unbiased, and whether complete use was made of all relevant, known information (unbiasedness and completeness being necessary conditions for fully rational expectations). Little bias was found in either the half-year or full-year predictions, but extensive underutilization of information -- particularly data on monetary growth -- occurred.

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"To prophecy is extremely difficult -- especially with respect to the future."
- Chinese proverb

1. INTRODUCTION

Do economists' expectations regarding key price and non-price variables utilize all known, relevant information, in an unbiased, efficient manner? This is a worthy subject for research, for several reasons. Properties of experts' predictions likely form an upper bound for those of laymen. Further, as John Muth [14] has noted, "the character of dynamic processes is typically very sensitive to the way expectations are influenced by the actual course of events" (p. 316); hence, we need to know precisely how events do affect expectations. Finally, the common practice of replacing a variable's (generally unobserved) expectation with a proxy based on its past values will be unbiased (and will not cause bias in other coefficients) only if expectations are optimal (Shiller [18]).

Since July 1, 1946, economic columnist Joseph A. Livingston has canvassed leading economists twice a year and published the consensus of their six-month and twelve-month forecasts. Ready availability of more than three decades of consistent uninterrupted observations, across more than a dozen variables, makes the Livingston data perhaps the richest source of information on experts' expectations. Studies by Turnovsky [21], Turnovsky and Wachter [22], Gibson [6], Pyle [16], Lahiri [9], Wachtel [23], Cargill [1], [2], McGuire [10], Pesando [13] and Carlson [3], [4], have made intensive use of the Livingston price and wage expectations. But Livingston panel forecasts of industrial stock prices, real and nominal GNP, industrial production, business fixed investment and the unemployment rate have not yet, to our knowledge, been evaluated.

For the above mentioned variables, together with consumer and wholesale prices and wages, this paper seeks to determine whether economists' expectations possess the property of full rationality. We test directly for full rationality by examining whether forecasters optimally utilized all relevant information known at the time their forecasts were made. A slightly weaker concept is partial rationality [minimizing the expected squared forecasting error conditional on the information set being used], for which we test indirectly by the presence or absence of bias. In addition, we have taken more careful account of the serial correlation inherent in the prediction errors, which has heretofore been ignored in studies of the Livingston data.

Both the six-month and twelve-month forecasts were found to be largely free of bias. However, we did detect the presence of inefficiently used information -- in particular, data on monetary growth. We cannot, therefore, reject the possibility that in formulating their expectations, experts did make efficient use of incomplete information.

2. THE DATA

Twice a year, in early May and early November, J. A. Livingston mails questionnaires to leading economists in industry, government and universities, soliciting forecasts of consumer and wholesale prices, weekly wages in manufacturing, Standard & Poor industrial stock price index, real and nominal GNP, industrial production, business fixed investment, unemployment rate, housing starts, defense spending, corporate profits, retail trade and auto sales. On the basis of data available for April or October (or sometimes, May or November) respondents predict levels of the 14 variables six and twelve months beyond mid-year or year-end. Since forecasts are submitted in June and December, length of the forecast periods is actually 7-8 months and 13-14 months.

In writing his business outlook column, Livingston has access to the most recent figures (May or November). When such figures show substantial and unexpected change from data available to the forecasters, the forecasts are revised to preserve the rate of change which respondents were predicting.[2] Subject to this proviso, published expectations are simply the arithmetic mean of the panel's responses. Generally, 50-60 economists respond. Panel membership is fairly stable. For the 52 respondents in the December 1975 survey, for example, 19 had been panel members for four or more surveys. We made use of only the published expectations averaged across panel members.

For this study, expected rates of change were calculated and expressed as annual rates. Housing starts, defense spending, corporate profits, retail trade and auto sales were excluded from consideration, either because of insufficient observations (corporate profits) or because of definitional ambiguities (defense spending, housing starts, retail trade, auto sales). The period 1961-1977 was chosen for study, even though the majority of the nine data series begins much earlier: there is compelling evidence of a structural break in the Livingston data, around 1960 (Gibson [6], Turnovsky [19]). Both half-year and full-year forecasts were analyzed. Real GNP forecasts were first included in Livingston's survey in 1971, but despite the short period, are included in this study because of this variable's central importance.

3. BASIC CONCEPTS

In this section we introduce our notation and examine the logical relationships among the properties that together characterize 'rational' expectations.

Let A and P represent realized and predicted values of a given variable, respectively. Denote by P_t^f a prediction made in period t and pertaining to period $t+f$: A_{t+f} represents the realized value of the variable at $t+f$. Suppose the prediction is based on some subset S_t of the relevant information available at time t , I_t . We denote the relation between S_t and I_t as:

$$S_t = S(I_t) \tag{1}$$

The dependence of P_t^f on the information used to construct it is stated as:

$$P_t^f = P_f(S_t) \tag{2}$$

We note that the function $P_f(\cdot)$ is time-invariant, so the same mechanism is used each period to form predictions from the subset of available information.

Rationality and Completeness: Full rationality implies that all available information has been used in an optimal manner. A related concept, sometimes confused with rationality, is completeness -- the property that all usable information is in fact made use of. Such use of information need not be optimal; thus, we see completeness is a necessary, but not sufficient, condition for full rationality.

Clearly, no direct test of completeness is possible, since we can know only imperfectly what the set of relevant information is, and only sketchily what information is actually used. Fortunately, we can formulate a direct test of the more general concept of full rationality.

The conditional expectation of the forecast error, R_{t+f}, given the information available at time t, is defined as:

$$(3)\qquad R_{t+f} = E[(A_{t+f}-P_t^f)|I_t]$$

$$= E[A_{t+f}|I_t] - P_f(S(I_t))$$

$$= R_f(I_t)$$

It follows that we can write the (possibly nonlinear) regression equation:

$$(4)\qquad (A_{t+f}-P_t^f) = R_f(I_t) + u_{t+f}$$

where the residual u_{t+f} satisfies: $E[u_{t+f}|I_t] = 0$ for any I_t.

The expectation P_t^f is said to be fully rational, and is optimal in the sense that no other unbiased predictor has smaller variance, if:

$$(5)\qquad P_t^f = E[A_{t+f}|I_t]$$

which in turn implies that $R_f(I_t) = 0$ for all I_t. If regression analysis shows $(A_{t+f}-P_t^f)$ to be a statistically significant function of I_t, we can reject the hypothesis of full rationality; in other words, forecasters do not make optimal use of available relevant information.

Partial Rationality and Unbiasedness: Suppose, now, that the prediction P_t^f is incomplete, in the sense that I_t, the relevant information available at time t, is not fully utilized. Let P_t^f be based on S_t, a proper subset of I_t. Predictions make efficient use of this subset of information when:

$$(6)\qquad P_t^f = E[A_{t+f}|S_t]\quad .$$

This property, which we shall refer to as partial rationality (Sargent [17]) means that the information actually used -- whether or not it is complete -- is used efficiently. Partial rationality is a necessary but not sufficient condition for full rationality.

Generally, the precise information set used by experts or laymen in constructing their expectations is unknown or very difficult to observe. However, a weak test for partial rationality can be constructed without knowing S_t . We know that $P_t^f = P_f(S_t)$, whereupon the condition for partial rationality implies:

$$(7) \qquad P_t^f = E[A_{t+f} | P_t^f]$$

P_t^f is said to be an <u>unbiased</u> prediction of A_{t+f} if it possesses this property. Unbiasedness is thus a necessary condition for partial rationality. The presence of bias leads to rejection of the hypothesis of partial rationality.

To test for unbiasedness, we write the regression equation:

$$(8) \qquad A_{t+f} = \alpha + \beta P_t^f + u_{t+f}$$

which will satisfy $\alpha = 0$, $\beta = 1$ and $E[u_{t+f} | P_t^f] = 0$ if P_t^f is indeed unbiased. If regression analysis of this equation leads to rejection of the joint hypothesis: $\alpha = 0$, $\beta = 1$, then we reject the hypothesis of unbiasedness and with it, the hypothesis of partial rationality.

4. ESTIMATION AND INFERENCE

In this section we point out certain difficulties associated with inferences concerning equations (4) and (8) based upon the usual least squares procedures. We suggest an asymptotically appropriate procedure.

Our tests of rationality (and bias) will be conducted within the framework of the linear model:

$$y_{t+f} = x_t'\beta + u_{t+f} \qquad t=1,2,\ldots,n$$

where y_{t+f} is the dependent variable, x_t' is a $(1\times k)$ vector of independent variables, β is a $(k\times 1)$ vector of corresponding coefficients, and u_{t+f} is the stochastic residual. In testing for full rationality $y_{t+f} = A_{t+f} - P_t^f$, x_t consists of variables in the information set I_t, and $\beta=0$ under the null hypothesis. When testing for the presence of bias, we choose $y_{t+f} = A_{t+f}$ and $x_t' = (1, P_t^f)$ while $\beta' = (0,1)$ is the null hypothesis. In either case, the null hypothesis implies $E[u_{t+f}|x_t, x_{t-1}, \ldots, y_t, y_{t-1}, \ldots] = 0$.

Some Econometric Problems: Unfortunately, tests of rationality or bias based upon the usual ordinary least squares procedures are inappropriate, because in general the usual assumptions concerning the properties of residuals u_{t+f} will not be met. In particular, we must allow for the possibility, in the event that forecasts are for several periods ahead, that the f-period ahead prediction errors u_{t+1}, $u_{t+2}, \ldots, u_{t+f}$ are serially correlated, perhaps generated by a low-order moving average process. Thus, the usual estimated covariance matrix generated with ordinary least squares estimates is inconsistent, even if the estimates $\hat{\beta}$ are themselves consistent.

The serial correlation arises from the fact that the realized values A_{t+1}, $A_{t+2}, \ldots, A_{t+f}$ are not yet known when P_t^f is being constructed (at time t), hence the corresponding f-period ahead forecast errors $u_{t+f-s} = A_{t+f-s} - P_{t-s}^f$ for $s=1,2,\ldots, f-1$ are not observable. Since

u_{t+1}, $u_{t+2}, \ldots, u_{t+f-1}$ are not part of the available information, we cannot rule out the possibility that $E(u_{t+f} | u_{t+f-s}) \neq 0$ or that:

(9) $$\text{cov}[u_{t+f}, u_{t+f-s}] \neq 0 \qquad s=1,2,\ldots,f-1$$

On the other hand, the preceding f-period ahead forecast errors u_{t+f-s} for $s \geq f$ <u>are</u> observable. Rationality thus requires $E(u_{t+f} | u_{t+f-s}) = 0$ and hence:

(10) $$\text{cov}[u_{t+f}, u_{t+f-s}] = 0 \qquad s \geq f$$

Note that these covariances are obtained by taking unconditional expectations.

We suppose the two processes $\{A_{t+f}\}$ and $\{P_t^f\}$ are jointly stationary and ergodic. Then $\{u_{t+f} = A_{t+f} - P_t^f\}$ will be covariance stationary, and from above, we can write:

(11) $$\text{cov}[u_{t+f}, u_{t+f-s}] = \begin{cases} \sigma^2 \lambda_s & s=1,2,\ldots,f-1 \\ 0 & s \geq 0 \end{cases}$$

covariance matrix consistent with (11) results when the residuals u_t are generated by an (f-1)th order moving average process. It is therefore true that both partial and complete rationality are quite consistent with:

(12) $$u_{t+f} = \varepsilon_t + \rho_1 \varepsilon_{t-1} + \rho_2 \varepsilon_{t-2} \ldots + \rho_{f-1} \varepsilon_{t-f+1}$$

where ε_t are white-noise residuals.

In view of the serially correlated errors, it seems logical to base any inferences concerning (4) or (8) on generalized least squares procedures. Unfortunately, since the regressors in each case are not strictly exogenous, GLS is likely to yield inconsistent estimates. The reason is that in effect GLS transforms the model to eliminate the serial correlation in the residuals. But the transformed residuals for some particular period will be linear combinations of the original residuals with their lagged values. These in turn are likely to be correlated with the transformed data for the same period, since these include current values of the variables in the information set.[3]

An Approach to Inference: How then should statistical inference be carried out, when OLS yields inconsistent covariance estimates but GLS yields inconsistent coefficient estimates? We propose that inferences be based upon the OLS estimates, but using an estimate of the appropriate covariance matrix.

The model may be represented more compactly as:

$$y = X\beta + u \tag{13}$$

where y is the $(n\times 1)$ vector of all observations on y_{t+f} , X is the $(n\times k)$ matrix of all observations on the x's , and u is the $(n\times 1)$ vector of disturbances. Under the null hypothesis of either rationality or unbiasedness, we find that:

$$E(uu') = \Omega \tag{14}$$

will satisfy (11), and hence have the form:

$$\omega_{ij} = \begin{cases} \sigma^2\lambda_{|i-j|} & |i-j| < f \\ 0 & \text{otherwise} \end{cases} \tag{15}$$

We note again that these covariances are based upon unconditional expectations.

Hansen [7] has examined the asymptotic properties of $\hat{\beta}$, the OLS estimator of β , in models of the type introduced above. With some additional assumptions,[4] he has shown that:

(16) $$\sqrt{n}(\hat{\beta}-\beta) \overset{d}{\rightarrow} N(0,Q)$$

where $\overset{d}{\rightarrow}$ denotes asymptotic convergence to the indicated distribution, and:

(17) $$Q = \text{plim}(\tfrac{1}{n}X'X)^{-1}(\tfrac{1}{n}X'\Omega X)(\tfrac{1}{n}X'X)^{-1} \quad .$$

Under the joint null hypothesis that $\beta=\beta_o$, we see:

(18) $$q = n(\hat{\beta}-\beta_o)'Q^{-1}(\hat{\beta}-\beta_o)$$
$$\overset{d}{\rightarrow} \chi^2_k$$

If the null hypothesis is not true, we might expect to observe extremely large values of q .

Since Ω and hence Q are not known, we must substitute estimates. A consistent estimate of Q is provided by:

(19) $$\hat{Q} = n(X'X)^{-1}X'\hat{\Omega}X(X'X)^{-1}$$

where the nonzero elements of $\hat{\Omega}$ are the sample covariances from the OLS residuals. Thus, an asymptotically appropriate test statistic for the joint null hypothesis is:

(20) $$q = (\hat{\beta}-\beta_o)'(X'X)(X'\Omega X)^{-1}(X'X)(\hat{\beta}-\beta_o)$$

which will follow χ^2_k under the null hypothesis, and be large under the alternate hypothesis.

5. UNBIASEDNESS

<u>Error Process</u>: For the six-month forecast errors, we postulate a first-order moving average process:

(21) $$u_{t+f} = \varepsilon_t + \rho\varepsilon_{t-1}$$

The rationale for this is as follows: The forecast for, say, January through June is constructed in October or November of the preceding year, at which time the forecast error for the July-December prediction is still not precisely known. The last known forecast error is the one pertaining to January-June of that year. Hence, the first-order moving average.

The twelve-month forecasts overlap, since they are made every six months. For a January-December prediction, made the preceding October or November, the forecast errors for neither the July-June period nor the January-December period of the same year are known. The last known forecast error is three periods before the prediction period. For full-year forecasts, therefore, we postulate:

(22) $$u_{t+f} = \varepsilon_t + \rho_1\varepsilon_{t-1} + \rho_2\varepsilon_{t-2}$$

To test for bias, we estimate the slope and intercept coefficients of equation (8) using OLS, making use of the appropriate error processes in calculating test statistics. If the joint null hypothesis: $\alpha=0$, $\beta=1$, is rejected, we accept the alternate hypothesis that expectations are biased, and infer that the experts' expectations are not partly (nor, of course, completely) rational.

Empirical Results: OLS estimates of (8), using the correct variance-covariance matrix, are given in Table 1, for nine expectational variables.

For the six-month forecasts, only for weekly wages and nominal GNP was bias detected. For full-year forecasts, bias was present for the aforementioned variables along with industrial production. (Note that statistically significant values of χ^2 imply that the joint null hypothesis should be rejected.)

The values of the moving-average coefficients, $\hat{\rho}$, were reasonable. For full-year forecasts, $\hat{\rho}_1$ was in general close to one (reflecting the virtually complete ignorance of the error in the twelve-month prediction made six months previously), while $\hat{\rho}_2$ was much smaller.[5]

These results tend to corroborate similar econometric tests performed on different expectations data. McNees [11] studied forecasts of the GNP price deflator, real GNP and the unemployment rate, by Chase, Data Resources and Wharton, and found them largely unbiased. DeMenil [5] found that inflation expectations of households are unbiased.

Table 1 indicates that where bias was present, it was invariably the case that $\alpha>0$ and $\beta<1$. This has the following interpretation: Forecasters tended to overestimate the underlying trend by some constant amount. For percentage changes that exceed (fall short of) the trend, predictions thus overstated (understated) the actual increase. Hence, predicted changes were more volatile around the trend than actual changes. This contrasts interestingly with the finding that econometric models typically understate fluctuations around the trend (Carlson [3]).

5. FULL RATIONALITY

If we knew precisely what information the Livingston panelists used in making their forecasts, we could proceed to test the hypothesis of partial rationality. Lacking such knowledge, we now test whether panel members made use of all available, relevant information optimally in constructing their forecasts (i.e., full rationality).

There are at least two empirical tests for fully rational predictions. One rather weak test regresses the current error on the preceding forecast

TABLE 1. Actual Percentage Change (A_t) Regressed on Predicted Change (P_t)
Six-Month and Twelve-Month Forecasts, 1961.IV-1977.IV+

SIX MONTH FORECAST: $A_{t+2} = \alpha + \beta P^2_t + u_{t+2}, u_{t+2} = \varepsilon_t + \rho\varepsilon_{t-1}$

TWELVE MONTH FORECAST: $A_{t+3} = \alpha + \beta P^3_t + u_{t+3}, u_{t+3} = \varepsilon_t + \rho_1\varepsilon_{t-1} + \rho_2\varepsilon_{t-2}$

	Dependent Variable	Six: $\hat{\alpha}$	Six: $\hat{\beta}$	Six: ρ	Six: χ^2	Twelve: $\hat{\alpha}$	Twelve: $\hat{\beta}$	Twelve: ρ_1	Twelve: ρ_2	Twelve: χ^2
CPI	Percent Change: Consumer Prices	0.99 (1.27)	0.91 (0.53)	0.20	2.69	0.97 (0.91)	1.01 (0.03)	0.92	-0.44	3.27
WPI	Wholesale Prices	-0.50 (-0.32)	1.58 (1.43)	0.18	4.51	0.62 (0.29)	1.34 (0.62)	0.85	0.76	2.19
WL	Weekly Wage (Mfg.)	3.93 (4.42)	0.38 (3.56)	-0.55	24.38*	2.82 (3.30)	0.63 (2.25)	0.37	-0.25	14.12*
SP	Std. & Poor Stock Price Index	8.38 (1.02)	-0.33 (-1.62)	-0.31	4.04	-4.57 (-0.68)	1.10 (0.14)	0.63	-0.07	1.08
GNPN	Gross Natl.Prod.	1.94 (1.18)	0.94 (0.27)	0.01	10.14**	3.37 (2.42)	0.75 (1.27)	(c)	(c)	17.34*
GNPR[a]	Gross Natl.Prod. (constant prices)	-4.33 (-2.01)	1.75 (1.76)	0.24	4.02	-6.11 (-2.03)	2.09 (1.77)	0.20	-0.04	4.28
IP	Industrial Production	1.39 (1.15)	0.78 (1.09)	0.09	1.45	2.51 (1.82)	0.50 (2.51)	0.74	0.05	6.31***
INV	Business Fixed Investment	3.34 (1.53)	0.98 (0.80)	0.18	3.01	4.97 (1.82)	0.64 (1.04)	(c)	(c)	4.19
UR[b]	Unemployment Rate	-0.03 (-0.31)	0.86 (0.69)	0.06	0.58	0.04 (0.18)	0.97 (0.11)	0.56	0.22	0.05

+ t-statistic in brackets (for $\hat{\beta}$: + = $(\hat{\beta}-1)/\sigma_\beta$)
* significant at 0.001
** significant at 0.005
*** significant at 0.05
a. 1971.IV-1977.IV
b. absolute change
c. roots imaginary (see footnote 4)

error. Presence of a statistically significant relation indicates that information exists which if used could have further reduced mean square forecast error. A second, more revealing test, which perhaps helps show what economists do not know, regresses the current forecast error on lagged policy and state variables whose values were known when the forecast was made.

Tables 2 and 3 present such regression estimates for the six-month and twelve-month forecasts, respectively, assuming the error processes of (21) and (22). Two types of lagged explanatory variables were used -- those reflecting monetary and fiscal policy,and those reflecting the state of the economy as it was known when the forecasts were made.

The three policy variables chosen were: DG , the absolute quarterly change in real government purchases of goods and services per labor force member; $\dot{M}_1$, the percentage change in M_1 over the same quarter a year ago; and $\dot{B}$, the percentage change in public interest-bearing debt over the same quarter one year ago. DG , $\dot{M}_1$, and $\dot{B}$ are calculated as three-quarter moving averages. They are lagged so that, for example, the error in a forecast made in late November 1976 is regressed on the value of each of the three policy variables averaged over the first, second and third quarters of 1976.[6]

The state variables chosen were: per cent change in consumer and wholesale prices, weekly wages, industrial production, business investment and the unemployment rate, and were appropriately lagged.[7]

We wish to emphasize that we did not screen a very large number of variables in order to come up with several that proved to be correlated with forecast errors. For policy variables, we chose the most obvious candidates, reflecting government spending, monetary growth and public borrowing. For state variables, we chose lagged values of variables the panelists themselves were forecasting.

TABLE II. Forecast Error Regressed on Lagged Policy and State Variables
Six-Month Forecasts, 1962.II-1977.IV
(t - values in brackets)

Dependent Variable Forecast Error In:		Constant	Spending DG	Money Growth $\dot{M}_1$	Debt $\dot{B}$	CPI	WPI	WL	IP	INV	UR	ρ	χ^2
						EXPLANATORY VARIABLES							
CPI	% Change in Consumer Price Index	0.345 (0.33)	---	0.454 (2.81)	-0.006 (-0.08)	-0.362 (-1.49)	0.193 (1.76)	-0.063 (-0.44)	-0.112 (-0.88)	-0.039 (-0.73)	-1.667 (-1.75)	-0.33	39.61*
WPI	Wholesale Price Index	-0.262 (-0.10)	-0.007 (-0.74)	1.302 (3.21)	0.067 (0.40)	-0.962 (-1.69)	0.48 (1.87)	-0.149 (-0.46)	-0.215 (-0.74)	-0.128 (-1.00)	-2.09 (-0.89)	-0.29	37.01*
WL	Weekly Wage (Mfg.)	3.278 (1.67)	0.00 (0.09)	-0.515 (-1.77)	0.033 (0.28)	-0.61 (-1.47)	-0.009 (-0.05)	0.903 (3.65)	-0.539 (-2.46)	0.039 (0.42)	-0.788 (-0.45)	-0.35	31.23*
SP	Std. & Poor Stock Price Index	14.108 (0.75)	0.033 (0.505)	-0.153 (-0.05)	0.370 (0.32)	0.899 (0.23)	0.324 (0.18)	-4.689 (-2.03)	1.356 (0.66)	-0.669 (-0.745)	13.567 (0.821)	-0.30	10.58
GNPN	Gross National Product (current prices)	4.565 (2.75)	---	0.046 (0.17)	0.089 (0.80)	-0.888 (-2.34)	0.315 (1.85)	-0.071 (-0.34)	-0.071 (-0.37)	-0.39 (-0.48)	0.813 (0.56)	-0.25	28.35*
GNPR+	Gross National Product (constant prices)	38,268 (0.92)	0.036 (0.49)	-3.817 (-0.89)	-0.503 (-0.37)	-3.022 (-2.08)	0.802 (2.32)	0.348 (1.05)	-0.134 (-0.155)	-0.050 (-0.23)	-0.926 (-0.34)	-0.40	47.65*
IP	Industrial Prod. Index	4.980 (1.55)	0.002 (0.17)	-0.395 (-0.81)	-0.027 (-0.13)	-1.179 (-1.76)	0.055 (1.84)	0.078 (0.21)	0.050 (0.149)	-0.044 (-0.30)	0.680 (0.25)	-0.23	7.42
INV	Business Fixed Investment	4.848 (1.08)	-0.021 (-1.22)	0.036 (0.05)	-0.079 (-0.28)	-0.712 (-0.77)	-0.214 (-0.53)	0.360 (0.79)	-0.011 (-0.03)	-0.032 (-0.16)	-0.800 (-0.23)	-0.07	12.34
UR++	Unemployment Rate	-0.345 (-0.94)	---	-0.066 (-1.03)	-0.031 (-1.18)	0.151 (1.89)	-0.030 (-0.88)	0.064 (1.94)	0.004 (0.12)	-0.014 (0.84)	-0.299 (-1.09)	0.13	10.77

++ absolute change
* significant at 0.001 level
\+ 1971.IV-1977.IV

TABLE III. Forecast Error Regressed on Lagged Policy and State Variables, Twelve-Month Forecasts, 1962.II-1977.IV
(t-value in brackets)

Dependent Variable Forecast Error In:		Con-stant	Spend-ing DG	Money Growth $\dot{M}_1$	Debt $\dot{B}$	CPI	WPI	WL	IP	INV	UR	ρ_1	ρ_2	χ^2
CPI	%Change in Consumer Price Index	0.26 (0.31)	-----	0.602 (4.67)	0.055 (0.62)	-0.296 (-1.29)	0.214 (2.404)	-0.365 (-1.52)	0.153 (1.11)	-0.094 (-1.92)	-0.473 (-1.75)	-0.12	0.44	147.59*
WPI	Wholesale Price Index	3.54 (1.50)	-0.017 (-2.13)	1.259 (3.84)	0.114 (0.54)	-1.889 (-3.53)	0.890 (4.11)	-0.101 (-0.18)	-0.317 (-0.97)	-0.219 (-1.74)	-1.450 (-1.11)	-0.16	0.42	104.71*
WL	Weekly Wage (Mfg.)	1.669 (0.88)	-0.003 (-0.48)	-0.412 (-1.55)	-0.077 (-0.46)	0.567 (1.30)	-0.317 (-1.78)	0.384 (0.86)	-0.185 (-0.72)	-0.051 (-0.51)	-1.056 (-1.04)	-0.06	0.24	21.05*
SP	Std. & Poor Stock Price Index	7.720 (0.67)	0.006 (0.17)	-4.947 (-3.18)	-1.507 (-1.50)	-0.164 (-0.06)	-0.839 (-0.80)	4.877 (1.79)	-1.941 (-1.21)	0.699 (1.19)	-1.87 (-0.30)	0.08	0.25	31.24**
GNPN	Gross National Product (current prices)	0.363 (0.17)	0.005 (0.63)	-0.077 (-0.25)	0.100 (0.505)	-0.380 (-0.75)	-0.079 (-0.48)	0.275 (0.53)	-0.004 (-0.15)	0.222 (1.867)	1.085 (0.91)	-- ++	-- ++	30.68*
GNPR+	Gross National Product (constant prices)	24.132 (1.50)	———	-4.070 (-2.01)	-1.109 (-0.118)	-1.35 (-0.94)	-0.271 (-0.57)	2.616 (2.46)	-0.249 (-0.54)	0.256 (0.37)	0.184 (0.10)	0.97	-0.24	224.28*
IP	Industrial Prod. Index	0.706 (0.20)	0.005 (0.41)	-0.489 (-0.94)	-0.118 (-0.38)	-0.645 (-0.76)	-0.116 ([illegible].33)	0.858 (1.08)	-0.140 (-0.30)	0.210 (1.11)	1.406 (0.77)	-0.14	0.07	6.24
INV	Business Fixed Investment	5.795 (1.37)	———	0.608 (0.88)	0.139 (0.33)	-1.523 (-1.34)	-0.207 (-0.44)	0.123 (0.117)	-0.158 (-0.266)	0.077 (0.305)	2.063 (0.94)	-0.36	0.09	18.31**
UR++	Unemployment Rate	6.386 (1.28)	-0.004 (-0.22)	0.055 (0.75)	0.133 (0.31)	-1.566 (-1.33)	-0.175 (-0.35)	0.141 (0.13)	-0.186 (-0.30)	0.060 (0.22)	1.803 (0.73)	-0.37	0.08	17.23

++ absolute change
* significant at 0.001 level
\+ 1972.IV-1977.IV
**significant at 0.05 level

For half-year forecasts, the null hypothesis that all available, relevant information was in fact used was not rejected for only four of the nine variables -- industrial production, investment, the unemployment rate, and for stock prices.[8] For full-year forecasts, unused information existed for all but real GNP, investment and unemployment rate forecasts. There is at least a suggestion here that the behavior of real variables is better and more completely understood than the behavior of nominal or price-related variables. Both Zarnowitz [24] and McNees [11] have found that real growth forecasts were typically more accurate than those for current-dollar growth.

Expectedly, for the two most volatile series, business investment and stock prices, half-year forecasts were efficient, while full-year forecasts were not. For all the other variables, the half-year and full-year forecasts did not differ a great deal in their completeness, though the six-month predictions did tend to be more accurate.

Monetary and Fiscal Policy: Studies of directly-observed inflation expectations have noted "a strong tendency to underestimate the actual change in the consumer price index in recent years" (Carlson [3]). Tables 2 and 3 suggest one possible explanation, which does not rely solely on OPEC. For both consumer and wholesale prices, the coefficient of $\dot{M}_1$ is positive and significant, for both six-month and twelve-month forecasts. This suggests that the effect of monetary growth on consumer prices was not taken fully into account by panel members. In contrast, only one of the twelve DG coefficients was significant -- for full-year forecasts of wholesale prices -- and none of the $\dot{B}$ coefficients. The impact of government spending on wholesale prices seems to have been overestimated.

The negative coefficient of $\dot{M}_1$ in the full-year stock price regression may perhaps be explained as follows. Panel experts may have continued to believe that monetary expansion (and ensuing fall in interest rates or rise in inflation) exerted upward pressure on stock prices, long after that relationship ceased to hold true. This was not true, however, of half-year forecasts.

No relation was found between forecast errors in real variables (industrial production, unemployment, real GNP), with one exception -- for twelve-month real GNP forecasts, the coefficient of $\dot{M}_1$ was significantly negative.

State Variables: In their full-year forecasts of consumer price rises, panelists seemed to fail to take into account sufficiently the effect of wholesale price rises. At the same time, the effect of consumer price rises on (later) wholesale price rises was overestimated, as shown by the significantly negative coefficient. The autoregressive nature of wholesale price rises was also not completely incorporated in predictions, as shown by the significant positive coefficient of lagged WPI , in the WPI regression. None of these results carried through to the half-year forecasts.

Only one of the constants was significant -- that pertaining to nominal six-month GNP forecasts. The positive constant term indicates these forecasts consistently underestimated the change in current-price GNP.

6. CONCLUSION

Two properties of economists' expectations were studied for the period 1961-1977 -- bias and completeness. In general, absence of bias for both six-month and twelve-month forecasts meant that the hypothesis that expectations were partly rational could not be rejected. But the presence of underutilized information, mainly for price and current-dollar variables, did in most cases lead us to reject the hypothesis of fully rational expectations.

Curiously, our findings both detract from, and support, the monetarist position. They do not fully uphold the assumption of rational expectations, a common feature of many modern monetarist models. On the other hand, they do indicate that had monetary growth been correctly understood and fully incorporated into expectations during the past two decades, our forecasts (and perhaps our policy-making) would have been considerably improved.

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FOOTNOTES

1. Research for this paper was supported by the Sloan Grant for Applied Microeconomic Research for the economics department, Princeton University, Ben Zion Filner and Haim Nisenson provided competent research assistance. To Joseph A. Livingston, who made available a complete set of his columns, we extend our thanks and admiration. Christopher Sims was untiringly patient in criticizing our initial, flawed estimation procedure and in suggesting the correct method. Computing was done with the NBER's TROLL interactive package.

2. "I should caution you that sometimes for journalistic purposes it has been necessary to raise the average of the forecasts so as to properly indicate to readers the rate of change the group expected.

"As a case in point. When we sent out the questionnaire for June 1973, the CPI was 128.8; when the article was published it was 131.5 . The actual arithmetic gave a consensus of 134.3 for December 1973 and 137.1 for June 1974. we raised these respectively (and respectfully) to 136.0 and 138.8. Not to have done so would have understated the expected increase." (J. A. Livingston, in personal communication).

Carlson [3] has made painstaking revisions of the Livingston inflation expectations data, taking the above factor into consideration.

3. We are grateful to Christopher Sims for the reasoning expressed in this paragraph. For further discussion of this point, see Hansen [7].

4. Hansen [7] supposes that the conditional expectations of y_{t+1} and x_{t+1}, conditioned on $[x_t, x_{t-1}, \ldots, y_t, y_{t-1}, \ldots]$, are linear in the conditioning variables. In addition, he assumes that the conditional covariance matrix of y_{t+1} and x_{t+1}, again conditioned on $[x_t, x_{t-1}, \ldots, y_t, y_{t-1}, \ldots]$, is not dependent on the elements of the conditioning set. The first of these assumptions is not too unreasonable, and the second will be met if the $\{y_t\}$ and the $\{x_t\}$ processes are jointly normal.

5. For nominal GNP and business fixed investment forecasts, the quadratic equation used to estimate ρ_1 and ρ_2 had imaginary roots. This suggests that the covariance matrix of the errors may have the band structure given above but may not be characterized by a second-order moving average.

6. These data series were used in Stein [19] and, more recently, in Maital [13], where they were applied to analyzing the structure of inflation expectations of both households and experts.

7. A panelist making his prediction in November 1978 was aware of the rise in the CPI during the first half of 1978, but not of course, during the entire last half. He is similarly aware of the CPI rise from mid-year 1977 to mid-year 1978, but not from end-year 1977 to end-year 1978.

8. A statistically significant χ^2 value implies that the joint null hypothesis (all coefficients, including the constant term, are zero) is false.