THE INFORMATIONAL EFFICIENCY OF ECONOMIC FORECASTS

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Forschungsbericht/
Research Memorandum No. 221

Juli 1985

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ABSTRACT

Assuming forecasting procedures to be consistent with the assumptions of the rational expectations hypothesis, a set of economic forecasts published by the Austrian Institute for Economic Research is tested for informational efficiency. First, the relationship between the concepts "optimal prediction" and "rational expectations" is discussed and the appropriate testing methodology described. In applying the tests, considerable care has been expended to circumvent possible methodological pitfalls. Three of the seven series tested are found to be informationally inefficient. It is suggested that such a result could be caused by pessimistic attitudes among forecasters, or in technical terms, that forecasters exhibit asymmetric loss functions. Additionally, the results of the paper demonstrate that the standard criteria for evaluating forecasting accuracy should be supplemented with tests for informational efficiency because judgements based on the standard criteria generally do not take into account the stochastic nature of the time series to be forecasted.

ZUSAMMENFASSUNG

Aus der rationalen Erwartungshypothese abgeleitete Kriterien werden dazu verwendet, sieben regelmäßig veröffentlichte Prognosereihen des Österreichischen Instituts für Wirtschaftsforschung auf effiziente Informationsverarbeitung zu testen. Die Arbeit diskutiert zuerst die Beziehung zwischen den Konzepten "Optimale Prognose" und "Rationale Erwartungen" und beschreibt daran anschließend die verwendeten Testverfahren. Besondere Beachtung finden mögliche Schwierigkeiten bei der Anwendung der Tests. Für drei der sieben getesteten Prognosereihen muß die Hypothese der Informationseffizienz verworfen werden. Als Erklärung für diese Ergebnisse wird auf die Möglichkeit hingewiesen, daß Prognosehersteller zu pessimistischen Einschätzungen der Wirtschaftsentwicklung tendieren, oder technisch ausgedrückt, asymmetrische Verlustfunktionen besitzen. Die Arbeit schließt mit einem Plädoyer für die Erweiterung der traditionellen Genauigkeits-und Treffsicherheitsanalysen von Prognosen durch Tests auf Informationseffizienz. Nur diese Tests berücksichtigen die stochastischen Eigenschaften der zu prognostizierenden Variable, was für die Beurteilung der Prognosegüte jedoch von entscheidender Bedeutung sein kann.

1. Introduction

During recent years, the rational expectations hypothesis (REH) has become one of the centers of attraction in economic research. Although the REH drew most of its current prominence (and a considerable amount of head shaking at that) from its application to questions of stabilization policy, various other fields of research are currently reconsidered from the perspective of rational expectations.[1] Some of these endeavours have concentrated on testing economic forecasts for exhibiting informational efficiency. In jumping on this ready band wagon, we present and interpret some test results for a set of economic forecasts published by the Austrian Institute for Economic Research.

As a kind of corollary from the test results, it is suggested that the standard accuracy analysis of economic forecasts may sometimes be inappropriate for judging forecasting quality.[2] An "excellent" root mean square error of prediction, say, does not imply that the forecast under scrutiny has used all readily available information. Viewed from the other side, a deteriorating accuracy statistic over time need not reflect an inaccurate forecaster but may be due to a change in the stochastic properties of the time series to be forecasted, e. g., a higher variance of the series.

Similar studies using professional economic forecasts as data basis have been presented for U. S. data by Nelson (1972), McNees (1978), Berger and Krane (1985). Forecasting data for Germany have been tested by Neumann and Buscher (1980), Kirchgässner (1984). Aiginger (1981) checked among other series the same data as that used in this paper but considered a shorter sample period. His testing procedures, however, differed in some respects from those employed here.[3] The results in the literature mentioned have been mixed, the only clearly detectable tendency is that testing procedures are becoming more and more sophisticated.[4]

The paper proceeds as follows. Section 2 discusses the relationship between optimal predictions and rational expectations. This section also contains a description of the testing methodology used in the sequel. Section 3 gives some information on the data used. Section 4 reports test results and attempts an interpretation. Concluding remarks are contained in section 5.

2. Optimal Predictions, Rational Expectations and Tests for Informational Efficiency

The REH may be interpreted as a special case of the formal notion "optimal prediction". From the perspective of the "optimal prediction problem", forecasting is a statistical decision problem characterized by four components:[5] (A) A discrete stochastic time series $\{X_t\}$. Let $\hat{X}_{t+f,t}$ denote the forecast of X_{t+f} made at time t and let $e_{t+f,t} = X_{t+f} - \hat{X}_{t+f,t}$ stand for the associated forecast error. (B) An information set I_t comprising the available information at time t. (C) A conditional distribution $F(X_{t+f}/I_t)$, representing, in a compact manner, the knowledge of the forecaster about the "data generation process" of $\{X_t\}$. (D) A loss function V(.) with the forecast error as the argument. Given this framework, an optimal prediction for X_{t+f} is defined as the forecast $\hat{X}_{t+f,t}$ that minimizes the expected value of the loss function $V(e_{t+f,t})$.

The REH in the formulation of Muth (1961) is essentially an "interpretation" or a "model" of the above defined concept of "optimal prediction".[6] It specifies the components (B),(C) and (D) by asserting that: (B') The information set I_t used by decision makers for forecasting contains all r e l e v a n t information for the prediction of an economic variable X_{t+f}. (C') The conditional distribution F held by the decision maker is equal to the t r u e or o b j e c t i v e conditional distribution generating X_{t+f}. (D') The loss function V is q u a d r a t i c and therefore s y m m e t r i c in the forecast error.[7] Important for our purposes is the well known result that under this specification the optimal prediction for X_{t+f} is equal to the true expected value of X_{t+f} conditional on I_t. Formally:

$$(1) \quad \hat{X}_{t+f,t} = E(X_{t+f}/I_t) = \int_{-\infty}^{\infty} X_{t+f}\, f(X_{t+f}/I_t)\, dX_{t+f}$$

where E stands for the expectation operator. Reflecting on the points raised so far, it should be clear that the REH is a very special case of an optimal prediction. Under circumstances different from those specified in (B'), (C') and (D'), the optimal prediction of X_{t+f} may differ decisively from the true conditional expectation (1).

From now on we assume that professional economic forecasters actually form their predictions in accordance to the REH. Two types of tests are suggested below for testing the validity of this assumption: Unbiasedness tests and efficiency tests, both subsumed in this paper under the general header "informational efficiency tests".[8]

Testing for unbiasedness: Following Theil (1966), a one-period forecast $\hat{X}_{t,t-1}$ is called unbiased if for the regression:

$$(2) \quad \dot{X}_t = a + b\hat{X}_{t,t-1} + e_t$$

the restriction a = O and b = 1 can not be rejected. Although this type of test is sometimes employed for checking forecasting accuracy, the REH provides an exact motivation for applying the test while at the same time pointing out a possible complication.

Assume, the stochastic process $\{X_t\}$ can be written generally as:[9]

$$(3) \quad X_t = \mu + \sum_{i=0}^{\infty} \alpha_i e_{t-i}$$

where μ is the mean of the process and the e's denote uncorrelated stochastic error terms (white noise) which may be interpreted as all the past and current disturbances in the economy generating $\{X_t\}$. Forecasters endowed with rational expectations can be assumed to know (3). Accordingly, the optimal forecast at time t-1 for X_t will be:

$$(4) \quad E_{t-1}(X_t) = \mu + \alpha_1 e_{t-1} + \alpha_2 e_{t-2} + \dots$$

with a corresponding forecast error:

$$(5) \quad X_t - E_{t-1}(X_t) = \alpha_0 e_t$$

Rearranging (5) gives:

$$(6) \quad X_t = E_{t-1}(X_t) + \alpha_0 e_t$$

Comparing (6) with (2), it is easily seen that the restriction a = 0 and b = 1 is an appropriate test for checking unbiasedness of the forecast.

Before performing convential F-tests on regression equations like (2), however, a serious problem should first be considered. In most practical forecasting situations, forecasting at time t-1 is executed without full knowledge of the current disturbance e_{t-1}. Specifically, forecasting in December for the next year has to be done without full knowledge of the realization for the current year. Forecasters are assumed to form an optimal prediction of e_{t-1} on the basis of their partial knowledge. Denote this prediction by $E(e_{t-1}/I_{t-1})$. Then, the forecast error (5) has to be recalculated under this assumption and is given by:

$$(7) \quad X_t - E_{t-1}(X_t) = \alpha_o e_t + \alpha_1(e_{t-1} - E_{t-1}(e_{t-1}))$$

Under very general conditions outlined in footnote (9), formula (7) can be transformed into:

$$(8) \quad X_t - E_{t-1}(X_t) = \alpha'_o \eta_t + \alpha'_1 \eta_{t-1}$$

The η's in (8) denote white noise terms. Assuming an information lag of one period thus changes the "well behaved" error term in regression equation (2) into an error term following a moving average process of order one (MA(1)). The convential F-tests will not be appropriate under this specification, because estimates of the parameter variances are biased. A suitable strategy to handle this complication has been suggested by Brown and Maital (1981). They estimate the parameters a and b by ordinary least squares (OLS), but use for testing purposes an adjusted variance-covariance of the parameters which takes into account the MA(1)-structure of the error term. An asymptotically valid test statistic following a χ^2-distribution under the null hypothesis can then be constructed to test a = 0 and b = 1.[10] The results for testing unbiasedness reported in section 4 have been calculated on the basis of this suggestion.

Efficiency Tests: Under the REH, forecasters use all relevant information known to them at time t-1 to forecast X_t. Let the set containing all relevant information be denoted by I_{t-1}. If S_{t-1} is a subset of I_{t-1}, conditioning the forecast error on this set and taking the expected value at time t-1 yields:

$$(9) \quad E_{t-1}((X_t - E_{t-1}(X_t/I_{t-1}))/S_{t-1}) = 0$$

The forecast error should not be correlated with any available information at time t-1. Considerable care must, however, be expended to include in S_{t-1} only the information that was actually known at t-1. In this paper, efficiency of forecasts is tested by regressing the forecast error on the once lagged values of a set of "information variables" described in section 4. The typical regression is:

$$(10) \quad (X_t - \hat{X}_{t,t-1}) = \beta_o + \beta_1 Y_{1,t-1} + \dots + \beta_n Y_{n,t-1} + e_t$$

Given that the $Y_{i,t-1}$ are known at time t-1, the null hypothesis:

$$(11) \quad H_o: \beta_o = \beta_1 = \dots = \beta_n = 0$$

can be tested by a convential F-test.

3. The Data

Since 1963, the Austrian Institute for Economic Research has published regular forecasts on the development of the Austrian economy. In this paper, seven yearly forecast series published in December for the next year are considered: the rate of unemployment, the inflation rate of the consumer prices, the real growth rate of gross domestic product, the real growth rates of private consumption, gross investment in buildings and machinery, exports of goods and imports of goods respectively. All variables are measured in percentage points. Forecast data are available for the time range 1964-1984. The realizations of the variables considered correspond to the official data published in March after the year they refer to.

Table 1 shows the mean and the standard deviation of the prediction series and the realized series, respectively. These statistics will be helpful in

TABLE 1

Some Standard Statistics for the Data Series

Series	Forecasting Series	Realized Series	Correlation betw. Pred. and Realiz.
	Arithmetic Mean (Standard Dev.)	Arithmetic Mean (Standard Dev.)	
Unemployment Rate	2.68 (.82)	2.50 (.84)	.92
Inflation Rate	5.13 (1.84)	5.28 (1.86)	.88
GDP-Growth Rate (real)	3.10 (1.49)	3.70 (2.30)	.58
Private Consumption Growth Rate (real)	3.36 (2.17)	3.48 (2.67)	.68
Gross Investment Growth Rate (real)	3.33 (2.86)	3.15 (5.18)	.72
Exports of Goods Growth Rate (real)	5.37 (3.25)	7.45 (5.62)	.10
Imports of Goods Growth Rate (real)	5.27 (3.71)	6.47 (6.64)	.37

Note: Sample Period: 1964-84 for all variables.

TABLE 2

Forecasting Accuracy Statistics

Series	RMSE			U		
	1964-84	1964-73	1974-84	1964-84	1964-73	1974-84
Unemployment Rate	.39	.28	.46	.15	.11	.17
Inflation Rate	.91	.91	.91	.16	.19	.14
GDP-Growth Rate	1.96	1.64	2.21	.45	.31	.70
Private Consumption	2.00	1.44	2.39	.45	.28	.67
Investment	3.71	3.93	3.50	.61	.53	.79
Exports of Goods	6.55	5.17	7.59	.70	.51	.89
Imports of Goods	6.42	3.62	8.17	.69	.38	.90

Notes: Root Mean Square Error (RMSE) is defined as:

$$RMSE = \left[\frac{1}{N}\sum_{t=1}^{N}(R_t - P_t)^2\right]^{1/2}$$

Theil's Inequality Coefficient is defined:

R_t = Realized Value in Period t

P_t = Forecasted Value in Period t

$$U = \left[\sum_{t=1}^{N}(R_t - P_t)^2 / \sum_{t=1}^{N} R_t^2\right]^{1/2}$$

Values $U < 1$, $U = 1$, $U > 1$ imply that the forecast at hand is better than, equivalent to or worse than a "no change" prediction, respectively.

interpreting the results of the tests. The third column of table 1 contains the correlation coefficient between the predicted and the realized series. Except for exports and imports, the means of predicted and realized series are of roughly equal size. Standard deviations for the predicted series are, as expected, generally lower than for the realized series. Correlations between the forecasts and actual outcomes are comparatively high for unemployment and inflation. Exports and imports exhibit low correlations and the remaining series are scattered around .65.

Table 2 contains root mean square errors (RMSE) and Theil's inequality coefficient for time periods 1964-84,1964-73 and 1974-84. The break up of the time range is included in order to illustrate the remarkable change in forecasting conditions starting with the first oil shock in 1973. Ironically, the inflation forecast for Austria got "better" in terms of the inequality coefficient for the time period 1974-84 compared to 1964-73. For all other forecasts, the change in forecasting accuracy is in the expected direction, namely deteriorating.

Judging from these accuracy statistics, the unemployment rate is forecasted most accurately, closely followed by the inflation rate. The other forecasts, especially exports and imports for the time period 1974-84, lag far behind. Accordingly, in terms of the accuracy statistics, they would probably be considered as "problematic forecasts". The question is, will tests for informational efficiency confirm this pattern?

4. Empirical Results

Tests for unbiasedness of the forecasts have been performed on the assumption that the error term in the typical regression (see equation 2) follows an MA(1)

TABLE 3

Tests for Unbiasedness

Realizations regressed on forecasted values: $X_t = a + b\hat{X}_{t,t-1} + e_t$ and $e_t = \alpha\varepsilon_{t-1} + \varepsilon_t$

Series	$\hat{a}$	$\hat{b}$	R^2_c	$\hat{\alpha}$	$\chi^2_{(2)}$
Unemployment Rate	-.05 (.26)	.95 (.09)	.84	.33	3.86*
Inflation Rate	.70 (.59)	.89 (.11)	.77	-.07	1.54
Real GDP-growth	.87 (.99)	.91 (.29)	.31	-.41	5.48*
Private Consumption	.66 (.83)	.84 (.21)	.43	-.24	1.00
Investment	-1.19 (1.27)	1.30 (.29)	.49	-.19	1.33
Exports of Goods	6.54 (2.48)	.17 (.39)	-.04	-.47	9.27**
Imports of Goods	3.02 (2.46)	.66 (.38)	.09	-.43	2.86

Notes: Sample period 1964-84. Coefficients a and b have been estimated by OLS. Figures in parentheses are OLS standard errors. The χ^2_2-statistic has been calculated on the basis of the corrected variance-covariance matrix of the residuals (see footnote 11 for details).

**Significant at the 1% level.

*Significant at the 5% level.

process. Results for the seven forecasting series are contained in table 3.[11] The hypothesis of unbiasedness has to be rejected for the export forecasts at the 1% significance level and for the forecasts of real GDP-growth and the unemployment rate at the 5% significance level. For the unemployment rate, the rejection occurs narrowly at the 5 % level (critical value is 3.84). These results tend not to corroborate the evidence presented by Aiginger (1981). He used essentially the same data set with time range 1964-78 but could not reject the hypothesis of unbiasedness for any of the series. Whether the different results are due to the different test procedures, especially the respective power of the tests, or the different time range of the data is open to question.

Unbiasedness is generally considered a weak criterion of forecasting rationality. But refering to the discussion in section 2, it is worthwhile to point out that the property of unbiasedness is critically dependent on the assumption of a symmetric loss function. It is not implausible that loss functions of professional economic forecasters exhibit a kind of "pessimistic mood". This interpretation could well account for the reported biases in unemployment, real GDP-growth and export forecasts. Unemployment rates have been slightly, but consistently, overestimated. 14 forecasts out of 21 overestimated, 5 underestimated and 2 forecasts were equal to the realization. Intuitively but not necessarily, this should trigger, through economic model relationships, a corresponding underestimation of the GDP-growth rate. Further, the underestimation of GDP-growth is bound to turn up through accounting identities in the forecasts of the aggregate demand components. An underestimation of exports would fit well into this picture because exports are probably taken as exogenous in forecasting and therefore amenable to "deliberate adjustment". Looking closely at the figures in table 1 and table 3 reveals that this interpretation may be reasonable. Thus, although three of the prediction series turn out to be biased and therefore inconsistent with the implications of the REH, the outcome may be well accounted for by an "optimal prediction scenario" with an asymmetric loss function.

The test results for checking efficient use of information in forecasting are presented in table 4. A priori, one would expect efficiency tests to result in more and stronger rejections than unbiasedness tests. Two caveats, however, apply here: (1) The forecasting error should not be regressed on information not really known to forecasters at time t-1. A special but important subcase of such a misapplication would be the regression of the forecast error on revised data (e. g. public expenditures). (2) Further, one should not regress the forecast error too often on too vast a universe of information. The "data mining trap" would invalidate the significance levels of the tests and make the conclusion of inefficiency almost inevitable.

To minimize these problems only a few preliminary regressions have been run and the following set of data has been chosen in view of caveat (1): The growth rate of the nominal money supply (M2) and representative long term interest rates from both Austria and Germany. The first two variables should proxy possibly neglected information from the financial sector, whereas the inclusion of the German interest rate makes sense if viewed against the background of the close integration of the Austrian and the German economy. Further variables included are: the projected change in the nominal Austrian Federal budget deficit and the change in the nominal wage rate representing possible information about fiscal policy and labour market behaviour respectively.

The test statistics in table 4 lead to a clear cut conclusion. Only the forecast of the unemployment rate is soundly rejected as being efficient at the 1% level. The rest of the test statistics are clearly insignificant.

Interpreting these results is more difficult. The resounding rejection of the efficiency hypothesis for the unemployment rate makes sense in view of the fact

TABLE 4

Tests for Efficiency

Forecast error ($X_t - \hat{X}_{t,t-1}$) regressed on information available at time t-1.

Series	Constant	Growth Rate Money Supply (M2)	Long Term Interest R. (Austria)	Budget Deficit	Growth Rate Nominal Wages	Long Term Interest R. (Germany)	R_c^2	F(6,13)
Unemployment Rate	.05 (.53)	-.06 (.02)	-.13 (.08)	-.001 (.002)	-.02 (.02)	.18 (.08)	.53	6.49**
Inflation Rate	1.32 (1.8)	.02 (.06)	-.23 (.27)	-.01 (.01)	-.01 (.07)	.12 (.26)	.03	.96
GDP-Growth Rate	5.39 (3.9)	.07 (.12)	.18 (.58)	.01 (.01)	.02 (.15)	-.90 (.55)	.08	1.56
Private Consumption	-.84 (5.2)	.08 (.16)	.10 (.77)	.01 (.02)	-.15 (.20)	.07 (.74)	-.28	.18
Investment	7.82 (8.3)	.02 (.25)	-.25 (1.2)	-.01 (.03)	.37 (.31)	-1.20 (1.2)	-.05	.70
Exports of Goods	11.06 (14.3)	.46 (.43)	1.18 (2.1)	.04 (.05)	-.16 (.54)	-2.77 (2.03)	.03	1.29
Imports of Goods	-.12 (14.1)	.64 (.43)	2.08 (2.1)	.07 (.04)	-.23 (.53)	-2.63 (2.00)	.08	1.21

Notes: Sample Period 1966-1984.
Numbers in parenthesis are standard deviations.
**Significant at the 1% level.

that this series has been overestimated over a wide range of observations. But one would also expect similar results for the GDP-growth rate and the exports for those reasons discussed in connection with the unbiasedness test. Thus, the power of the F-test is particularly low for detecting inefficiency or the information variables chosen in this paper do not contain relevant information.

Summarizing the important results, both tests for informational efficiency reveal that the unemployment series is not consistent with the standards set for forecasting by the REH. This result should be contrasted with the forecasting accuracy measures in table 2 where the unemployment series was ranked as the "top forecast". This difference seems to be due to the fact that tests for informational efficiency take into account the stochastic nature of the series to be forecasted. The unbiasedness tests also reveal the interconnectedness of the forecasts since the bias in one series (say GDP-growth) is transmitted to other series (unemployment rate and exports). The outstanding forecast, both in terms of accuracy measures and test statistics, is the inflation series. Any normative conclusion based on these results should take into consideration the assumptions of the REH discussed in section 2, especially the assumption of symmetric loss functions.

5. Conclusion

The paper tested the forecasts of seven macroeconomic series for consistency with two implications of the REH. In section 2, the REH was discussed as a special case of the formal concept "optimal prediction" so as to bring out clearly the assumptions behind the REH. Two tests for informational efficiency were discussed and the exact form of the tests motivated. Section 3 gave a short description of the data plus several accuracy statistics.

The results revealed informational inefficiency for some of the series, notably the unemployment rate. An interpretation of the results was given in terms of asymmetric loss functions.

Work on the question of informational efficiency of economic forecasts should, in our view, be considered as complementary to the traditional accuracy analysis of forecasts. It may sometimes provide more valuable insights in forecasting procedures if the stochastic nature of the forecasted series is important for judging the quality of the forecast. But work of this kind should always stress the background assumptions of the tests and certainly not jump hastily to conclusions condemning forecasts as "irrational" or "suboptimal".

Sources of the data:

The seven forecasting series as well as the realizations of the variables have been kindly made available by K. Aiginger and G. Thury. The information variables used for the efficiency tests are all taken from the WIFO-data base with the exception of the variable "projected nominal growth rate of the Federal budget deficit" which is taken from the yearly bulletin "Der Bundesvoranschlag".

As already mentioned in the text, the realizations of the forecasted variables correspond to the official data published in March after the year they refer to. To make checks of the results possible, the forecasted and realized series are listed in a data appendix.

Data Appendix:

Unemployment Rate (realized):

1964 - 1967	2.700	2.700	2.600	2.700
1968 - 1971	3.000	2.800	2.400	2.100
1972 - 1975	1.700	1.500	1.300	2.000
1976 - 1979	2.000	1.800	2.100	2.000
1980 - 1983	1.900	2.400	3.700	4.500
1984 - 1984	4.500			

Unemployment Rate (forecasted):

1964 - 1967	2.800	2.600	2.700	2.600
1968 - 1971	2.900	2.800	2.600	2.400
1972 - 1975	2.300	2.000	1.600	1.600
1976 - 1979	2.800	2.100	2.500	2.400
1980 - 1983	2.300	2.400	3.100	4.600
1984 - 1984	5.200			

Inflation Rate (realized):

1964 - 1967	5.000	3.400	3.700	4.200
1968 - 1971	3.000	2.900	4.400	4.600
1972 - 1975	6.300	7.600	9.800	8.500
1976 - 1979	7.000	5.500	3.600	3.700
1980 - 1983	6.400	6.800	5.600	3.300
1984 - 1984	5.600			

Inflation Rate (forecasted):

1964 - 1967	3.000	3.500	3.000	5.000
1968 - 1971	3.500	2.800	4.200	5.100
1972 - 1975	4.700	7.500	8.500	9.500
1976 - 1979	7.500	6.300	4.500	3.000
1980 - 1983	4.800	6.000	5.800	4.200
1984 - 1984	5.300			

Real GDP-Growth Rate (realized):

1964 - 1967	6.300	2.600	4.700	3.000
1968 - 1971	4.100	6.400	7.100	5.200
1972 - 1975	6.400	5.800	4.100	-2.000
1976 - 1979	5.200	3.500	1.500	5.200
1980 - 1983	3.600	.100	1.100	1.500
1984 - 1984	2.200			

Real GDP-Growth Rate (forecasted):

1964 - 1967	4.500	5.000	4.200	3.200
1968 - 1971	2.300	5.000	5.000	4.000
1972 - 1975	4.000	5.000	3.000	3.500
1976 - 1979	1.500	4.000	1.500	3.000
1980 - 1983	2.500	.000	2.000	.500
1984 - 1984	1.500			

Real Private Consumption Growth Rate (realized):

1964 - 1967	3.900	5.200	4.600	3.200
1968 - 1971	3.600	2.800	5.800	7.200
1972 - 1975	8.300	4.100	3.700	2.500
1976 - 1979	4.000	6.900	-3.400	5.100
1980 - 1983	1.600	.200	1.100	3.500
1984 - 1984	-.900			

Real Private Consumption Growth Rate (forecasted):

1964	- 1967	5.500	4.600	5.000	4.200
1968	- 1971	3.000	4.800	5.000	5.500
1972	- 1975	5.500	5.000	5.500	6.000
1976	- 1979	2.500	3.500	1.000	3.000
1980	- 1983	1.000	.000	1.000	.500
1984	- 1984	-1.500			

Real Gross Investment Growth Rate (realized):

1964	- 1967	7.600	5.600	7.100	-.100
1968	- 1971	-1.200	4.800	10.500	12.000
1972	- 1975	11.400	2.800	1.200	-5.900
1976	- 1979	5.700	8.200	-3.200	4.200
1980	- 1983	3.400	-2.000	-5.400	-2.200
1984	- 1984	1.700			

Real Gross Investment Growth Rate (forecasted):

1964	- 1967	2.000	8.500	3.500	2.000
1968	- 1971	1.000	8.000	8.500	6.000
1972	- 1975	5.500	5.500	3.000	1.000
1976	- 1979	.500	6.500	1.500	2.500
1980	- 1983	3.500	-.500	-1.000	.500
1984	- 1984	2.000			

Real Exports of Goods Growth Rate (realized):

1964	- 1967	5.500	7.500	7.100	7.300
1968	- 1971	10.200	18.100	13.400	.400
1972	- 1975	11.300	9.800	10.300	-9.300
1976	- 1979	14.200	6.000	7.800	12.300
1980	- 1983	4.400	4.900	1.400	3.800
1984	- 1984	10.000			

Real Exports of Goods Growth Rate (forecasted):

1964	- 1967	5.000	7.000	7.000	4.000
1968	- 1971	5.500	7.500	13.500	7.000
1972	- 1975	2.500	9.500	3.500	6.500
1976	- 1979	3.000	8.000	4.000	7.300
1980	- 1983	4.000	3.000	7.000	-2.000
1984	- 1984	.000			

Real Imports of Goods Growth Rate (realized):

1964	- 1967	9.100	9.500	10.000	1.500
1968	- 1971	7.600	8.900	15.900	7.000
1972	- 1975	10.800	8.400	5.500	-10.800
1976	- 1979	20.300	7.700	-2.100	10.300
1980	- 1983	7.100	-4.100	-1.100	6.200

Real Imports of Goods Growth Rate (forecasted):

1964	- 1967	6.000	9.500	9.000	6.500
1968	- 1971	5.000	8.300	10.500	7.000
1972	- 1975	4.000	12.000	4.000	6.000
1976	- 1979	3.500	6.500	-1.000	8.000
1980	- 1983	4.300	-1.500	4.000	-1.000
1984	- 1984	.000			

NOTES

[1] For a comprehensive review of the theoretical discussion about the issue of stabilization policy under rational expectations, see McCallum (1980). The empirical evidence on the question is surveyed by Barro (1981). Begg (1982) gives an overview on other fields of research (e. g. consumption, investment, financial markets).

[2] Thury (1984) presents a plethora of accuracy measures on forecasts published by three institutions for the Austrian economy with sample period 1974-84.

[3] Most work directly testing observed expectations for rationality uses the inflation survey data collected by the business columnist J. Livingstone. Only a very comprehensive survey article could do justice to the rapidly expanding literature on the Livingstone survey data. See Sheffrin (1983) for a short overview.

[4] An interesting feature of the "testing for rationality" literature has been the interpretation of results concerning the empirical validity of the REH. The studies using survey data generally interpret their results as direct evidence on the empirical validity of the REH, whereas studies employing professional forecasts as a data base consider the REH as a standard of rationality. This paper takes neither of these positions.

[5] Granger and Newbold (1973) use the same formal framework in a discussion of the usefulness of various accuracy statistics for evaluating prediction performance.

[6] The words "interpretation" and "model" are used in this context in the sense of model theory, meaning, vaguely speaking, that the REH gives an "actual description" of the components of an optimal prediction.

[7] The specifications (B'), (C') and (D') are subject to extensive controversy; some of the main points of critique are discussed by Shiller (1978).

[8] A third type of test, the consistency test, is relevant if forecasts have been made for more than one time period ahead.

[9] Peel and Walters (1984) present a different, but presumably flawed argument to derive formula (8). The argument in this paper is based on the assumption that forecasters derive their partial knowledge about the realization of e_{t-1} from observing the contemporanous innovation in another variable Y_t (the argument may be generalized to the case of n variables being observed). If the innovations e_{t-1} and v_{t-1} (stemming from Y_t) are orthogonal, the forecast error is expressible as the sum of a MA(1) and a MA(0) process. This sum can eventually be written as an MA(1) process (see Harvey, 1981, p. 43).

[10] For details see Brown and Maital (1981) or for the actual calculations in this paper note (11). The pioneer work for testing unbiasedness under the assumption of general MA(q)-processes for the error term is due to Hansen. See the paper by Hansen and Hodrick (1980).

[11] The following steps lead to the χ^2-test statistics reported in table 3:
(1) An OLS regression was performed to get unbiased estimates of a and b.
(2) A program written by A. Pagan was employed to estimate the moving average parameter in a regression with a specified MA(1) error term.
(3) The estimated parameter $\hat{\alpha}$ was used for calculating the variance-covariance matrix of the residuals ($\hat{\Omega}$). See Judge et. al. (1980), pp. 196-97 for the form of this matrix.
(4) The test statistic $q = (\hat{\beta} - \beta_0)' X'X(X'\hat{\Omega}X)^{-1}X'X(\hat{\beta} - \beta_0)$ was calculated, where the vector represents the OLS-estimates a and b. q is asymptotically χ^2 distributed. For references see note 10.
All computations, estimates and tests were done with the Institute for Advanced Studies' IAS-SYSTEM econometric software package.

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