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FORECAST ERRORS AND FINANCIAL DEVELOPMENTS

by

Palle S. Andersen

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Abstract

As central banks have moved towards a forward-looking implementation of monetary policy, the role of forecasts in the policy process has greatly increased. Against this background, this paper looks at the accuracy of forecasts and, more specifically, addresses the question whether forecasts of growth and inflation can be improved by including information from financial markets. The empirical work presented suggests that average forecast errors are not large enough to seriously undermine the basis for forward-looking monetary policies, except in periods of common shocks and at cyclical turning points. It also appears that unexpected changes in non-financial variables are the primary source of forecast errors. Nonetheless, for several countries, forecasts could also be improved by using the information contents of changes in the yield curve and of movements in exchange rates and other asset prices.

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Introduction

As inflation has been reduced to very low levels in most countries, more and more central banks have moved towards a forward-looking or pre-emptive implementation of monetary policy. There are essentially three reasons for this change: (i) a general consensus that the best way in which central banks can support real growth is by preventing inflation from reaccelerating; (ii) the rather long lags between changes in monetary policy and their impact on growth and inflation implying that monetary policy today has to take account of likely developments over the next one to two years; and (iii) growing evidence that the temporary trade-off between output and inflation is asymmetric, supporting the view of many policy makers that the costs of reducing inflation are significantly higher than the temporary benefits from higher inflation and that there are significant gains from preventing an overheating of the economy.

Because of this shift, monetary policy is increasingly based on expected developments. Indeed, in countries that have adopted inflation targets, one of the defining features is the paramount role that inflation forecasts play in the policy process and in communicating policies to the general public. Moreover, in countries that no longer rely on intermediate monetary aggregate targets but instead monitor a wide range of indicators, forecasts seem to play a more prominent role than they used to. In fact, even in countries with fixed exchange rate targets, the reliance on forecasts may have increased as signs of potential future deviations from the core currency country would imply a need for policy corrections.

The greater role of forecasts in the policy process raises several questions that will be addressed in this paper. How accurate or precise are forecasts and does low accuracy pose problems for the implementation of monetary policy and for the credibility of central banks? What are the main sources of forecast errors and are there particular phases of the business cycle where forecast errors are particularly large?[1] How can forecasts be improved? More specifically, given the marked changes in national and international financial markets and the unexpectedly slow recovery of the industrial countries from the 1989-91 recession, is there a relationship between developments in financial markets, including asset prices, and forecast errors?

To answer these questions, the paper estimates regressions of the form:[2]

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1 The size and nature of forecast errors as well as the comparative performance of different forecasters have been studied in numerous earlier papers; see, for instance, Artis (1988 and 1996), Granger (1996), Zarnowitz (1992) and several articles by McNees (see the Bibliography).

2 Although this paper only looks at forecast errors from one model, some readers may find it useful to interpret the results within the framework proposed by Holden and Thompson (1997) for tests of forecast encompassing and efficiency. To illustrate, assume that two models, *F* and *G*, are available, and that we are interested in knowing whether *G* adds anything to the prediction power of *F*. One way of testing this would be to estimate the equation:

$$y_t^{actual} - y_t^{forecast,F} = \beta(y_t^{forecast,G} - y_t^{forecast,F})$$

(1) $$y_t^{actual} - y_t^{forecast} = \alpha + \beta(x_t^{actual} - x_t^{forecast}) + \sum_i \delta_i z_{t-i} + \varepsilon_t$$

where the dependent variable is the forecast error for output or inflation in year *t*, *x* is a vector of variables for which the development in year *t* differs from what the forecaster had predicted and *z* is another vector of variables which are known to the forecaster at the time of the forecasts but affect the outcome in a different way from what had been expected. Furthermore, ε denotes the random error of the regression (or the remaining forecast error) and α, β and δ are vectors of parameters.

Unexpected changes in variables assumed to be exogenous by the forecaster are contained in the vector *x*, for instance, changes in policy instruments or exchange rates. *x* may also comprise changes which were incorrectly captured by the forecasting model or totally ignored, for instance, cyclical turning points and financial or non-financial shocks to the world economy.

While unexpected developments in the *x*-variables can be regarded as "shocks" or "innovations", estimated effects of the *z*-variables mainly capture various modelling errors, such as incorrect coefficients or lag structures for variables included in the model but also the impact of variables that the forecaster has ignored when making predictions. In theory, indicators of financial developments could be included in both *z* and *x* but, in practice, we mainly found such variables in *z*; i.e., contrary to what we expected when starting this work, we found little evidence of any direct relationship between financial shocks and forecast errors.

Trying to answer several questions using just one equation is not easy. In fact, several sources of biases and errors should be recognised. First, with only 16 annual observations per country (1980-95), an extensive search for possible sources of errors faces the risk of "data mining" biases of an unknown size. One possible solution to this problem would have been to extend the data base to include 1970-80. However, because forecast errors during this period were mainly due to supply shocks (see, for instance, Artis (1988)) while those occurring after 1980 can mostly be ascribed to demand shocks, such an extension would not add much information. Instead, we have tried to strengthen the statistical inferences by supplementing the country-specific time series analyses with panel estimates.[3]

Secondly, because OECD forecasts (the principal data source for this study) are conditional on the policies known at the time of the forecasts, it is natural to include unforeseen policy changes among the variables tested. One condition for identifying the effect of such policy changes is that they are exogenous and independent of the forecast errors themselves. However, as further discussed in Section 4 of the paper, this condition is not satisfied when policy-makers respond to

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If β is significant, model *G* contains information (for instance, more variables or more plausible parameters) which would improve the accuracy of predictions from *F*.

3 To reduce the risk of multicollinearity and "sharpen" the estimated influence of financial developments, equation (1) was also estimated with all non-financial variables suppressed.

evidence that output growth or inflation is deviating from earlier forecasts. Another difficulty in testing the influence of policy changes is the small number of observations referred to above. To overcome this, we did not evaluate policy effects using estimates of equation (1) but by *ex post* simulations.

Thirdly, an alternative way of assessing whether financial variables help to improve the forecasts would be to estimate the equation:

$$(2) \qquad y_t^{forecast} = \alpha' + \sum_i \beta'_{t-i} z'_{t-i} + \sum_i \delta'_{t-i} x'_{t-i} + \varepsilon'_t$$

where *z*' denotes a vector of variables normally used in making forecasts, *x*' financial variables which may potentially improve the forecasts and ε' a random error. A subsequent comparison of $y^{forecast}$ with y^{actual}, complemented with an F-test on the contribution of *x*', then tells whether the inclusion of such variables is helpful.[4] However, one important difference between the two approaches is that $y^{forecast}$ in (1) is not a "pure" model forecast but includes subjective or intuitive adjustments ("add factors") by the forecaster whereas $y^{forecast}$ in (2) does not. Because such add factors are difficult to quantify and have "odd" statistical properties, the error term in (1) may not satisfy the conditions required for statistical tests.

Finally, it should be stressed that even though a number of significant correlations will be reported in the paper, conclusive evidence of *causal* relations has not been identified. Similarly, it is generally difficult to derive *structural* equations from the estimated relations. This is especially so for variables in the *x*-vector but, in case of autocorrelation, would also apply to the *z*-variables.

Nonetheless, to summarise the major findings of the paper, it appears that forecasters systematically underpredict changes in the trends of both output growth and inflation and that, in periods of generally falling price increases, the rate of inflation is overpredicted. Moreover, forecast errors are positively correlated across countries, reflecting interactions via international trade and capital flows and making forecasts particularly vulnerable to common financial and non-financial shocks. Finally, the paper identifies a number of significant relations between financial developments and forecast errors. However, these relations are not very robust across countries and their strength also seems to vary over time.

The paper consists of five sections. Section 1 presents some general statistical features and relations of the forecast errors for output growth and inflation.[5] Section 2 attempts to relate the forecast errors to monetary and financial market developments, using time series data for individual countries, while Section 3 goes one step further in using panel data to analyse the potential influence

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4 See, for instance, Tallman and Chandra (1997) and several of the references in Section 2.

5 The analysis is confined to forecast errors for real GDP growth and inflation and does not discuss forecast errors for individual demand components or components of inflation. We also exclude balance of payments forecasts, which are generally known to suffer from relatively large errors (see, for instance Artis *op cit*).

of monetary and financial developments. Section 4 reports and discusses the results of *ex post* simulations of the OECD Interlink Model and the last section concludes. Two annexes complement the main text. Annex A discusses more formally the likely signs of the regression coefficients estimated in Section 2 and Annex B presents country-specific results of the *ex post* simulations.

1. General statistical features and relations

The source of the forecast errors analysed in the following is the OECD semi-annual *Economic Outlook* for the period 1980-95.[6] This source was *not* chosen in the expectation of finding particularly large errors or with the intention of criticising the OECD forecasting procedures and record. On the contrary, it was chosen because:

- it provides a consistent time series, unlike the forecasts made by other institutions and agents, which often show breaks or change the date of the forecasts;
- the *Economic Outlook* contains a number of additional variables or assumptions which are relevant to evaluating the forecasts and the possible errors;
- the *Economic Outlook* presents comparable and consistent forecasts for a large number of countries and recognises various cross-country constraints;[7]
- earlier comparative studies have shown that the forecast errors in the OECD *Economic Outlook* are of largely the same magnitude as those found in other publications of a similar nature, in particular the IMF *World Economic Outlook*;[8]
- finally, given the semi-annual series of meetings held at the OECD, the forecasts in the *Economic Outlook* are largely representative of official forecasts for individual countries.

Various statistical measures of the forecast errors for real GDP growth, the rate of inflation (measured by changes in the GDP deflator) and nominal GDP growth are presented in Tables 1-3. Throughout this paper the forecast errors are measured as *outcome less forecast,* so that a negative (positive) error indicates that the outcome is over- (under-) predicted. Moreover, to illustrate the dependence of forecast errors on the date of the forecasts, Tables 1-3 present two types of error, though for the subsequent analyses we rely only on the second type:

- *current-year* forecast errors which refer to forecasts made for year *i* in June of year *t*, compared with the outcome for year *i* as of June of year *t* + 1;

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6 The structure of OECD Interlink Model used for the forecasts and its evolution over time is described in several OECD *Working Papers.*

7 For instance, the aggregate current balance of payments for the world should be zero or kept within certain limits of past aggregation errors.

8 See Artis (1988) and OECD (1993).

- *year-ahead* forecast errors which refer to forecasts made for year *t* +1 in December of year *t*, compared with the outcome for year *t* + 1 as of December of year *t* + 2.

Table 1

Forecast errors, current year, real GDP growth, 1980-95

	US	**JP**	**DE**	**FR**	**IT**	**UK**	**CA**	**G7**
$\bar{g}$	2.3	3.4	2.0	1.7	1.8	1.6	2.1	2.1
AVE	–0.8	0.14	0.17	0.14	–0.10	0.03	–0.24	0.01
MAE	0.58	0.83	0.78	0.62	0.56	0.52	0.95	0.47
MAE/$\bar{g}$	0.25	0.25	0.40	0.37	0.31	0.33	0.44	0.22
RMSE	0.72	0.98	0.93	0.72	0.74	0.68	1.18	0.57
RMSE/*V*	0.24	0.26	0.37	0.35	0.23	0.26	0.36	0.23
β	–0.13	0.09	–0.15	–0.03	–0.01	0.06	0.03	0.02
δ	–0.14	–0.21	–0.27	–0.14	0.09	–0.16	–0.24	–0.11

Forecast errors, year ahead, real GDP growth, 1980-95

	US	**JP**	**DE**	**FR**	**IT**	**UK**	**CA**	**G7**
$\bar{g}$	2.4	3.5	2.1	1.7	1.7	1.7	2.1	2.2
AVE	0.23	0.08	0.11	–0.13	–0.10	0.15	–0.48	–0.05
MAE	1.05	1.05	1.16	0.90	0.90	1.18	1.69	0.75
MAE/$\bar{g}$	0.44	0.30	0.56	0.53	0.52	0.71	0.81	0.34
RMSE	1.21	1.23	1.37	1.15	1.08	1.44	2.06	0.94
RMSE/*V*	0.38	0.32	0.47	0.55	0.45	0.52	0.63	0.38
β	–0.17	–0.95	–0.20	–0.15	–0.03	0.05	–0.11	–0.01
δ	0.15	–0.05	–0.23	–0.11	0.25	0.47*	–0.15	0.06

Notation: $\bar{g}$: average growth of GDP, %; *AVE*: mean error; *MAE*: mean absolute error; *V*: root mean squared of actual output growth; *RMSE*: root mean squared error; β: coefficient obtained from regressing forecast errors on the forecasts; δ: first order autocorrelation of forecast errors; G7: average growth and error information, unweighted averages; and *, **: coefficient significant at respectively the 95 and 99% level.

(i) Forecast errors for real growth

Eight general measures are provided for the forecasts for real GDP growth (Table 1) and they are repeated in Tables 2 and 3 for inflation and nominal GDP growth. The average rate of growth for the sample period 1980-95 ($\overline{g}$) for each of the G-7 countries and their unweighted average (G7). The average forecast errors (*AVE*) which, for unbiased and efficient forecasts, should not be significantly different from zero. As the table shows, the forecasts for real GDP growth are in all cases unbiased.[9] The mean absolute error (*MAE*) which measures the forecast errors regardless of sign. When the *MAE* is compared with the average actual growth rate ($MAE/\overline{g}$), it gives an indication of the relative size of the error, which in all cases ranges from 0.25 - 0.5% for the current year, rising to 0.3 - 0.8% for the year-ahead forecasts. The root mean squared errors (*RMSE*) which tend to "penalise" large forecast errors. Similar to *MAE*, the *RMSE*s can be compared with the variance of the actual growth rate (*RMSE*/*V*) to provide an indication of the relative size of the error variance. The ranges of the relative *RMSE*s are of about the same size as those of the relative *MAE*s. The last two measures are usually used in evaluating the efficiency of the forecasts, with β obtained by regressing the forecast errors on the actual forecasts and δ by regressing the current forecast error on the one-year lagged error.[10] In both cases, a coefficient significantly different from zero would indicate that information has not been used efficiently. However, except for the year-ahead forecast for UK growth, all forecasts satisfy the efficiency conditions.

(ii) Forecast errors for inflation

This is not, however, the case for the inflation forecasts (Table 2). For four of the G-7 countries, neither the current-year nor the year-ahead forecasts are efficient. In particular, information available from the size and structure of past errors has not been taken sufficiently into account. This apparent tendency to ignore past errors (in most cases overpredictions of inflation) probably also explains why, for the same four countries, the forecasts are biased, in the case of Japan by as much as 0.6 of 1 percentage point per year.[11, 12] Despite the biases and inefficiencies, the relative size of the forecast errors tends to be smaller than those for real output growth, the main exception to this being Italy. The inflation forecasts for Italy also differ from those for the other G-7 countries in that inflation is actually underpredicted.[13]

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9 We also tested for unbiasedness using pooled data but, unlike Artis (1996), we did not find any tendency towards overpredicting growth.

10 As noted by Pain and Britton (1992) and Barrionuevo (1992), a *necessary* but not *sufficient* condition for an optimal (or rational) forecast is that it is unbiased. In addition, the forecast has to be independent of the forecast value (β-condition) and independent of past forecast errors (δ-condition).

11 In the 1970s, by contrast, rates of inflation were widely underpredicted; see Artis (1988) and Croushore (1996). This suggests that forecasters tend to underpredict inflation when it is accelerating and overpredict inflation when it is decelerating.

12 See also Granger's (1996) argument that the accuracy of forecasts could be significantly improved by including past forecast errors in the conditioning set.

13 In the case of Canada, Campbell and Murphy (1996) find that private sector forecasters are more accurate in predicting inflation than in forecasting other macroeconomic variables.

Table 2

Forecast errors, current year, change in GDP deflator

	US	JP	DE	FR	IT	UK	CA	G7
$\overline{p}$	4.1	1.3	3.3	5.4	9.3	6.2	4.3	4.8
AVE	–0.21*	–0.60*	0.09	–0.13	0.54*	–0.04	–0.36*	–0.10
MAE	0.31	0.71	0.46	0.48	0.88	0.78	0.64	0.33
MAE/$\overline{p}$	0.07	0.55	0.14	0.09	0.09	0.12	0.14	0.07
RMSE	0.40	0.90	0.56	0.60	1.10	1.01	0.83	0.41
RMSE/*V*	0.09	0.55	0.16	0.09	0.10	0.14	0.15	0.07
β	–0.05*	–0.32*	0.03	–0.02	0.04**	–0.03	–0.05	–0.02
δ	0.09	0.57*	0.17	0.03	–0.23	–0.03	0.49*	0.07

Forecast errors, year ahead, change in GDP deflator

	US	JP	DE	FR	IT	UK	CA	G7
$\overline{p}$	4.1	1.3	3.2	5.3	9.3	6.3	4.3	4.8
AVE	–0.65*	–0.86*	0.21	–0.18	0.69*	–0.18	–0.61*	–0.23
MAE	0.68	1.06	0.55	0.53	1.28	1.05	1.16	0.52
MAE/$\overline{p}$	0.16	0.81	0.17	0.10	0.14	0.17	0.27	0.11
RMSE	0.91	1.32	0.67	0.61	1.54	1.28	1.31	0.62
RMSE/*V*	0.20	0.80	0.19	0.09	0.14	0.18	0.25	0.11
β	–0.13*	–0.43	0.05	–0.03	0.06**	–0.02	–0.07	–0.04
δ	0.74*	0.65*	0.12	0.20	0.42	–0.00	0.54*	0.55*

Notation: See Table 1, except for $\overline{p}$ (average rate of inflation).

(iii) Forecast errors for nominal GDP growth

A typical finding in analyses of the 1970s and early 1980s was that forecast errors for real growth and inflation tended to be mutually offsetting, so that predicted changes in nominal GDP were quite close to the actual outcomes. This is not the case for the sample used in this paper (Table 3), probably because the major source of forecast errors has been demand shocks (which affect output and the rate of inflation in the same direction) whereas in the earlier periods supply shocks (which affect output and inflation in opposite directions) dominated. Thus for the United States, Japan

Table 3

Forecast errors, current year, nominal GDP growth

	US	**JP**	**DE**	**FR**	**IT**	**UK**	**CA**	**G7**
$\overline{y}$	6.4	4.7	5.3	7.1	11.1	7.8	6.4	6.9
AVE	–0.29	–0.46**	0.26	0.00	0.43	–0.01	–0.61	–0.10
MAE	0.60	0.81	0.84	0.77	0.83	0.99	1.31	0.53
MAE/$\overline{y}$	0.09	0.17	0.16	0.11	0.07	0.13	0.21	0.07
RMSE	0.74	1.12	0.94	0.95	1.15	1.23	1.61	0.64
RMSE/*V*	0.11	0.22	0.17	0.12	0.10	0.14	0.22	0.09
β	–0.03	–0.10*	0.05	–0.01	0.03	–0.01	–0.06	–0.01
δ	0.18	0.45*	0.09	-0.18	–0.01	–0.06	0.27	0.30

Forecast errors, year ahead, nominal GDP growth

	US	**JP**	**DE**	**FR**	**IT**	**UK**	**CA**	**G7**
$\overline{y}$	6.5	4.8	5.3	7.0	11.0	8.0	6.4	7.0
AVE	–0.42**	–0.96*	0.32	–0.32	0.59	–0.07	–1.09**	–0.15
MAE	1.08	1.56	1.09	1.22	1.66	1.39	2.11	0.79
MAE/$\overline{y}$	0.16	0.32	0.21	0.17	0.15	0.18	0.33	0.11
RMSE	1.40	1.92	1.31	1.43	2.15	1.75	2.75	1.00
RMSE/*V*	0.20	0.37	0.24	0.18	0.18	0.20	0.38	0.13
β	–0.05	–0.18*	0.05	–0.05	0.06	0.01	–0.14**	–0.02
δ	0.15	0.62*	-0.12	0.16	0.45*	0.13	0.27	0.27

Notation: See Table 1, except for $\overline{y}$ (average rate of growth of nominal GDP).

and Canada, the biases of the inflation forecasts are reflected in the forecasts for nominal GDP and in three cases (Japan, Italy and Canada) the efficiency conditions are not met.[14] Even so, the relative size of the *MAE*s and the *RMSE*s is much smaller than for real growth and inflation.[15]

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14 Due to the bias, the forecast for US nominal GDP is also inefficient.

15 The *MAE*s and *RMSE*s for the G-7 average are also significantly smaller than those shown for each individual country. While this might give the impression that an overprediction for country *i* is partly offset by an underprediction for country *j*, it is merely the tautological property that for any set of numbers (in this case forecast errors) the absolute value of their mean is less than (or equal to when the actual value is outside the range of all predicted values) the

All in all, the average forecast errors for real growth and inflation do not seem large enough to seriously undermine the process of formulating and implementing monetary policy. However, at turning points in the cycle and in periods of common shocks the forecast errors are larger. Moreover, possibly due to mean reverting expectations, forecasters have overpredicted inflation in several countries during the last 16 years.

(iv) Inter-country and intra-country correlations of forecast errors

To analyse the impact of common shocks and possible relationships between forecast errors for real growth and inflation, Table 4 looks at the extent to which one-year-ahead forecast errors are correlated across and within countries. One source of cross-country correlations of forecast errors for inflation may be unexpected exchange rate changes. This would generate negative (positive) correlations for countries experiencing exchange rate movements in the opposite (same) directions vis-à-vis other G-7 countries. The significant positive correlation of inflation forecast errors in Italy/Canada, Italy/United Kingdom and partly also United States/United Kingdom (entries above the diagonal) might thus reflect the influence of exchange rate changes. In contrast, the positive correlations for inflation forecast errors in Germany/Italy and France/Canada seem to be just coincidental.

Table 4

Correlation of forecast errors

Year-ahead forecasts

Country	**US**	**JP**	**DE**	**FR**	**IT**	**UK**	**CA**
US	**–0.02**	0.36	–0.14	0.19	0.16	0.49*	0.30
JP	0.15	**0.10**	0.12	0.04	–0.22	0.09	–0.21
DE	0.30	0.57**	**–0.35**	–0.02	0.47*	0.01	0.24
FR	0.45*	0.70**	0.71**	**0.24**	0.37	0.30	0.62**
IT	0.49*	0.33	0.23	0.48	**0.40**	0.48*	0.70**
UK	0.48*	0.10	0.12	0.31	0.17	**–0.16**	0.38
CA	0.71**	0.31	0.47*	0.45*	0.42	0.42	**0.21**

Notes: Figures *above* the diagonal indicate bilateral correlations of forecast errors for inflation.
Figures *on* the diagonal indicate correlations between forecast errors for respectively inflation and growth *within* each of the seven countries.
Figures *below* the diagonal indicate bilateral correlations of forecast errors for growth.
*, ** Coefficient significant at respectively the 95 and 99% level.

mean of their individual absolute values. Similarly, for any set of numbers the squared value of their mean is less than (or equal to) the mean of the squared value of the individual numbers. See McNees (1987b) on the properties of consensus forecasts.

The cross-country correlations of forecast errors for real growth (entries below the diagonal) could also reflect exchange rate movements. However, because of the long and uncertain lags with which such changes affect output, their influence on contemporaneous forecast errors is likely to be much smaller and will, in most cases, be dominated by errors related to the trade multipliers, policy changes and common supply and, in particular, demand shocks. The significant correlations shown for the US column in Table 4 probably indicate demand-side linkages as does the high correlation seen for Germany/France. The significant correlation observed for Germany/Japan is difficult to interpret but could reflect common exchange rate movements vis-à-vis other G-7 countries.

The figures along the diagonal, showing within-country correlations of forecast errors for inflation and real growth, suggest that such errors are largely independent of each other. However, as will be shown below, quite high covariations are found in some countries once other factors are included in the analysis.

(v) "Large" forecast errors

While forecast errors are small on average, the range of errors for individual years and countries is rather wide. Moreover, large forecast errors tend to be concentrated on certain years, suggesting that these years might be "candidates" for analysing possible influences of financial and monetary developments (Table 5 and Graphs 1a - 1g). For instance, both GDP growth and the rate of inflation tended to be overpredicted during 1981-82 when a number of countries simultaneously tightened monetary policy to bring inflation under control. In contrast, growth was underpredicted for 1988-89, probably reflecting that forecasters expected the 1987 stock market crash to have a major contractionary effect and did not take sufficient account of compensatory monetary measures.

During the latest recession, growth was also underpredicted in virtually all countries, confirming earlier findings that turning points are difficult to predict but, perhaps, also suggesting that new and additional factors (debt reduction and balance-sheet restructuring) were at work. However, because of the asynchronous business cycle, the forecast errors for the 1990s were not concentrated on specific years, but ranged from 1991 in the United States, the United Kingdom and Canada to 1993 for the continental European countries and 1993-95 for Japan. Note also that despite the nature of the business cycle, there were no offsetting effects across countries as the G-7 average shows a series of large overpredictions for the first half of this decade, which was only broken temporarily in 1994.

Table 5

"Large" forecast errors*

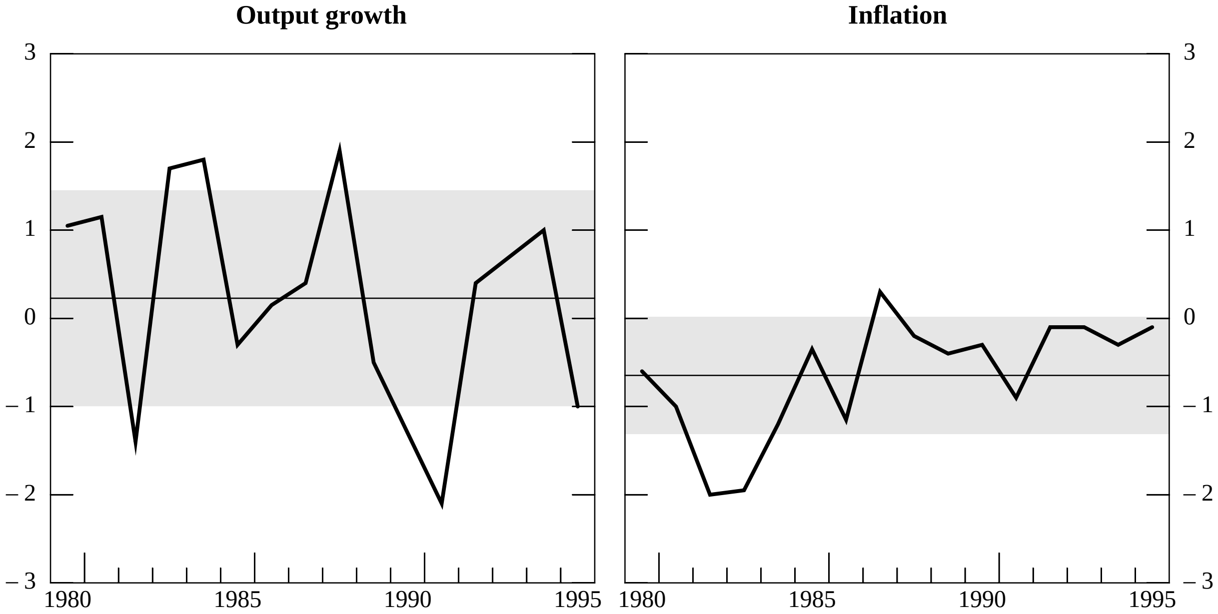
Year-ahead forecasts

Country	Growth		Inflation	
United States	1982	(–)	1982-83	(–)
	1983-84	(+)	1987	(+)
	1988	(+)		
	1991	(–)		
Japan	1984	(+)	1980-83	(–)
	1987-88	(+)	1986	(+)
	1993	(–)	1989	(+)
	1995	(–)		
Germany	1982	(–)	1982	(+)
	1983	(+)	1984	(–)
	1988	(+)	1986	(+)
	1993	(–)	1992	(+)
	1994	(+)	1993-94	(–)
France	1984	(+)	1980	(+)
	1988	(+)	1982	(–)
	1993	(–)	1986	(+)
	1994	(+)	1989	(+)
			1991	(–)
Italy	1980	(+)	1980	(+)
	1982-83	(–)	1983-84	(–)
	1988	(+)	1989	(+)
	1993	(–)	1992-93	(–)
United Kingdom	1982-83	(+)	1980	(+)
	1991-92	(–)	1981-82	(–)
			1985	(+)
			1988	(+)
			1993	(–)
Canada	1981	(+)	1980-81	(+)
	1982	(–)	1984	(–)
	1983	(+)	1987	(+)
	1988	(+)	1989	(+)
	1991	(–)	1990-91	(–)
G-7	1982	(–)	1980	(+)
	1984	(+)	1981	(–)
	1988	(+)	1984	(–)
	1991-93	(–)	1985-86	(+)
	1994	(+)	1988	(+)
	1995	(–)		

* Years in which the forecast error deviated by more than one standard error from the mean.
(+): outcome exceeds forecast; (–): outcome below forecast.

Graph 1a

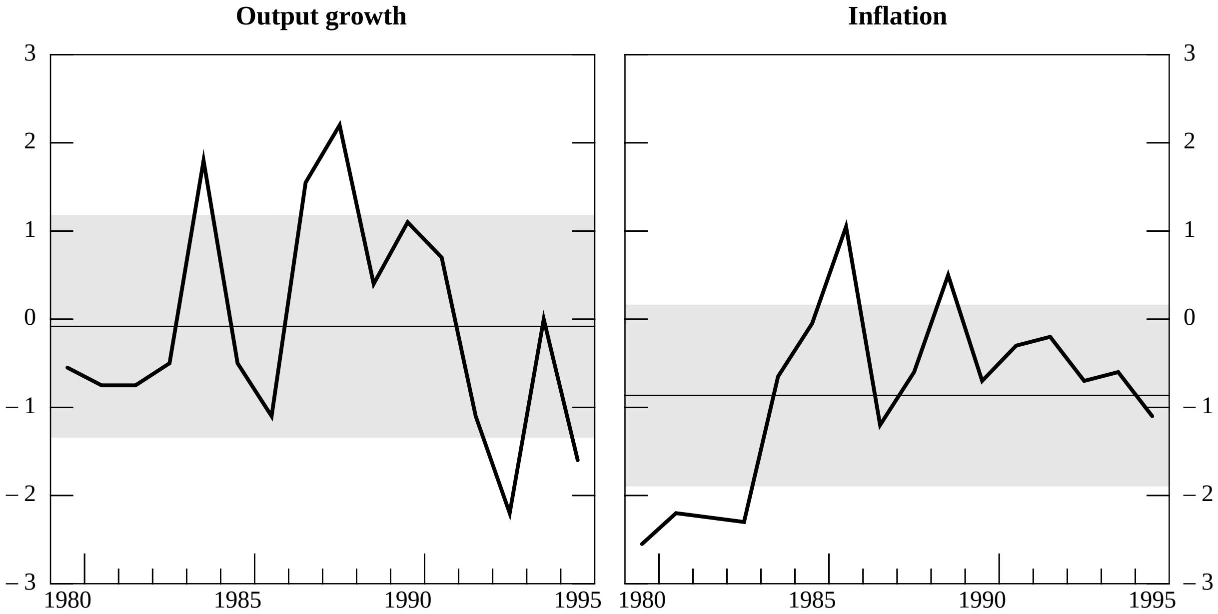
Forecast errors, one year ahead: United States



Note: The horizontal reference line represents the mean and the shaded band the mean ±1 standard deviation.

Graph 1b

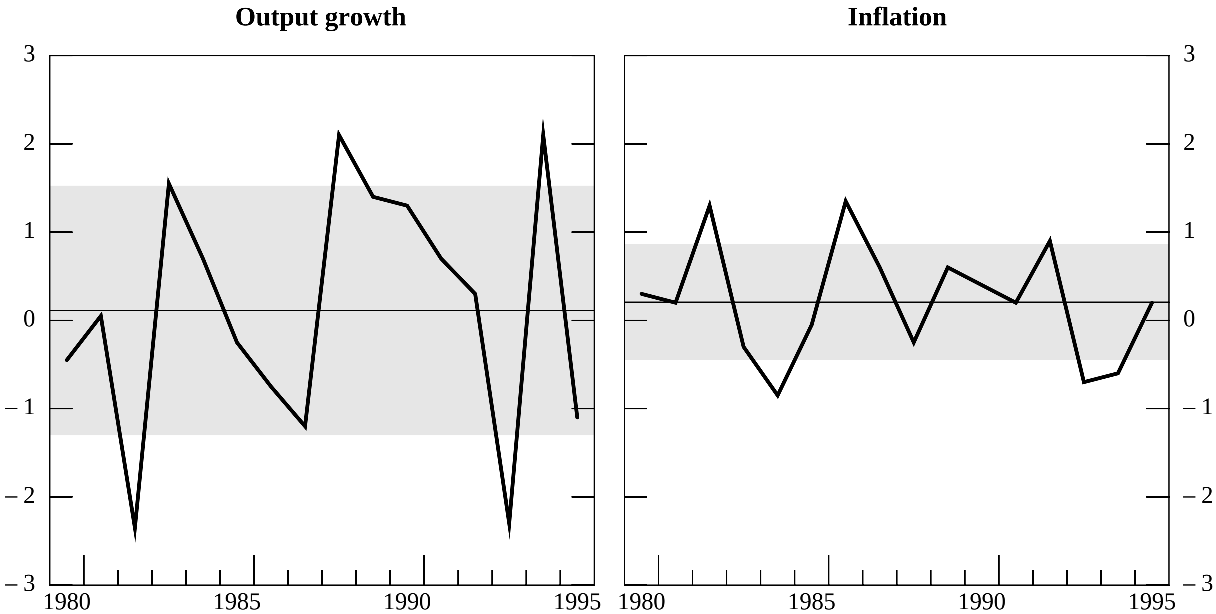
Forecast errors, one year ahead: Japan



Note: The horizontal reference line represents the mean and the shaded band the mean ±1 standard deviation.

Graph 1c

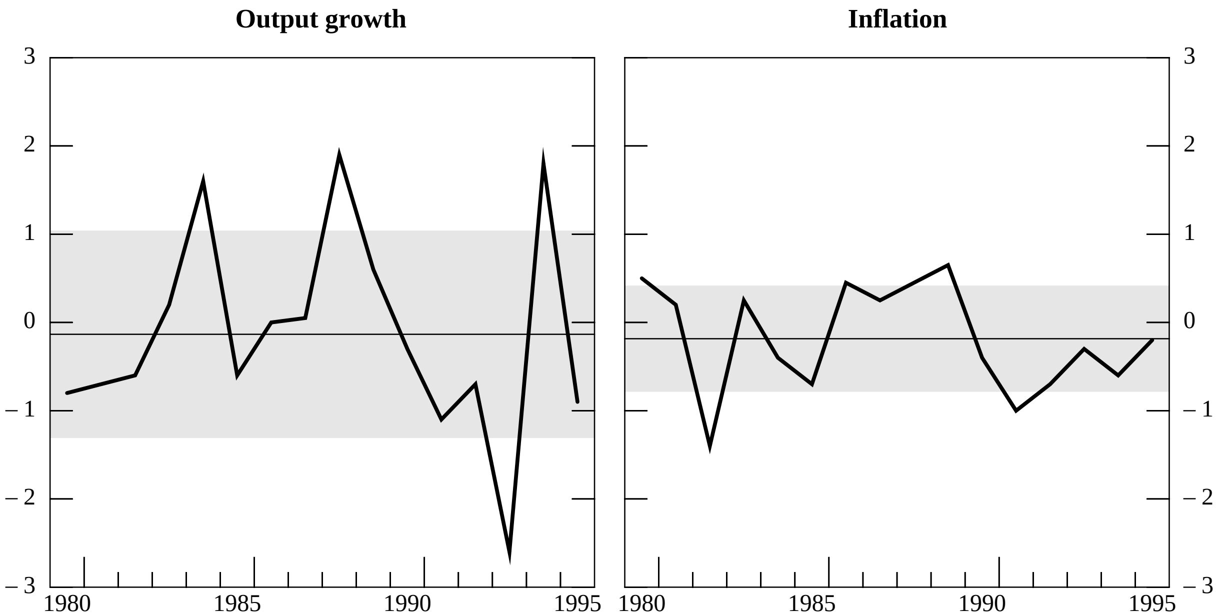
Forecast errors, one year ahead: Germany



Note: The horizontal reference line represents the mean and the shaded band the mean ±1 standard deviation.

Graph 1d

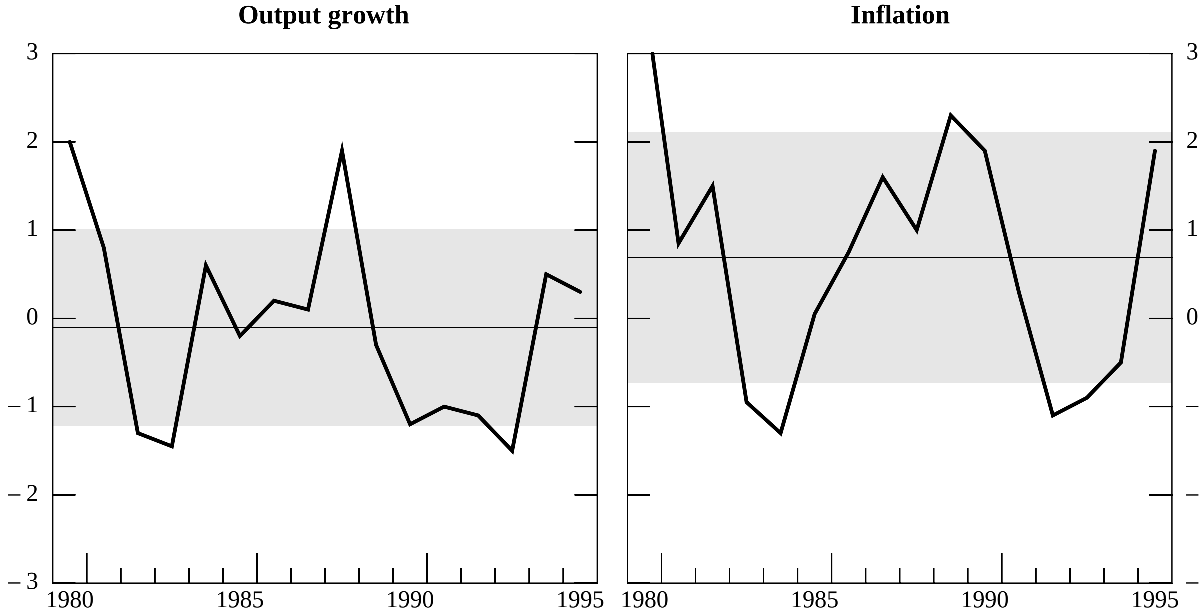
Forecast errors, one year ahead: France



Note: The horizontal reference line represents the mean and the shaded band the mean ±1 standard deviation.

Graph 1e

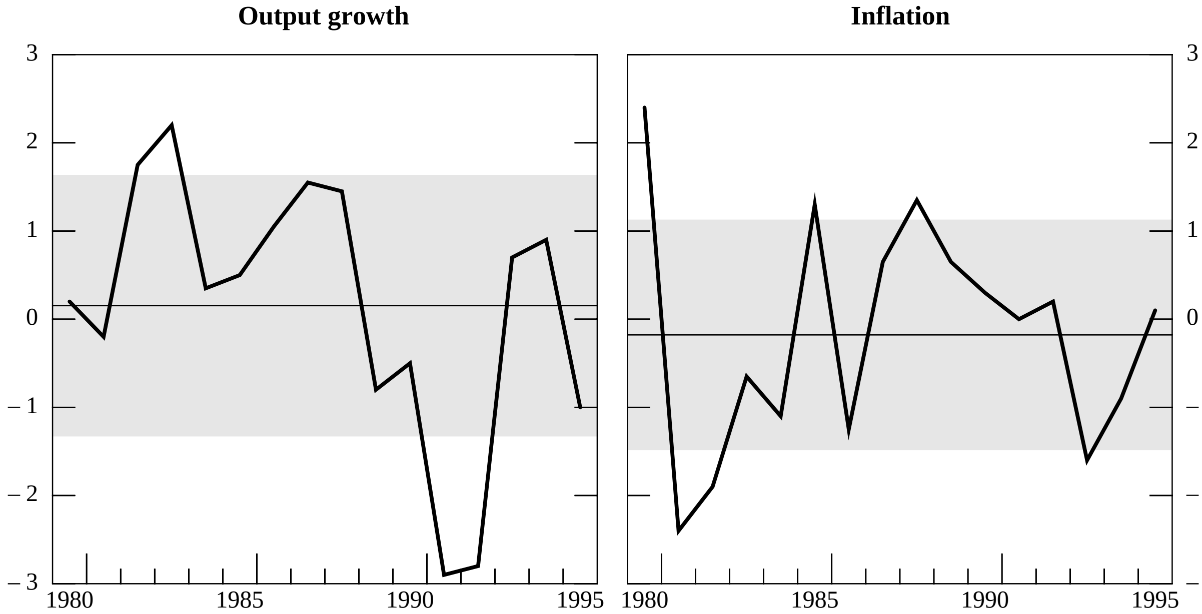
Forecast errors, one year ahead: Italy



Note: The horizontal reference line represents the mean and the shaded band the mean ±1 standard deviation.

Graph 1f

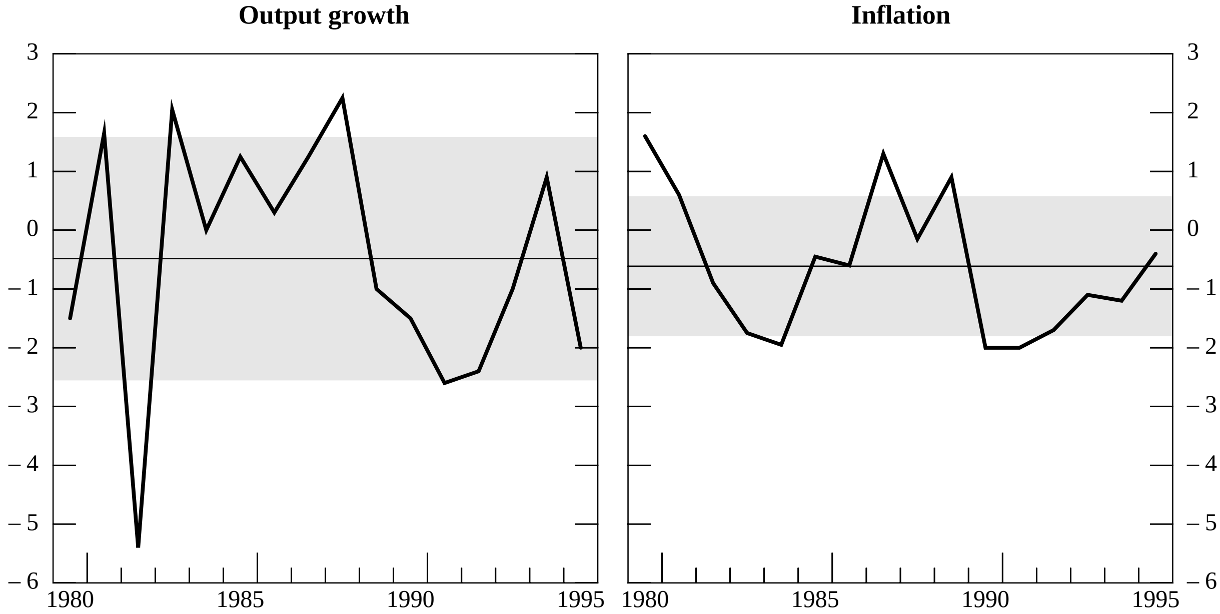
Forecast errors, one year ahead: United Kingdom



Note: The horizontal reference line represents the mean and the shaded band the mean ±1 standard deviation.

Graph 1g

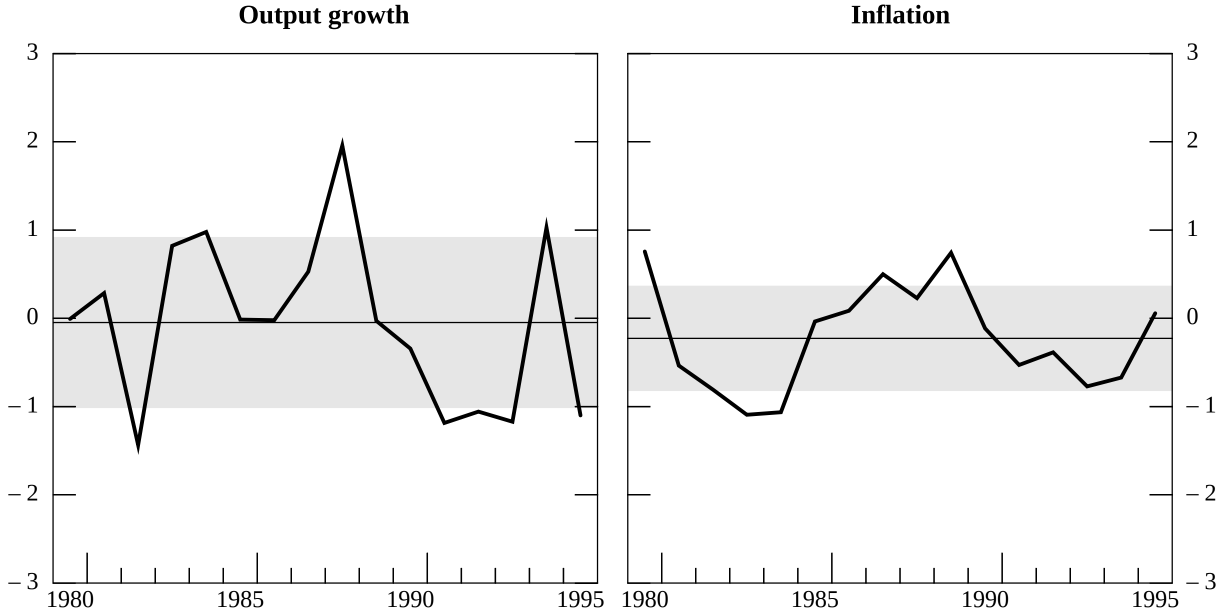
Forecast errors, one year ahead: Canada



Note: The horizontal reference line represents the mean and the shaded band the mean ±1 standard deviation.

Graph 1h

Forecast errors, one year ahead: Group of Seven countries



Note: The horizontal reference line represents the mean and the shaded band the mean ±1 standard deviation.

(vi) Impact of "non-financial"/technical factors

In closing this section we combine the various effects and issues discussed above in an attempt to identify the potential scope for monetary and financial market effects. To this end, the forecast errors for real growth and inflation were regressed on various "non-financial"/technical sources of forecast errors, with particular attention given to the following:

- a tendency for forecasters to underpredict large changes in real growth and inflation, regardless of the sign of the change. Earlier studies have found this tendency in connection with turning points in the business cycle.[16] In addition, most forecasters are disinclined to deviate too far from the average or consensus forecast and to take "extreme" positions.[17,18] The potential influence from this source was tested by including the change in respectively the rate of output growth (Δy) and the rate of inflation ($\Delta\pi$) among the regressors;

- evidence that forecast errors are positively correlated across countries, notably for real growth. To quantify this effect, the regressions also included, for each country, the average error for other G-7 countries among the determinants (*ERG*6);

- finally, in view of the evidence that past forecast errors for inflation are not taken sufficiently and efficiently into account in predicting future inflation, the lagged forecast error (ER_{-1}) was included among the determinants.[19]

As can be seen from Table 6, a large fraction of the errors for real growth is attributable to the three aforementioned sources, in particular the underprediction of large changes. The influence of forecast errors in other countries is comparatively small and not significant for Japan and Germany. This is not surprising in view of the evidence in Table 4, whereas it *is* surprising that this influence is so weak in the United Kingdom and Canada. The large and significant coefficient found for the United States is likely to be biased due to a dual causality relation as a forecast error for the United States both affects and is affected by the forecast errors for other G-7 countries.[20] Even though only one country (the United Kingdom) did not satisfy the efficiency conditions in Table 1, past forecast errors play a significant role in four countries.

Turning to the lower part of Table 6, the overprediction bias (as measured by the intercept) disappears for Japan, once the influence of past errors is taken into account and is markedly

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16 See McNees (1987a) and Zarnowitz (1992). One reason for the low accuracy of forecasts at cyclical turning points could be that deep recessions tend to be followed by particularly strong recoveries; see Balke and Wynne (1996) and the references cited therein.

17 We are by no means the first to note this problem. Granger (1996) discusses it at some length and, as an illustration, shows that all UK forecasters underpredicted the 1994 recovery, because none of them wished to deviate too much from the UK Treasury forecast. He also draws attention to Theil (1961) who suggests that "if forecasts of changes are likely to be downwardly biased, this needs to be investigated and corrected whenever possible" (see citation in Granger, *op cit*).

18 Forecasters' aversion to taking extreme position is not without exceptions. According to recent studies (see Lamont (1995), Laster *et al* (1997) and Stark (1997)), some professional forecasters have an incentive to distort their forecasts to gain more publicity.

19 Granger, *op cit* discusses various reasons for and ways of incorporating past forecast errors as a means of improving forecasts. He also suggests that in forecasting a certain variable (y) it might be useful to include not only past forecast errors for y but also past forecast errors for other variables in the system, in particular if cointegrating relations have been identified.

20 Because the analysis is based on growth rates rather than levels of output, this dual causality bias may also be present for other G-7 countries.

reduced in other countries. Except for France, changes in the rate of inflation tend to be underpredicted, whereas there is little evidence that inflation errors are correlated across countries.

All in all, Table 6 points to a larger potential scope for monetary and financial market influences on forecast errors for inflation than for real growth. On the other hand, in view of the evidence in Table 5, it should be kept in mind that some of the influences captured by the "non-financial" factors (for instance the *ERG*6 errors) may, in fact, be the result of world-wide financial or monetary shocks. Similarly, the significant influence of changes in the rate of inflation found for six of the G-7 countries could reflect that forecasters overestimate the speed with which inflation responds to changes in monetary policy.[21]

Table 6

Estimated impact of "non-financial" factors

Sample period 1980-95, annual data

Output growth

Country	**c**	**$\Delta y/\Delta\pi$**	**ERG6**	**ER_{-1}**	**R^2**
United States	0.01 (0.1)	0.38 (6.4)	0.33 (2.1)	0.40 (3.1)	0.85
Japan	0.08 (0.9)	0.57 (3.6)	0.29 (1.3)	0.46 (2.6)	0.62
Germany	0.12 (0.5)	0.61 (3.0)	0.19 (0.5)	0.22 (0.3)	0.51
France	-0.07 (0.4)	0.49 (5.2)	0.68 (5.1)	0.19 (1.7)	0.85
Italy	-0.16 (0.9)	0.23 (1.9)	0.50 (2.7)	0.47 (2.5)	0.51
United Kingdom	-0.14 (0.7)	0.62 (4.8)	0.13 (0.5)	0.65 (3.1)	0.67
Canada	-0.38 (1.1)	0.50 (2.3)	0.73 (1.2)	0.30 (1.0)	0.67

Inflation

United States	-0.32 (1.7)	0.38 (2.8)	0.21 (0.6)	0.22 (0.9)	0.45
Japan	-0.07 (0.4)	0.35 (4.0)	-0.55 (1.2)	0.60 (3.6)	0.64
Germany	0.22 (1.7)	0.54 (4.2)	-0.12 (0.4)	0.23 (1.2)	0.53
France	-0.28 (1.4)	-0.12 (0.8)	-0.01 (0.0)	0.17 (0.6)	-0.19
Italy	0.72 (2.3)	0.46 (2.6)	-0.25 (0.3)	0.25 (1.2)	0.38
United Kingdom	0.13 (0.7)	0.42 (5.3)	0.05 (0.2)	0.06 (0.5)	0.66
Canada	-0.30 (1.4)	0.50 (4.2)	-0.66 (1.7)	0.24 (1.4)	0.59

Note: Coefficients obtained from regressing forecast errors for respectively output growth and inflation on a constant term (*c*), changes in respectively output growth and inflation ($\Delta y/\Delta\pi$), average forecast errors in other G-7 countries (*ERG*6) and one-year lagged forecast error ((ER_{-1}). R^2 is corrected for degrees of freedom; figures in brackets indicate t-statistics.

[21] According to Ball and Croushore (1995) and Croushore (1996), the forecast errors for US inflation tend to increase by one-third of 1 percentage point whenever the Federal Reserve Board, in response to accelerating or decelerating inflation, changes the federal funds rate by 1 percentage point.

2. Forecast errors and monetary and financial developments

As mentioned earlier, the main approach to identifying the sources of forecast errors used in this paper is to regress errors on variables, potentially affecting the accuracy of forecasts. The empirical results are reported below. However, when looking at the estimated coefficients it should be kept in mind that there are numerous problems in predicting and interpreting their sign and size. These problems are analysed in greater detail in Annex A, using the impact on real growth and/or the rate of inflation of actual and predicted changes in respectively exchange rates, the yield curve and the output gap as illustrations. The conclusions of the Annex can be summarised in three points:

- because there are numerous sources of potential forecast errors, it is generally not possible to assign any *a priori* values to the estimated coefficients or to say whether a given coefficient indicates the effect of a shock or of a model specification error;
- when forecast errors are associated with lagged movements of the explanatory variables, *a priori* values can be derived. However, in that case, the estimated coefficients do not measure the effects of shocks but rather provide information about possible specification errors;
- even for lagged values the sign may be ambiguous either because the *a priori* impact is uncertain (as in the case of the yield curve) or because additional information is required (as in the case of exchange rate movements and the output gap).

(i) Output growth

The most satisfactory results are summarised in Table 7a and in Graphs 2a-2g, with two equations reported for each country. The first equation includes non-financial as well as financial variables and, in all cases, "explains" a relatively large fraction of the forecast errors as the standard errors are below 1% while the R^2s range from 0.6 - 0.9, being highest for the United States and lowest for Italy. For all countries, the most significant variable is the *change* in the growth rate (Δy), reflecting the prediction problems around cyclical turning points and forecasters' caution in predicting "large" changes compared with historical patterns. Forecast errors for other G-7 countries also have a significant influence,[22] whereas past forecast errors only appear in the equations for Japan and Italy.

The second equation focuses on the influence of financial variables by suppressing all the non-financial variables included in the first equation. As the table shows, the standard errors increase significantly compared with the first equation and, in some cases, financial variables that were significant in the first equation are either insignificant or appear with the sign reversed. The yield spread is the most significant financial variable, though the estimated signs differ between North America (positive) and Japan and Europe (negative). Changes in the nominal effective exchange rate are also significant and, in all cases, the estimated impact is negative, implying that a depreciation

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[22] Recall, however, that the estimated coefficients may be biased by dual causal relations.

Table 7a

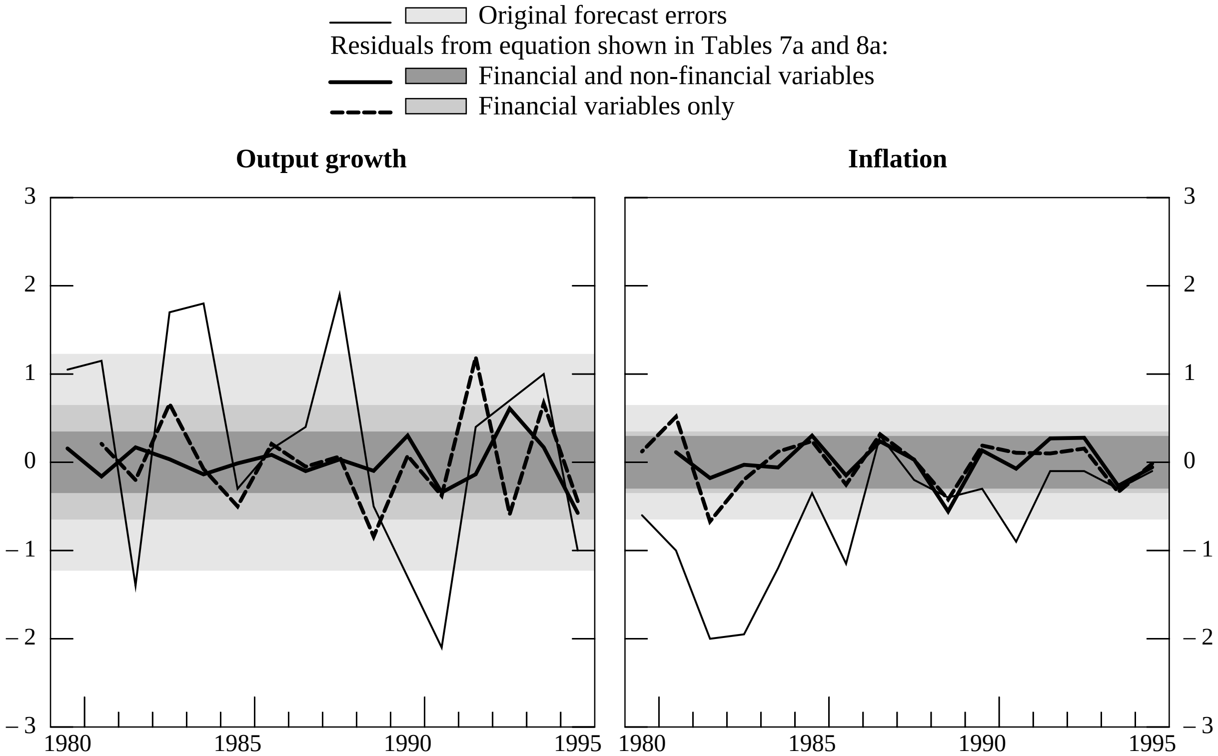
Real growth forecast errors

Country	c	Δy	ERG6	ER_{-1}	s	Δs	Δe	NMCI	RMCI	Debt	ΔRass	ΔMi	R^2	S.E.
US	15.3 (6.5)	0.20 (5.3)	0.51 (4.5)	–	0.32^{-1} (4.1)	–	-0.04^{-2} (3.3)	–	–	-0.22^{-1} (6.7)	–	-0.11^{-1} (2.6)	0.92	0.34
	18.4 (4.0)	–	–	–	0.32^{-1} (2.5)	–	–	-0.69^{-1} (5.1)	–	-0.34^{-1} (4.6)	–	0.30^{-1} (2.6)	0.74	0.64
JP	–	0.76 (6.5)	0.29 (1.8)	0.38 (3.1)	-0.56^{-1} (3.7)	–	–	–	–	–	0.23^{-1} (2.5)	–	0.82	0.54
	-3.03 (2.4)	–	–	–	–	–	-0.06^{-2} (2.8)	–	–	0.20^{-1} (2.1)	0.11^{-1} (5.8)	–	0.67	0.72
DE	-0.31 (1.0)	0.70 (8.0)	–	–	–	-0.43 (3.6)	-0.08 (1.8)	–	–	–	0.04^{-1} (1.7)	0.09^{-1} (2.3)	0.85	0.55
	–	–	–	–	–	–	-0.33 (2.8)	–	-0.38^{-1} (1.6)	–	0.09^{-1} (2.0)	0.13^{-1} (2.7)	0.38	1.10
FR	–	0.60 (7.0)	0.70 (6.0)	–	–	-0.30^{-1} (3.0)	-0.04^{-2} (1.9)	–	–	–	0.04^{-2} (2.4)	-0.04^{-1} (2.5)	0.90	0.37
	-0.30 (1.0)	–	–	–	–	-0.29^{-1} (1.1)	-0.16^{-2} (2.6)	-0.43^{-1} (2.3)	–	–	–	–	0.42	0.97
IT	0.87 (1.3)	0.25 (2.0)	0.50 (3.0)	0.49 (2.9)	-0.09* (1.8)	–	-0.05 (1.4)	–	–	–	–	–	0.61	0.63
	14.7 (3.6)	–	–	–	–			-0.38^{-1} (4.8)	–	-0.29^{-1} (4.0)	–	0.14^{-1} (3.1)	0.59	0.64
UK	2.32 (2.8)	0.39 (3.9)	–	–	–	–	-0.06^{-2} (2.5)	–	–	-0.05^{-2} (3.3)	0.08^{-3} (2.7)	–	0.69	0.83
	6.00 (4.3)	–	–	–	–	–	–	-0.25^{-1} (2.9)	–	-0.10^{-2} (4.2)	–	–	0.53	1.05
CA	14.7 (3.1)	0.49 (5.6)	0.56 (1.5)	–	0.32^{-1} (1.9)	–	-0.08^{-1} (1.6)	–	–	-0.17^{-1} (3.3)	–	–	0.87	0.74
	14.7 (1.9)	–	–	–	-0.43^{-1} (1.5)	–	–	–	-0.70^{-2} (3.8)	-0.16^{-1} (1.9)	–	–	0.50	1.50

Notation: *c* = intercept term; Δ*y* = change in output growth; *ERG*6 = average forecast error for other G-7 countries; ER_{-1} = lagged forecast error; *s* = yield spread (defined as the difference between short and long-term interest rates); Δ*s* = change in the yield spread; Δ*e* = change in the nominal effective exchange rate; *NMCI* = monetary conditions index, nominal (defined as a trade-weighted average of the nominal short-term interest rate and the nominal effective exchange rate and measured as deviations from end-1989); *RMCI* = monetary conditions index, real (defined as a trade-weighted average of the real short-term interest rate and the real effective exchange rate and measured as deviations from end-1989); *Debt* = gross debt of non-financial firms (United States 1st equation, Italy and Canada) or households (United States 2nd equation, Japan and the United Kingdom), as a percentage of GDP; Δ*Rass* = percentage change in real asset prices (see Borio *et al* (1994) and Andersen and White (1996); Δ*Mi* = percentage change in M3 (for Italy M2); R^2 = coefficient of determination; S.E. = standard error of estimate. t-statistics are shown in brackets below the coefficients and superscripts denote the number of lags. * Short-term interest rate, lagged one year.

Graph 2a

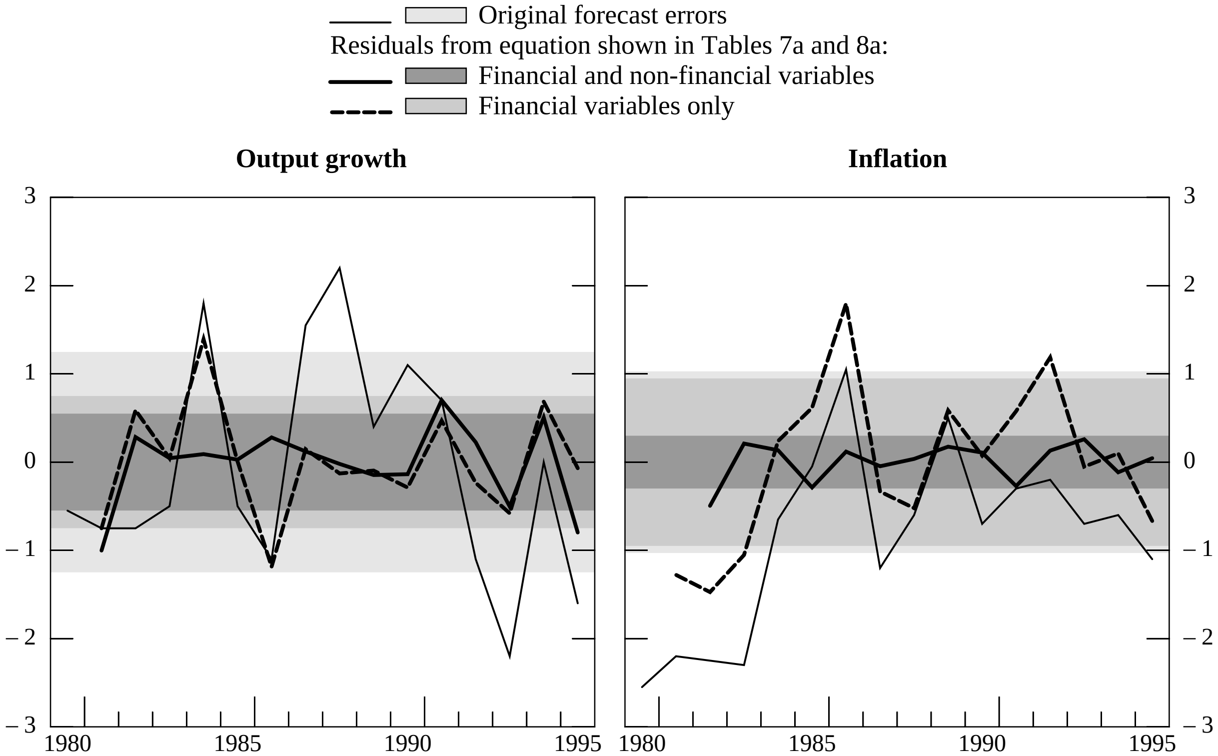
Forecast errors, one year ahead: United States



Note: The shaded areas represent 1 standard error bands.

Graph 2b

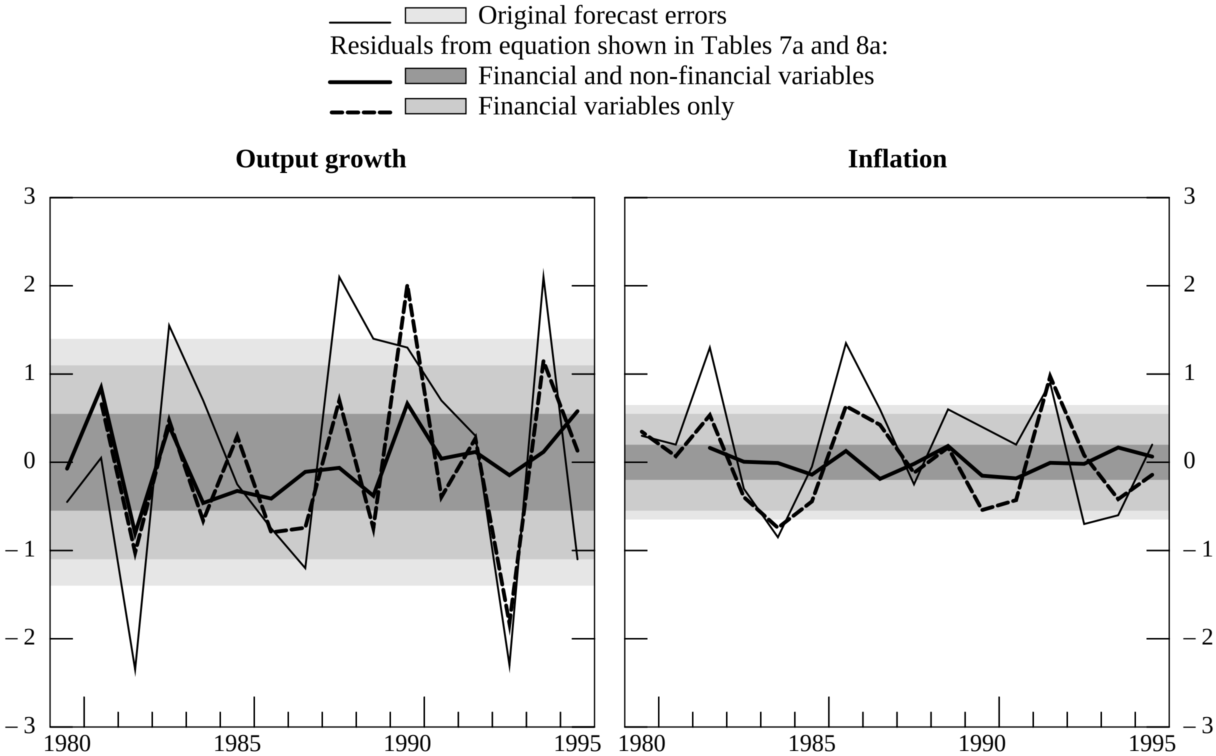
Forecast errors, one year ahead: Japan



Note: The shaded areas represent 1 standard error bands.

Graph 2c

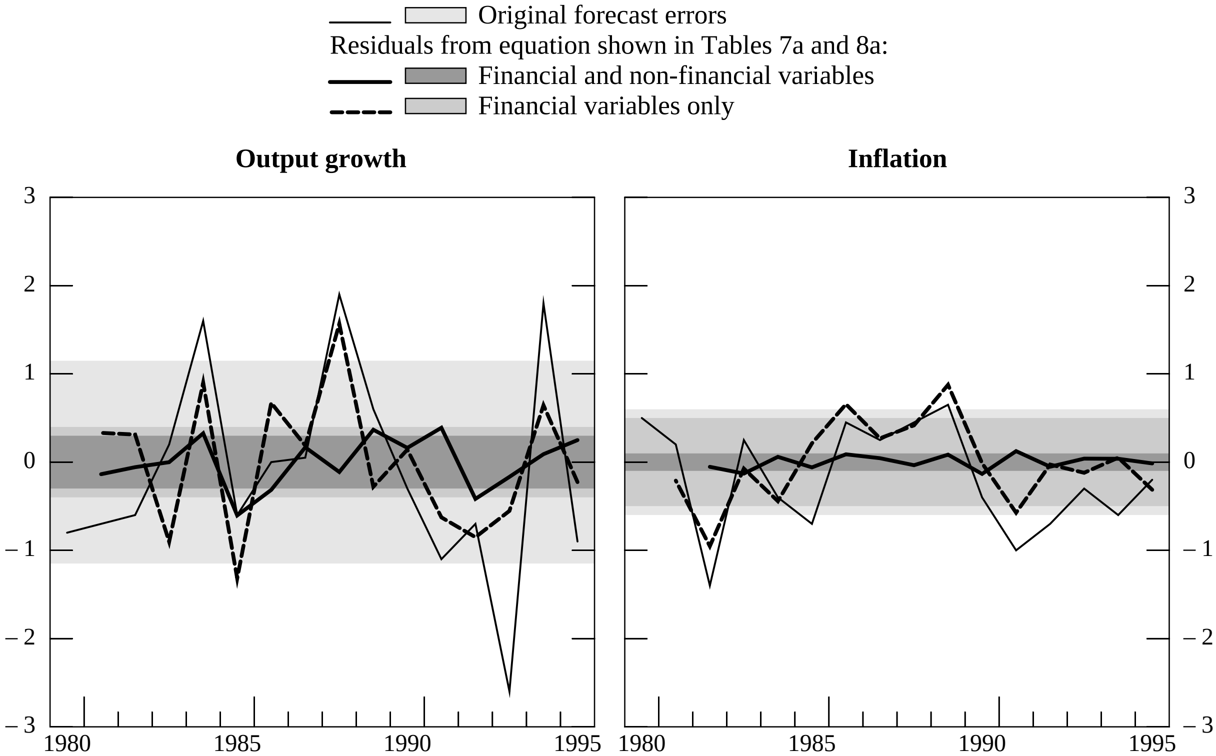
Forecast errors, one year ahead: Germany



Note: The shaded areas represent 1 standard error bands.

Graph 2d

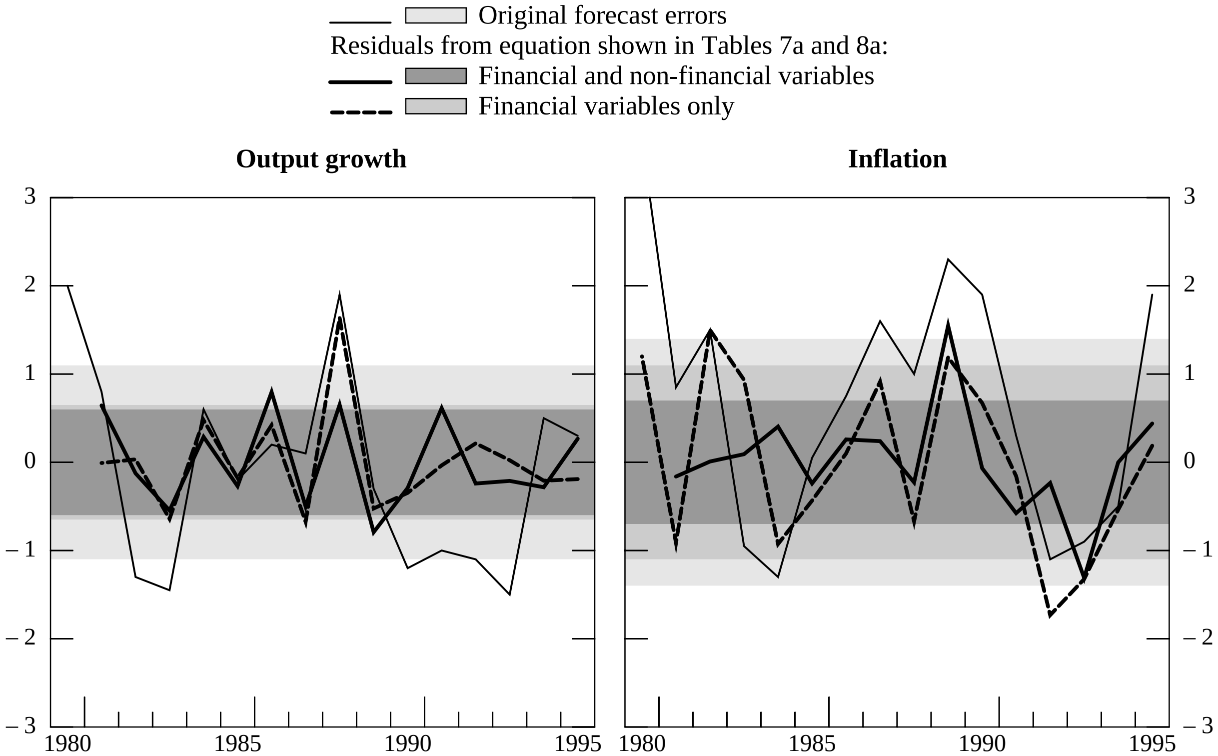
Forecast errors, one year ahead: France



Note: The shaded areas represent 1 standard error bands.

Graph 2e

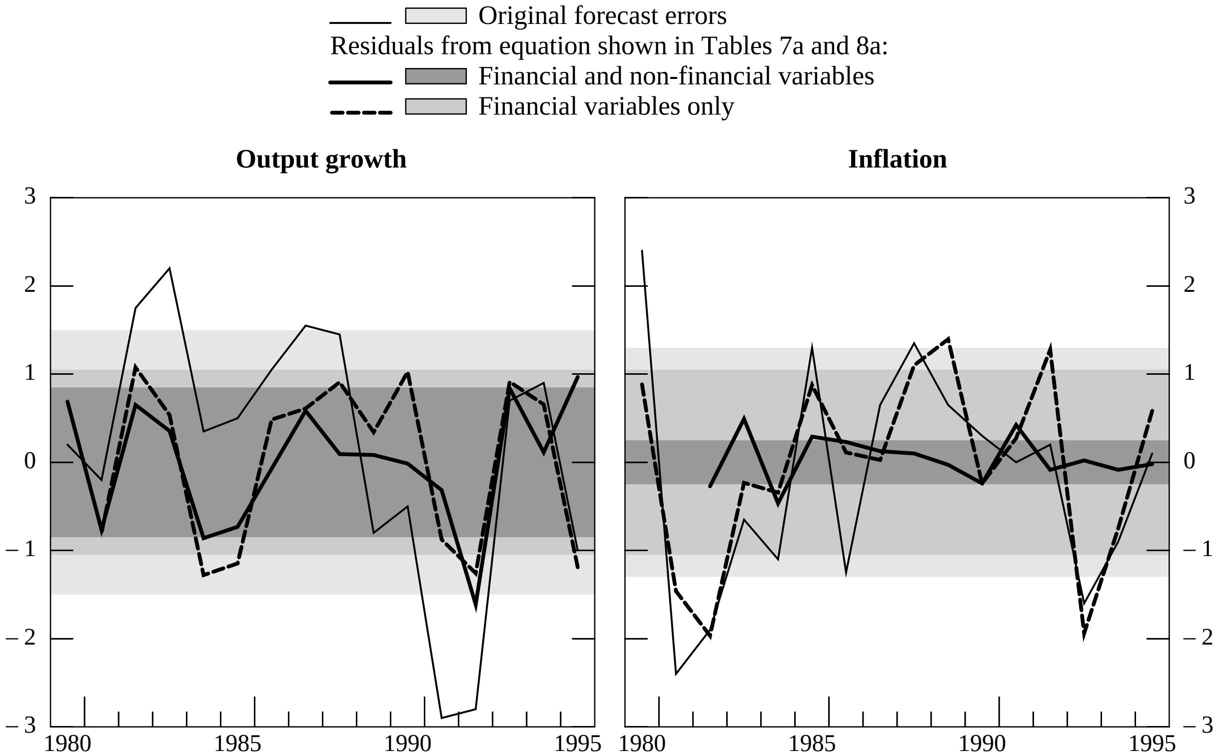
Forecast errors, one year ahead: Italy



Note: The shaded areas represent 1 standard error bands.

Graph 2f

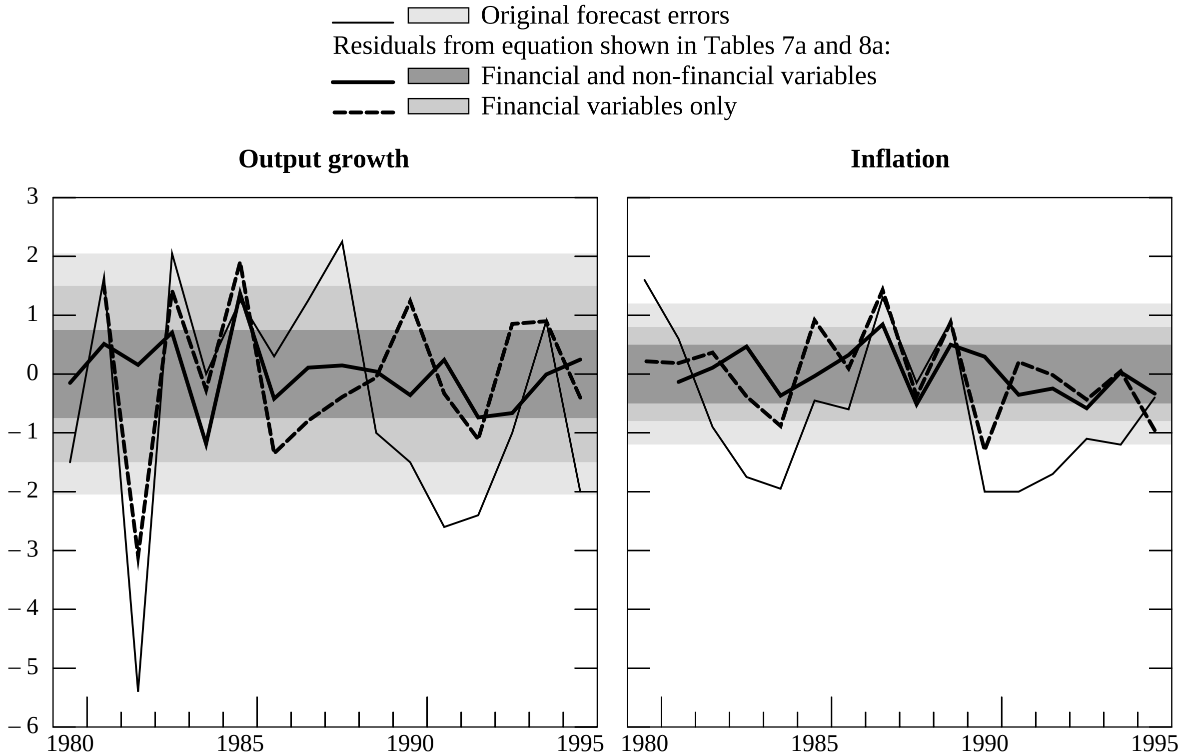
Forecast errors, one year ahead: United Kingdom



Note: The shaded areas represent 1 standard error bands.

Graph 2g

Forecast errors, one year ahead: Canada



Note: The shaded areas represent 1 standard error bands.

(appreciation) generates an underprediction (overprediction) of real growth. Note also that when non-financial variables are suppressed, the effect of exchange rate movements is best captured by a monetary conditions index, measured in either nominal or real terms. The evidence for other financial variables is more mixed. Past changes in monetary aggregates have some influence in three countries and the asset price cycle has also affected growth rates in three cases, with particularly large effects for Japan and the United Kingdom. Debt of the non-financial sector is influential in five countries and, in all cases, this effect is most pronounced when non-financial variables are suppressed.[23]

Table 7b complements the first equation of the previous table with β-coefficients; i.e. regression coefficients based on variables expressed in terms of their standard deviation. Because of the relatively high volatility of exchange rate movements and the fact that debt enters the regressions in levels rather than changes, the main effect of this normalisation is that the estimated exchange rate and debt coefficients are much larger than in Table 7a; other coefficients are more or less unchanged.

Regarding country-specific forecast errors and the sources of such errors suggested in the literature, Zickler (1993), Steindel (1993) as well as Stockton (1993) all emphasise the unexpected

[23] Contrary to our expectations, it is the *level* of rather than the *change* in debt which seems to matter. However, as will be discussed below, the estimated coefficients may be interpreted as capturing the effects of deviations of the debt/GDP ratios from their means.

slowdown of household spending in the *United States* as a major cause of the 1990-91 recession and the subsequent slow recovery. Using a VAR model, Blanchard (1993) also identifies consumption shocks as a major cause of the recession and further notes that such shocks tend to have particularly long-lasting output effects. While Blanchard's model does not identify the source of the consumption shocks, one possibility is a breakdown of the traditional wealth transmission channel of changes in interest rates. Thus a notable feature of the early 1990s was that the marked reduction in official rates did not have the predicted positive effect on spending either because household spending had become less sensitive to changes in wealth or because adverse structural changes or shocks had offsetting effects.[24] Another feature of the early 1990s with potentially adverse effects on spending was that both households and firms restructured their balance sheets, as the build-up of debt and the rise in debt service burdens during the 1980s were sharply reversed in the 1990s.

Table 7b

Real growth forecast errors: β-coefficients

Item/country	**US**	**JP**	**DE**	**FR**	**IT**	**UK**	**CA**
Δy	0.44	0.91	0.90	0.78	0.43	0.56	0.80
*ERG*6	0.41	0.23	–	0.57	0.47	–	0.22 *
ER_{-1}	–	0.38	–	–	0.49	–	–
s	0.40	-0.51	-0.60	-0.30	-0.27	–	0.20
Δe	-0.21	–	-0.18	-0.21	-0.46	-0.37	-0.21 *
DEBT	-2.86	–	–	–	–	-0.52	-0.53
ΔMi	-0.35	–	0.24	-0.13	–	–	–
$\Delta RASS$	–	0.02	0.18	0.25	–	0.39	–
S.E.	0.28	0.43	0.39	0.33	0.56	0.56	0.36

Notation: See Table 7a.

On balance, the net effect of the changes mentioned above is uncertain; indeed, for some of the changes even the sign is hard to predict. Nonetheless, including lagged changes in the exchange rate as well as the slope of the yield curve does seem to reduce the forecast errors. Indebtedness has also influenced actual real growth compared with the predicted rate and adding lagged changes in broad money further reduces the forecast error.[25] Three points are worth highlighting regarding the

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24 As noted by Stockton (1993), the profile of US monetary policy over the latest business cycle was unusual in that the authorities started to reduce the federal funds rate well before the 1989 business cycle peak. In fact, according to the Board model, the 700 basis point reduction in the federal funds rate provided a stimulus of 1¾% per year during 1989-92. Even so, the recovery was much weaker than previous upturns and well below the rate of growth predicted by the model.

25 We also tested some additional variables, frequently mentioned as indicators that seem to have "lost" their previous influence on spending or have been characterised by unusually large fluctuations in recent years, including bond rate

estimates obtained when only financial variables enter the equation. First, a monetary conditions index is far more significant than changes in the effective exchange rate alone. Secondly, changes in M3 now enter the equation with a positive coefficient which is more in line with traditional theory.[26] Thirdly, household debt replaces the debt of non-financial enterprises as the most significant debt variables.[27] This corresponds to the evidence found in other studies and helps to produce smaller residuals for the 1990s than the equation with the overall best fit (see Graph 2a).[28]

In an earlier study, Kaku and Fukuda (1993) explored three channels by which the fluctuations in assets prices in *Japan* might have affected spending: household wealth and consumption, firms' indebtedness and investment and banks' intermediation capacity. In all three cases they found only weak evidence of asset price effects. On the other hand, in a more recent study, Horioka (1996) estimates that capital gains accounted for up to two-thirds of the 17% rise in household consumption between 1986 and 1989 while capital losses slowed consumption growth by perhaps 3½ percentage points during 1990-93. Moreover, Inoue *et al* (1996) find that the excessive rise in Japanese equity and real property prices in the second half of the 1980s led to an unexpected strong increase in business fixed investment and total demand, followed by an equally unexpected decline in spending when the "bubble burst".

Against this background and given the pattern of forecast errors in the mid-1980s and early 1990s (see Graph 2b), an asset price index was included in the estimates for Japan, together with the lagged yield spread. The results clearly suggest that fluctuations in asset prices and changes in the term structure have had significant effects in Japan, substantially reducing the underpredictions of growth in the mid-1980s as well as the overpredictions in the early 1990s.[29] Moreover, the inclusion of financial indicators strengthens the influence of other determinants. When the non-financial

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volatility, changes in the volatility of equity returns (which according to Hamilton and Lin (1996) can be used in identifying and forecasting business cycle turning points) and changes in unemployment (the latter as an indicator of household uncertainty with respect to future income). However, none of these variables contained any explanatory power and they were not tested for other countries.

26 The sign on ΔM3 looks implausible in the first equation. Since the OECD model does not include M3 among the explanatory variables, the coefficient would imply that a rise in the growth of M3 reduces actual spending whereas, according to most models, a rise in money supply growth stimulates spending. It is possible, however, that structural changes in the demand for M3 could have shifted the relationship between M3 and nominal income and thus affected outcomes relative to predictions. See Stockton, *op cit* for a similar explanation regarding the unexpected slow growth of M2.

27 As for the first equation, the very large intercept could suggest that growth is overpredicted. In fact, the intercept serves as an "offset" to the debt term as can be seen by rewriting the estimated equation as .....-0.34 (*DEBT* - 18.4/.34) = ...-0.34 (*DEBT* - 54.1), with 54.1 only insignificantly different from the average ratio of household debt to GDP over the sample period. In other words, it is the deviation of *DEBT* from its mean rather than the level of debt which affects the forecast errors.

28 One exception is Stockton *op cit* who tested the influence of changes in the debt burden of households on spending and found an insignificant coefficient.

29 In contrast to the United States, the lagged spread between long and short-term interest rates has had a negative and not a positive effect on the forecast errors. However, as discussed above, the impact of changes in the term structure on real growth and inflation is theoretically ambiguous.

variables are disregarded, changes in the effective exchange rate play a significant role and household indebtedness also becomes significant. The latter leads to a very large intercept but, as for the United States, the equation can be rewritten in terms of the deviation of household debt from its mean.[30]

In the case of *Germany,* the spread between short and long-term interest rates is significantly correlated with the forecast error, with the sign of the coefficient suggesting a strong influence of long-term bond rates on spending or expectations of higher future short-term interest rates. However, in contrast to the results for the United States and Japan, it is the *change* in the yield spread rather than the *level* which is correlated with the forecast error. Moreover, because Δe enters without lags, the estimated coefficient needs to be interpreted cautiously as it could be subject to a large simultaneity bias. This caution also applies to the estimated impact of contemporaneous movements in the effective exchange rate. The growth effect of lagged changes in M3 appears to be understated in the prediction model whereas real asset prices are of only marginal significance; this was to be expected since Germany largely "escaped" the asset price bubble of the mid-1980s. The influence of exchange rate movements substantially increases when non-financial variables are disregarded and a monetary conditions index also enters the equation. Moreover, changes in both M3 and asset prices appear with larger and more significant coefficients. Nonetheless, because the inclusion of financial variables does not help to reduce the forecasting errors associated with turning points, the R^2 of the second equation is rather low.

One feature of the forecast errors for *France* is the high correlation with developments in Germany (Table 4) and the large influence of forecast errors for other G-7 countries (Table 6). This characteristic, together with a marked tendency to underpredict changes in the real rate of growth, remains after financial variables are allowed for. As a result, even though four financial variables were found with significant coefficients, their combined contribution reduces the standard error by only one-tenth of 1 percentage point and raises the R^2 by only 0.06. Moreover, the explanatory power drops substantially when the non-financial variables are disregarded in the second equation.

Among the financial variables tested, lagged changes in the yield spread were the most significant, with the sign of the coefficient pointing to a transmission mechanism very similar to that of Germany. The volatility of asset prices has also affected the accuracy of the growth forecasts for France, though the coefficient is rather small when compared with that found for Japan. Changes in the effective exchange rate and in M3 are significant too but the sign of the coefficient on M3 is not very plausible, unless changes in M3 are capturing demand-side effects rather than the impact of policy changes.

For *Italy,* the non-financial variables tested are all significant but, among the financial and monetary variables, only exchange rate changes and the lagged short-term interest rate were found

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[30] More precisely, the estimated equation can be rewritten as .....0.20 (*DEBT* - 3.03/.20) = ...0.20 (*DEBT* - 15.1), with 15.1 broadly similar to the average ratio of household debt to GDP over the sample period.

to have some, albeit only marginal, influence.[31] On balance, the estimates obtained when using only financial variables look more satisfactory. The R^2 remains high and the enhanced effect of exchange rate movements, incorporated in a monetary conditions index, as well as the impact of enterprise debt and changes in M2, looks plausible.

Turning to the *United Kingdom*, a number of recent studies have pointed to consumption shocks in explaining the duration of the 1989-91 recession as well as the subsequent slow and hesitant recovery. Applying a VAR model, similar to the one used by Blanchard *op cit*, Catão and Ramaswany (1995) find that shocks to household consumption and residential investment explain most of the variation in aggregate growth. Moreover, such shocks can, to a large extent, be attributed to swings in real property prices and developments in household debt. Lagged changes in short-term interest rates also seem to have affected output growth whereas exchange rate movements are only important from 1992 onwards. Fisher (1993) also finds that changes in real property prices help to explain consumption in the 1980s and 1990s, although, in theory, the net effect of changing house prices is ambiguous for the household sector as a whole. He further observes that a variable capturing the effects of negative housing equity (i.e. mortgage debt exceeding the value of the property) has the expected sign but is not statistically significant.

Against this background and taking account of Fisher's argument that property price effects on consumption are likely to be gradual, we added a three-year moving average of changes in real asset prices to the UK output error equation in Table 6. Moreover, to capture the effects of respectively negative housing equity and exchange rate movements, two-year moving averages of gross household debt relative to GDP and changes in the effective exchange rate, were also included. The results suggest that while the forecasting errors associated with large changes in output growth remain, those associated with past errors are largely explained by the additional variables. Moreover, consistent with Fisher's results and observations, changes in real property prices and household debt are significantly correlated with the prediction errors. Thus taking account of past increases (declines) in real asset prices helps to reduce underprediction (overprediction) of output growth while household debt affects the forecast errors with the opposite sign. In addition, the effect on growth of past exchange rate movements seems to have been significantly underpredicted. Finally, disregarding non-financial factors enhances the role of household debt and introduces a strong influence of changes in monetary conditions, whereas real asset prices are no longer significant. All in all, when including financial as well as non-financial variables, the standard deviation is reduced by 60% compared with the "raw" forecast errors and the rapid growth in the early 1980s, as well as the unexpected slow recovery in 1992, seems to be more or less accounted for (Graph 2f).

In the case of *Canada*, Longworth and Poloz (1993) investigated whether the inclusion of financial variables improved the forecasting ability of two models used at the Bank of Canada: a

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[31] It is possible, that the forecast errors can mostly be assigned to unexpected changes in fiscal policy, which we have not tested.

reduced-form IS curve and two versions of a financial indicator model based on respectively changes in real M1 and the spread between long and short-term interest rates. They generally find private sector net wealth and real equity and house prices to be sigificant when added to the reduced-form IS-curve and for the financial indicator models there is a strong relationship between the yield curve and output growth. However, the tracking and forecasting ability of the models improves only marginally, because the influence of financial variables tends to be "at the expense" of other variables. Moreover, it is uncertain whether the influence of financial developments is a temporary or permanent feature. Subsequently, however, Fillion (1994) and Montplaisir (1995) have found evidence of permanent effects and of a significant improvement in the ability of the reduced-form IS curve in explaining developments in the 1990s.

When developments in financial markets and asset prices are included in the equation estimated for Canada, both the yield spread and gross debt of non-financial enterprises are significant. The sign of the yield spread suggests that a widening generates faster output growth than predicted while a rise in firms' indebtedness leads to growth being overpredicted.[32] When non-financial variables are dropped, the role of the exchange rate is captured by a monetary conditions index (measured in real terms) and the impact of firms' indebtedness remains significant.[33] On the other hand, the sign of yield curve effect is reversed and the coefficient is only marginally significant.

(ii) Inflation

In analysing potential sources of forecast errors for inflation, we first added the lagged output gap on the assumption that the cyclical sensitivity of inflation might have changed compared with the OECD model. In addition, lagged values of the yield spread, exchange rate movements and changes in broad money aggregates as well as in asset prices were included in the estimated equations. However, before discussing the results, we highlight three problems in identifying potential sources of forecast errors.[34] First, variables with reliable early warning signals of future inflationary pressures will not yield stable and significant coefficients in this exercise if the monetary authorities respond to such signals or when there are changes in the reaction function of the monetary authorities.[35]

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32 However, the estimates shown in Table 7a are only marginally better than those obtained from an equation which includes contemporaneous forecast errors for inflation. In other words, it is uncertain whether the forecast errors for Canada should be ascribed to changes in interest rates and debt or result from demand shocks that affect both real growth and inflation.

33 Because the monetary conditions index enters the reaction function of the Bank of Canada, the estimated coefficient is likely to be biased.

34 See Baumgartner and Ramaswamy (1996) and Woodford (1994) for further discussion of this point.

35 This potential problem can be illustrated by reproducing the proof in Cecchetti (1995), though leaving out time subscripts and lags to simplify the notation. Assume that inflation (π) is determined as:

(i) $\pi = \alpha r + \beta x + \varepsilon$

where r is a vector of policy instruments, x is a vector of early warning indicators and ε denotes a random error. The policy reaction function is written as:

(ii) $r = \gamma x$

Secondly, if variables providing reliable predictions of inflation serve as monetary instruments or are closely related to such instruments (for instance short-term money market interest rates), there is a risk of unstable feedback rules and effects. This also reduces the probability that the effect of such variables will be correctly captured in an exercise aimed at identifying sources of forecast errors.

A third problem concerns the expected coefficient and interpretation of the yield spread. As noted by Tzavalis and Wickens (1996), a general finding in the literature is that the longer the time horizon, the more information the term structure of interest rates provides about future inflation. Their underlying model is an n-period Fisher equation with a constant real interest rate and risk premium. However, if the real interest rate and the term premium do not remain constant, the information value of changes in the term structure may decline dramatically and the real interest rate or the long-term interest rate alone may provide more information. Accordingly, in the estimates below we first included the yield spread and in those cases where the coefficient was insignificant, we replaced the spread by the long-term interest rate.

The most satisfactory equations are summarised in Table 8a and, as in Table 7a, we present two equations for each country, with the β-coefficients corresponding to the broader equation given in Table 8b. As for real growth, the R^2s are mostly around 0.9 or higher, the main exception being Italy. The explanatory variables are also similar to those identified for output growth, including forecasters' caution in predicting large changes in the rate of inflation, which is significant for five of the seven countries. Except for the United States, cyclical effects are even more important. In fact, the low R^2s for the second equation can mainly be related to the suppression of the output gap, implying that inaccurate predictions of cyclical effects are a major source of forecasting errors for inflation and that the influence of financial variables is conditioned by the cyclical phase. The signs of the cyclical effects differ between countries. In Japan, France and Italy, inflation seems to be less sensitive to cyclical changes than assumed in the model, whereas in the other three countries the cyclical sensitivity is underpredicted. Yield curve or long-term interest rate effects also appears for a majority of countries and, given the ambiguity regarding the *a priori* impact, it is not surprising that the signs vary. By contrast, exchange rate changes mostly appear with a negative coefficient, implying that a depreciation (appreciation) tends to be accompanied by a larger acceleration (deceleration) of inflation than predicted.[36] Lagged changes in broad monetary aggregates have a significant effect in six countries; a rise in the growth of monetary aggregates leads to higher inflation in France, Italy and Canada than predicted by the OECD model, whereas for the United States, Japan and Germany, the

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which generates the reduced-form inflation equation:

(iii) $\pi = (\alpha\gamma + \beta)\, x + \varepsilon'$

Hence, a change in the parameters of the policy reaction function (γ) would also change the coefficient of x in estimates of (iii). Moreover, if the policy objective is to minimise the variance of π or the deviations of π from a target, then in an "optimal" reaction function $\gamma = \beta/\alpha$ and the correlation between x and π would be 0. A similar point is made in Woodford (1994) who also notes that this problem may be most applicable to financial variables in x.

36 For some countries, it helps to take account of the cyclical conditions in assessing the effect of exchange rate changes. However, the coefficients on the composite variable are not very robust (see also Annex A).

Table 8a

Inflation forecast errors

Country	c	$\Delta\pi$	ER_{-1}	gap	Δgap	s	i_L	Δe	Δe(gap)	ΔRass	ΔMi	R^2	S.E.
US	-0.40 (2.2)	0.21 (2.7)	–	–	–	0.15^{-2} (2.7)	–	-0.03^{-2} (3.3)	–	–	-0.05^{-2} (2.2)	0.84	0.28
	-0.49 (2.2)	–	–	–	–	0.18^{-2} (2.6)	–	-0.03^{-2} (3.2)	–	0.03^{-1} (1.2)	0.06^{-1} (2.2)	0.75	0.33
JP	2.17 (5.6)	0.26 (2.0)	–	-0.52^{-2} (5.2)	–	-0.74^{-1} (5.8)	–	-0.04^{-2} (2.5)	–	-0.04^{-2} (2.2)	-0.26^{-2} (6.2)	0.89	0.30
	–	–	–	–	–	–	–	–	–	0.05^{-2} (1.8)	-0.13^{-2} (3.3)	0.38	0.94
DE	5.10 (7.0)	0.16 (2.5)	-0.30* (6.3)	0.23^{-2} (5.4)	–	–	-0.41^{-1} (5.6)	-0.04^{-2} (1.7)	–	–	-0.19^{-2} (7.7)	0.94	0.18
	2.64 (2.4)	–	–	–	–	–	-0.20^{-1} (1.5)	-0.10^{-2} (2.2)	–	–	0.09^{-2} (2.5)	0.31	0.54
FR	-1.06 (12.5)	–	–	-0.47^{-2} (16.6)	–	-0.10^{-1} (3.7)	–	–	0.07 (11.1)	0.04^{-1} (5.9)	0.08^{-2} (7.8)	0.97	0.10
	–	–	–	–	–	-0.18^{-1} (1.8)	–	–	0.06 (2.4)	–	-0.04^{-2} (2.4)	0.33	0.51
IT	–	0.80 (5.5)	–	-0.10^{-2} (2.9)	–	–	-0.04^{-2} (0.9)	–	-0.01 (1.5)	–	0.15^{-2} (2.8)	0.69	0.72
	3.77 (2.8)	–	–	–	–	–	-0.31^{-2} (3.4)	–	-0.01 (0.9)	–	0.10^{-2} (1.6)	0.39	1.11
UK	–	–	-0.23 (2.8)	0.42^{-2} (7.8)	0.47^{-2} (11.9)	0.71 (7.2)	–	-0.02^{-2} (2.2)	0.01^{-2} (3.6)	–	–	0.93	0.27
	–	–	–	–	–	–	–	0.08 (2.8)	–	–	–	0.28	1.07
CA	-2.54 (4.4)	0.52 (4.8)	–	–	-0.52** (3.1)	–	–	-0.05^{-3} (1.7)	–	–	0.19^{-3} (3.3)	0.79	0.49
	-0.93 (4.4)	–	–	–	–	–	–	-0.14^{-3} (4.5)	–	–	–	0.56	0.79

Notation: *c* = intercept term; $\Delta\pi$ = change in the rate of inflation; ER_{-1} = lagged forecast error; *gap* = output gap (defined as the log ratio of actual to potential GDP); Δ*gap* = change in the output gap; *s* = yield spread (defined as the difference between short and long-term interest rates); i_L = long-term interest rate; Δe = change in the nominal effective exchange rate; $\Delta e(gap)$ = change in the effective exchange rate times the output gap; Δ*Rass* = percentage change in real asset prices (see Borio *et al* (1994) and Andersen and White (1996)); Δ*Mi* = percentage change in M3 (for Japan M2 + CDs and for Italy and Canada M2); R^2 = coefficient of determination; S.E. = standard error of estimate. t-statistics are shown in brackets below the coefficients and superscripts denote the number of lags. * Contemporaneous forecast error for real growth. ** Change in the rate of unemployment.

Table 8b

Inflation forecast errors: β-coefficients

Item/country	US	JP	DE	FR	IT	UK	CA
Δπ	0.36	0.22	0.25	–	0.92	–	0.68
gap	–	-1.11	0.64	-1.15	0.40	0.78*	-0.43
ER_{-1}	–	–	–	–	–	-0.23	–
ERy	–	–	-0.65	–	–	–	–
s	0.35	-0.82	-0.71	-0.22	-0.11	–	–
Δ*e*	-0.28	-0.28	-0.17	–	–	-0.13	-0.22
Δ*e*(*gap*)	–	–	–	0.62	-0.20	3.58	–
Δ*Mi*	-0.26	-1.63	-1.08	0.60	0.60	–	0.72
Δ*RASS*	–	-0.39	–	-0.38	–	–	–
S.E.	0.42	0.29	0.27	0.19	0.50	0.25	0.41

Notation: See Table 8a. * β-coefficient for changes in GAP is 0.76.

inflationary impact of such changes seems to be overstated.

For the normalised coefficients (Table 8b) it is noticeable that the changes in the estimated parameters are considerably larger than in the case of real growth. Again, the most pronounced parameter shift is observed for exchange rate movements but the coefficients on monetary aggregates are also substantially larger when measured in units of standard deviations.

Turning to the estimates for the *United States*, the forecast errors are reduced by about 50% when the yield spread, exchange rate movements and changes in M3 (all with a two-year lag) are added to changes in the rate of inflation as potential sources of errors. The coefficient on the exchange rate suggests that an effective depreciation of the dollar increases US prices by more than is allowed for in the OECD model. Similarly, a steepening of the yield curve serves as an early warning of future inflationary pressures which are not allowed for in the predictions. The negative coefficient on ΔM3 would suggest that prices are less sensitive to money supply growth than assumed; however, it could also be capturing the effects of structural shifts in liquidity preferences. Constraining the coefficient on Δπ to zero has only a minor impact on the explanatory power and the size of the coefficients. However, as noted above, this result does not hold for other G-7 countries.

For *Japan* inflation seems to be less sensitive to changes in the output gap and in the growth of M2 than assumed in the forecast model. In contrast, the response of Japanese prices to movements in the exchange rate are underpredicted. In fact, the effective appreciation of the yen during the last ten years may have led to inflation being overstated by a cumulative 4 percentage points. A further source of overpredicting inflation might be that the forecasting model does not take account of future changes in monetary policy, as indicated by the yield spread. Finally, higher real asset prices have been accompanied by lower-than-expected goods price inflation. This could indicate that, in periods of asset price inflation, liquid funds are being channelled into asset markets rather than into goods markets and thus induce less inflationary pressure than typically assumed. Alternatively, the estimates might simply reflect that the steepest rise in asset prices occurred during a period when goods price inflation was unusually low in Japan. It should be noted that the estimated sign on asset price changes is reversed when the non-financial variables are dropped. However, the R^2 is only 0.38, suggesting that the influence of asset prices and other financial variables is conditioned by the cycle.

This conclusion also applies to the estimates for *Germany*. Although there is a significant improvement in the explanatory power when the estimating equation is extended to include financial variables and the output gap, most of the improvement can be attributed to an underprediction of the cyclical sensitivity of prices.[37] At the same time, the inflationary impact of an acceleration of M3 growth and of higher long-term interest rates seems to be overstated, assuming that a rise in long-term interest rates is signalling expectations of higher future inflation. Although exchange rate movements are only marginally significant, the sign of the coefficient would imply that the dampening effect of the appreciation of the Deutsche mark during the sample period has been larger than predicted.

At first glance, the equation for *France* looks promising as the output gap, together with three financial variables, produces an R^2 of 0.97. However, alternative specifications uncovered a high degree of parameter instability, clearly underlining the limitations of estimates based on only 16 observations. From the alternative specifications, it also emerged that the lack of robustness is mainly attributable to problems in assessing the influence of exchange rate movements; these, in turn, are related to the fact that, for the sample period as a whole, the effective exchange rate is relatively stable (an average depreciation of 0.75% per year), whereas the year-to-year fluctuations have been large (standard deviation of 5.8%). In contrast, the effects of changes in ΔM3 and the output gap are quite insensitive to specification changes, with the coefficient of the former suggesting that an acceleration in money growth has a larger-than-predicted effect on inflation, whereas the cyclical sensitivity of prices is overstated.

The effect of changes in money supply growth is also understated in the case of *Italy* and the same is true for the cyclical sensitivity of inflation. The influence of the combined output gap-exchange rate variable has the expected sign for a country with a depreciating exchange rate but is of only marginal importance. As for other countries, the suppression of non-financial variables substantially reduces the explanatory power (second equation) and generates an implausibly large impact of changes in long-term interest rates.

Using a VAR model to identify forward-looking indicators for inflation in the *United Kingdom,* Baumgartner and Ramaswamy (1996) concluded that changes in M0 far outperformed other

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[37] The gap variable might, however, be interacting with the forecast error for real growth, implying that a respecification of the level and rate-of-change effects of real output on inflation is warranted.

variables. They also found some explanatory power for the long-term interest rate whereas there was no correlation between the yield spread and future inflation, nor did exchange rate movements seem to have any predictive power. However, when we tested these results on forecast errors for inflation in the United Kingdom, neither M0 nor the long-term interest rate had any effect, whereas both the yield spread and the effective exchange rate were significant. Although the impact of cyclical movements may be overstated in the first equation, the estimates clearly show that non-financial variables need to be taken into account in identifying sources of forecast errors; otherwise, contemporaneous exchange rate movements appear as the only significant variable which, *a priori*, is not very plausible.

For *Canada*, too, the suppression of non-financial variables leaves exchange rate movements as the only significant influence, implying that most of the overprediction of inflation during the sample period can be attributed to overpredicting the impact of the depreciating Canadian dollar. In contrast, the equation including financial as well as non-financial variables point to a systematic underprediction of the degree of deceleration ($\Delta\pi$), together with an underprediction of the dampening effect of higher unemployment and slower money supply growth as additional sources of prediction errors. However, despite an R^2 of 0.8, the equation may still be misspecified as the negative intercept term is indicative of additional but unknown sources of overprediction.

3. Estimates from panel data

Because of the short observation period, many of the results discussed above are not very robust, notably when several specifications are tested. To overcome this problem, the equations including only financial variables were repeated on data pooled across the G-7 countries.

The results for forecast errors for real growth are displayed in the upper part of Table 9, with the most satisfactory estimates obtained when the intercept is allowed to vary between countries and debt ratios are entered as levels rather than as rates of change. With this specification, a widening of the yield spread tends to raise output growth compared with the predicted rate. Similarly, stronger growth of monetary aggregates and asset prices increases output growth. By contrast, a rise in the indebtedness of the non-financial sector, especially debt contracted by the household sector, tends to reduce growth compared with the predicted outcome. Finally, a tightening of monetary conditions (higher short-term interest rates and/or an appreciation of the exchange rate) reduces output growth relative to predictions.

While Table 9 identifies several variables that are relevant in evaluating forecast errors for the G-7 countries as a group, an additional question is whether these variables also help to explain developments in years with particularly large forecast errors (cf. Table 5). This is further explored in Table 10 by calculating ratios between the residuals for a particular country and year and original forecast errors. Starting with the average for the G-7 countries, it appears that changes in financial markets and asset prices have an asymmetric effect on the accuracy of the forecasts. For years when

Table 9

Estimates based on pooled data[1]

Real growth

Equations[2]	**c**	**s**	**Δe**	**ΔMi**	**ΔRass**	**$Debt_F$**	**$Debt_H$**	**NMCI**	**S.E.**
(*a*)	-0.62	0.39*	–	0.09*	0.01**	-0.01	0.00	-0.03	1.30
(*b*)	–	0.33*	–	0.09*	0.01**	-0.04	-0.09*	-0.11*	1.25
(*c*)	–	0.46*	–	0.10*	0.01**	-0.04	0.02	-0.04	1.33

Inflation

(*a*')	-0.37	0.09	0.03	–	0.01*	–	–	–	0.92
(*b*')	–	0.15*	0.02*	–	0.01*	–	–	–	0.84
(*c*')	–	0.13*	–	-0.02	0.01*	–	–	0.11*	0.75

Notation: *c* = intercept term; *s* = yield spread; Δ*e* = change in the nominal effective exchange rate; Δ*Mi* = change in broad monetary aggregates; Δ*Rass* = change in real asset prices; $Debt_F$ = debt of non-financial enterprises as a percentage of GDP; $Debt_H$ = household debt as a percentage of GDP; *NMCI* = monetary conditions index (nominal); and S.E. = standard error of estimate. * Indicates coefficients with t-ratios ≥ 1.96.

[1] The coefficients shown above were obtained by regressing forecast errors for real growth and inflation on the variables listed in the first row. [2] For (*a*) and (*a*') a common intercept is imposed and (*c*) differs from (*b*) by entering debt ratios as changes. In (*a*') and (*b*') Δ*e* is measured as (Δe - Δe_{-2}) and in (*c*') NMCI is measured as ($NMCI$ - $NMCI_{-2}$); otherwise all explanatory variables are entered with one or two-year lags.

growth falls short of the predicted rate (-), about one-half of the overprediction can be related to developments in the financial indicators included in the pooled regressions. By contrast, such variables explain less than 20% in years when growth is underpredicted (+); in fact, all the entries exceeding 1 refer to years when growth was underpredicted.

With respect to individual years, most of the unexpectedly high growth in 1984 can be related to financial developments, as can the unexpectedly low growth (or slow recovery) during 1991-93. This supports the earlier view that factors, such as debt reduction and balance-sheet restructuring, had a larger influence during this period than had previously been observed. In contrast, the underpredictions of growth observed for 1988 and 1994 are rather poorly explained when only financial developments are considered.

Pooled estimates of the forecast errors for inflation are shown in the lower part of Table 9, with the most satisfactory results obtained when the intercept term is allowed to vary between countries and monetary conditions indices are used instead of changes in effective exchange rates. According to the estimates, the information contained in a widening of the yield spread is not sufficiently taken into account in the prediction model, leading to an underprediction of inflation. Similarly, the dampening effect of tighter monetary conditions is overstated (or assumed to occur with a shorter time lag), again leading to an underprediction of inflation. Ignoring higher real asset prices also causes actual inflation to exceed the predicted rate whereas lagged changes in monetary aggregates enter with a negative but insignificant coefficient.

In analysing the extent to which financial developments help to explain particularly large forecast errors (Table 11), the definition in Table 5 was extended to include all years for which the forecast errors exceed one standard deviation.[38] Even so, the number of observations is rather small so that, similar to those shown in Table 10, the results should be regarded with caution. It does appear, however, that financial developments, in part, explain the overprediction of inflation during the last ten years. In other words, if the forecasting model had included more financial indicators (such as the yield spread) and/or the coefficient for changes in monetary conditions had been adjusted, it would have captured a larger proportion of the observed disinflation. This is evident for the G-7 countries as a group, as the overprediction errors are reduced by about one-half, and even more so for individual countries, such as Canada and the United States.

Table 10

Large forecast errors and financial variables: real growth

Ratio of residuals to forecast errors, selected years and averages

Years	**US**	**JP**	**DE**	**FR**	**IT**	**GB**	**CA**	**G7**
1981	–	–	–	–	–	–	1.41+	–
1982	0.61 -	–	0.70 -	–	0.95 -	0.25 +	0.73 -	0.94 -
1983	0.96 +	–	0.82 +	–	0.85 -	0.28 +	1.03 +	–
1984	0.48 +	0.63 +	–	0.34 +	–	–	–	0.28 +
1987	–	0.85 +	–	–	–	–	–	–
1988	0.73 +	0.75 +	0.84 +	0.92 +	1.17 +	–	1.01 +	0.87 +
1991	0.71 -	–	–	–	–	0.33 -	0.22 -	0.16 -
1992	–	–	–	–	–	0.35 -	–	0.19 -
1993	–	0.55 -	0.73 -	0.41 -	0.17 -	–	–	0.35 -
1994	–	–	1.09 +	1.53 +	–	–	–	1.29 +
1995	–	0.49 -	–	–	–	–	–	0.83 -
Ave. (+)	*0.72*	*0.74*	*0.92*	*0.93*	*1.17*	*0.26*	*1.22*	*0.81*
Ave. (-)	*0.66*	*0.52*	*0.71*	*0.41*	*0.66*	*0.34*	*0.47*	*0.49*
Ave.	*0.70*	*0.65*	*0.84*	*0.80*	*0.78*	*0.30*	*0.85*	*0.61*

Note: Signs after the figures indicate whether the forecasts exceed (-) or fall short of (+) the actual rates of growth.

[38] As discussed in Section 1, the inflation forecasts are biased for several countries and the years shown in Table 5 are those for which the forecast errors deviate from the *mean* by more than one standard deviation.

Table 11

Large forecast errors and financial variables: inflation

Ratio of residuals to forecast errors, selected years and averages

Years	US	JP	DE	FR	IT	GB	CA	G7
1982	0.66 -	0.62 -	0.95 +	0.95 -	0.13 +	0.56 -	–	–
1983	0.38 -	0.99 -	–	–	–	–	0.10 -	0.43 -
1984	0.35 -	–	1.08 -	–	–	0.51 -	0.51 -	0.79 -
1985	–	–	–	1.08 -	–	0.70 +	–	–
1986	0.37 -	1.21 +	0.48 +	–	–	–	–	–
1987	–	1.02 -	–	–	0.21 +	–	0.70 +	–
1988	–	–	–	–	–	0.67 +	–	–
1989	–	–	–	1.03 +	1.02 +	–	–	1.28 +
1990	–	–	–	–	0.71 +	–	0.51 -	–
1991	0.31 -	–	–	0.31 -	–	–	0.26 -	–
1992	–	–	0.70 +	0.40 -	–	–	0.16 -	–
1993	–	–	0.97 -	–	–	0.93 -	–	0.41 -
1994	–	–	–	0.43 -	–	–	0.65 -	0.49 -
1995	–	0.01 -	–	–	0.53 +	–	–	–
Ave. (+)	–	*1.21*	*0.71*	*1.03*	*0.50*	*0.68*	*0.70*	*1.28*
Ave. (-)	*0.40*	*0.66*	*1.02*	*0.63*	–	*0.67*	*0.36*	*0.53*
Ave.	*0.40*	*0.77*	*0.83*	*0.72*	*0.50*	*0.66*	*0.39*	*0.68*

Notation: See Table 10.

In contrast, financial developments do not seem particularly helpful in years when inflation is underpredicted, suggesting that underpredictions can mainly be associated with non-financial developments (notably cyclical changes) and with their coefficients in the prediction model. This is the case for the G-7 countries as a group and, especially, for Japan.

4. Policy changes and forecast errors

One important feature of the OECD forecasts is that they are conditional on unchanged policies. More precisely, fiscal policy is assumed to be implemented according to known or announced budget plans while future short and long-term interest rates are predicted by taking account of announced targets for monetary policy and the levels of "official" interest rates on the day when the forecasts are finalised. Similarly, exchange rates are "fixed" as of this date which usually precedes the publication date by 1-1½ months.[39] Consequently, one important source of forecast errors could be changes in fiscal and monetary policies as well as unexpected movements of exchange rates. Conversely, it is frequently argued that if only forecasters had known future policy changes and exchange rate movements, their predictions would have been more accurate.

In order to test this hypothesis, the OECD Secretariat kindly provided "*ex post* projections" by simulating the Interlink Model over the period 1989-95, using actual long and short-term interest rates as well as the exchange rate movements observed during the period. The results of these simulations are summarised in Tables 12 (real growth) and 13 (inflation) while Annex B provides more details with respect to the distribution of initial and revised forecast errors as well as the unpredicted changes in interest rates and exchange rates.

Table 12

Cumulative forecast errors, real growth, 1989-95

Items	**US**	**JP**	**DE**	**FR**	**IT**	**GB**	**CA**	**G7**
Original	-2.8	-2.7	2.4	-3.2	-4.3	-6.4	-9.6	-3.8
Rev. (*i*)	-4.8	-3.3	2.3	-3.1	-4.2	-6.6	-10.4	-4.3
Rev. (Δe)	-2.3	-2.2	3.8	-2.3	-7.3	-7.9	-11.2	-4.2
i_s	-4.7	-3.2	2.6	4.6	3.1	-1.4	1.2	2.2
i_l	-4.4	-3.3	0.4	0.4	8.7	0.9	1.3	-0.6
Δe	2.2	9.0	8.2	8.0	-20.1	-11.3	-10.2	-2.0

Notation: Original: original forecast error; *Rev.* (*i*): prediction error using actual short and long-term interest rates; *Rev.* (Δe): prediction error using actual changes in effective exchange rates; i_s: *ex post* adjustment to short-term interest rates; i_l: *ex post* adjustment to long-term interest rates; Δe: *ex post* adjustment to nominal effective exchange rates; G7: unweighted average.

Turning first to the original and revised forecast errors for output growth, one striking feature of Table 12 is the apparent lack of any systematic relationship between the original and the revised forecast errors. In some cases, the cumulative forecast errors increase when actual interest rates and exchange rates are used. This is observed for the G-7 countries as a group and is especially evident for *ex post* forecasts using actual interest rates for the United States and Japan and for forecasts based on actual exchange rates in the case of Germany, Italy, the United Kingdom and Canada. By contrast, the cumulative forecast errors are reduced when actual exchange rates are used for the United States, Japan and, in particular, France.

Several factors may be responsible for this pattern of changes in the forecast errors. For instance, policies could have changed during the forecasting period in response to perceived

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[39] The forecasts also assume that oil prices remain constant relative to OECD export prices for manufactured goods.

Table 13

Cumulative forecast errors, inflation, 1989-95

Items	US	JP	DE	FR	IT	GB	CA	G7
Original	-2.2	-3.1	1.0	-2.5	3.9	-1.2	-7.5	-1.7
Rev. (i)	-2.7	-2.7	0.9	-2.3	4.1	-1.2	-7.4	-1.6
Rev. (Δe)	-2.0	-2.8	1.0	-2.2	1.0	-2.7	-8.1	-2.2
i_s	-4.7	-3.2	2.6	4.6	3.1	-1.4	1.2	2.2
i_l	-4.4	-3.3	0.4	0.4	8.7	0.9	1.3	-0.6
Δe	2.2	9.0	8.2	8.0	-20.1	-11.3	-10.2	-2.0

Notation: See Table 12.

deviations between previously announced forecasts and revised expectations of output growth. Consequently, the assumption of exogenous policies on which the original forecasts were based no longer holds and, because of this endogeneity, the policy parameters of the model will be biased. More precisely, when the monetary authorities raise (lower) interest rates in response to a perceived underprediction (overprediction) of real growth and the Interlink model is rerun using the higher (lower) interest rates, the predicted growth rate will be even lower (higher) than initially assumed and, as a consequence, the revised forecast error will rise relative to the initial one. Such policy reactions probably explain the higher forecast errors observed for the United States and Japan as several reductions in official interest rates failed to "lift" actual spending corresponding to the predictions.

A similar error pattern may be observed, if markets react to stronger (weaker) growth than previously assumed by bidding up (down) the exchange rate. Consequently, when the model is rerun using revised exchange rate data, it will produce even lower (higher) predictions of output growth and the revised forecast error will exceed the initial one. For example, the marked rise in the prediction error for Germany can probably be explained by this reaction as the exchange rate strengthened in response to the higher growth induced by the 1989 reunification and, when the model is simulated taking account of the appreciation, it produces an even lower prediction and, as a result, a larger forecast error. The rise in the prediction errors observed for Italy, the United Kingdom and Canada when actual exchange rate developments are used can probably also be related to this factor. In all three countries, actual growth rates were well below the predicted growth rates during the early 1990s, contributing to downward pressures on the exchange rates. Moreover, because the depreciations were partly induced by the growth performance and were not exogenous as assumed in the prediction model, the tendency towards overpredicting growth is strengthened for model simulations using revised exchange rate data.

In other cases, revised values for interest rates and exchange rates may attenuate forecast errors due to other factors. In France, for instance, growth has been overpredicted during 1989-95.

However, reflecting the policy of linking the franc to the appreciating Deutsche mark, the effective exchange rate strengthened and when the model is simulated taking account of the appreciation, it generates lower predictions and hence a lower forecast error. Similarly, the strengthening of the US dollar and the yen during 1989-95 reduced the ex post model predictions and thus the tendency to overpredict growth.

Generally, the revised prediction errors for inflation tend to be closer to the original errors than in the case of forecast errors for growth. However, the pattern of changes varies across countries, depending on whether inflation is over- or underpredicted. In the case of Italy the *ex post* simulations using actual exchange rate changes partly remove an early tendency to underpredict inflationary pressures and the error is substantially reduced. In contrast, for the United Kingdom and Canada the tendency to overpredict inflation is reinforced when the model is simulated using the depreciated currencies. Similarly, the tendency to overpredict inflation becomes somewhat more pronounced in the United States, when the model is rerun using actual interest rates. This can be explained by the higher rate of output growth generated by the revised and lower interest rates, combined with a relatively high cyclical sensitivity of US inflation. In other countries, this influence is hardly noticeable as both the interest sensitivity of output growth and the cyclical sensitivity of inflation tend to be smaller.

Due to the nature of the simulations discussed above, they should not be used in evaluating the forecasting performance of the OECD Secretariat or in assessing the effectiveness of policy changes. For instance, had the forecasters known that policies were likely to change in the event of large deviations between predictions and expected outcome, they would have reconsidered their *ex ante* forecasts and, undoubtedly, made substantial adjustments. It should also be stressed that due to the *ex post* nature of the simulations, the rise in the revised forecast errors cannot be interpreted as a sign that the stimulatory measures were ineffective or even counterproductive. The simulations only compare *ex post* outcomes with revised predictions and provide no information about possible developments in the absence of the measures taken.

Summary and conclusion

Given the aim of this paper, it is natural to focus this section on two related questions: Is there any evidence that changes in financial and monetary variables affect actual developments in output and inflation relative to forecasts? If so, should forecasters take account of such changes to reduce future forecast errors? Given the preliminary and *ad hoc* nature of the analysis it is not possible to provide definitive answers but some "guidelines" might be worth considering.

First, while financial and monetary variables do seem to be important in explaining forecast errors, they are not the primary sources of such errors. In most cases the explanatory power of the equations tested drops substantially when non-financial variables are suppressed, with two non-financial sources of errors being especially prominent:

- in virtually all countries, there is a systematic tendency to underpredict changes in both output growth and the rate of inflation. This finding is not unique to the data sample analysed in this paper (1980-95); in fact, already in 1961 Theil suggested that "this [problem] needs to be investigated and corrected whenever possible";
- for forecast errors for inflation it appears that cyclical effects are misspecified, due to biased coefficients, incorrect lag assumptions or unexpected structural changes in the cyclical sensitivity of prices and wages. However, the pattern of errors varies across countries and is, therefore, not the sole explanation of the apparent tendency to overpredict inflation during the sample period.

Secondly, the financial variables that are most frequently related to forecast errors are:[40]

- the slope of the yield curve, even though, *a priori*, the implications of a change in the yield curve for future output growth and inflation are ambiguous;
- exchange rate movements, measured by either nominal effective exchange rates or real or nominal monetary conditions indices. To the extent that exchange rate movements *during* the forecast period are the principal source of errors, this finding is difficult to use in improving the forecasts, given the "non-forecastability" of future exchange rate movements. However, such "shocks" seem to be relatively rare (mainly confined to Italy, the United Kingdom and Canada) and, in most cases, forecast errors are caused by *past* exchange rate movements; i.e. events that were known when the forecasts were finalised;
- the asset price cycle in the 1980s and related changes in the indebtedness of the non-financial sector. This is especially evident in Japan and France but such effects are also observed in countries where the asset price cycle was less pronounced;
- changes in monetary aggregates, suggesting that even though such aggregates have become less important for monetary policy, they may still exert a significant influence on changes in output growth and the rate of inflation.

Thirdly, even though the evidence should be regarded with some caution given the small number of observations, there appears to be a systematic but asymmetric effect of monetary and financial variables in years when forecast errors are particularly large:

- when either growth or inflation is *overpredicted*, about one-half of the error can be explained by developments in financial and monetary conditions;

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40 It should also be stressed that identifying a high *correlation* between financial developments and forecast errors does not necessarily imply that a *causal* relationship has been uncovered.

- in contrast, when either growth or inflation is *underpredicted*, only a minor part can be related to financial and monetary developments.

In other words, the analysis provides some tentative evidence that unfavourable developments in financial markets (some of which may be shocks) can have a significant and negative effect on output growth and inflation whereas favourable developments seem to have relatively little influence.[41]

Finally, it is too early to conclude that all the financial variables found to be related to forecast errors should be more extensively used in the forecasting process. The yield curve appears to be a useful complement, even though the sign is theoretically ambiguous in the estimated equations. It also seems that the effect of past exchange rate movements on both output growth and inflation should be reconsidered. On the other hand, the case for including asset prices and debt seems less convincing as such influences may be less important in future business cycles than they were in the 1980s and early 1990s. Similarly, as long as it is unknown whether the influence of changes in monetary aggregates on prediction errors reflects structural changes in demand or incorrect model coefficients, it may be premature to assign a larger role to monetary aggregates in predicting future developments.

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[41] It thus appears that despite the massive changes in and growing influence of financial markets, it is still not possible to "push on a string".

Annex A

A priori coefficients

As mentioned in the text, there are numerous problems in relating the coefficients estimated in Section 2 to structural parameters. Because the dependent variable is derived as the difference between the actual outcome of an unknown model (the real world) and the predicted outcome of a known forecasting model, it is generally impossible to precisely identify the sources of the forecasting errors. As an illustration, consider the impact of movements in nominal effective exchange rates (Δe) on real growth and inflation forecast errors. When a positive (negative) value for Δe indicates an appreciation (depreciation), the predictions for respectively output growth (y) and inflation (π) can be written as:[42]

(1) $$y_t^{forecast} = -\sum_i \alpha_i \Delta e_{t-i}^{forecast} + \varepsilon_t$$

(2) $$\pi_t^{forecast} = -\sum_j \beta_j \Delta e_{t-j}^{forecast} + \nu_t$$

For the outcome, the corresponding equations are:

(3) $$y_t^{actual} = -\sum_m \alpha'_m \Delta e_{t-m}^{actual} + \varepsilon'_t$$

(4) $$\pi_t^{actual} = -\sum_n \beta'_n \Delta e_{t-n}^{actual} + \nu'_t$$

with α, β, α' and $\beta' > 0$ and i, j, m and $n = 0, 1, 2, ...$

The observed forecast errors for output growth and inflation can then be expressed as:

(5) $$y_t^{actual} - y_t^{forecast} = -(\sum_m \alpha'_m \Delta e_{t-m}^{actual} - \sum_i \alpha_i \Delta e_{t-i}^{forecast}) + (\varepsilon'_t - \varepsilon_t)$$

(6) $$\pi_t^{actual} - \pi_t^{forecast} = -(\sum_n \beta'_n \Delta e_{t-n}^{actual} - \sum_j \beta_j \Delta e_{t-j}^{forecast}) + (\nu'_t - \nu_t)$$

with four separate sources of errors in each case:

- the assumed and actual coefficients differ,
- the forecast and actual change in exchange rates differ,
- the assumed and actual lag patterns differ, and
- the assumed and actual random errors differ,

[42] To simplify the discussion we disregard other variables in the prediction equations.

plus any combination of the four sources. Even with a larger sample it would not be possible to predict the coefficient signs in (5) and (6), let alone identify what "went wrong". However, by introducing additional assumptions and simplifications we can derive the expected signs of the regression coefficients. Starting with the forecast error for growth, we shall ignore the random error components as well as lags > 1. Moreover, because exchange rate changes affect growth with some lag, the only source of error is $\alpha_1 \neq \alpha'_1$. This gives two possible values for the expected covariance (cov) between the forecast error for output growth (say y') and exchange rate changes (Δe):

(7) $\alpha_1 > \alpha'_1 \Rightarrow (\text{cov}_{y', \Delta e}) > 0$; i.e. growth will be under- (over-) predicted for $\Delta e > (<) 0$

(8) $\alpha_1 < \alpha'_1 \Rightarrow (\text{cov}_{y', \Delta e}) < 0$; i.e. growth will be over- (under-) predicted for $\Delta e > (<) 0$

Accordingly, if the effects of lagged exchange rate movements are systematically overstated (7) when predicting developments one year ahead, we would expect the regression coefficient to be positive regardless of whether the currency is appreciating or depreciating. Conversely, a negative coefficient is likely if the impact coefficient is understated (8). However, because the estimates are based on *lagged* values, the coefficients do not identify the effects of shocks but should be interpreted as indicators of possible specification errors in the forecast model.

With respect to forecast errors for inflation, the lags are likely to be much shorter than for real growth and for $j = n = 0$, the covariance between forecast errors and exchange rate movements would reflect differences in the assumed and actual coefficients as well as unexpected movements in the exchange rate. For lagged exchange rate changes, however, and using the same simplifying assumptions as above, the expected covariance between the inflation forecast error (π') and the exchange rate (Δe) can be derived as:

(9) $\beta_1 > \beta'_1 \Rightarrow (\text{cov}_{\pi', \Delta e}) > 0$; i.e. inflation will be under- (over-) predicted for $\Delta e > (<) 0$

(10) $\beta_1 < \beta'_1 \Rightarrow (\text{cov}_{\pi', \Delta e}) < 0$; i.e. inflation will be over- (under-) predicted for $\Delta e > (<) 0$

Consequently, if the effects of lagged exchange rate movements are systematically overstated (9 **)** when predicting future inflation, we would expect the regression coefficient to be positive, whereas a negative coefficient is more likely if the impact effect were overstated (10).

As a second illustration, consider the likely sign of the output gap (*gap*) or changes in the output gap in regressions on forecast errors for inflation. Using the same notation as above, we have:

(11) $$\pi_t^{forecast} = \sum_j \phi_j gap_{t-j}^{forecast} + \upsilon_t$$

(12) $$\pi_t^{actual} = \sum_i \phi'_i gap_{t-i}^{actual} + \upsilon'_t$$, with ϕ and $\phi' > 0$ and $i, j = 0, 1, \ldots$.

If only the one-year lagged output gap affects the current rate of inflation (i.e. $i = j = 1$), the expected covariance between the output gap and the forecast error for inflation (π') would only depend on the assumed and actual coefficients:

(13) $\phi_1 < \phi'_1 \Rightarrow (\text{cov}_{\pi', gap}) > 0$; i.e. inflation will be under- (over-) predicted for *gap* > (<) 0

(14) $\phi_1 > \phi'_1 \Rightarrow (\text{cov}_{\pi', gap}) < 0$; i.e. inflation will be under- (over-) predicted for *gap* < (>) 0

The expected covariance between the output gap and the forecast error for inflation can thus be derived but, again, inferences would refer to possible specification errors rather than to the effects of output shocks. For instance, if hysteresis or a more credible monetary policy has made inflation less sensitive to cyclical changes than assumed in the model (13), it can be inferred that inflation will be overpredicted in periods of excess demand and underpredicted when demand is low. Conversely, if structural or other changes have increased the cyclical sensitivity of prices (14), inflation will be underpredicted in periods of excess demand and overpredicted when demand is below trend. Given the earlier evidence of inflation being overpredicted since the mid-1980s, this combination may be important in evaluating forecast errors.

For some countries we also experimented with an interaction variable (defined as the product of exchange rate changes and the output gap and (denoted by $\Delta e(gap)$) on the assumption that the cyclical situation can affect the extent to which exchange rate changes are passed through into domestic prices. Even assuming that the predicted impacts of the output gap and exchange rate movements are correct, the expected covariance between the forecast error and the interaction variable will, as shown in the table below, depend on whether the exchange rate strengthens or weakens. A negative (positive) regression coefficient for the interaction term is to be expected in countries where depreciations (appreciations) have predominated whereas, in cases where the exchange rate has fluctuated around a constant level, the sign of the interaction effect is ambiguous.

Items	**gap ≤ 0**	**gap ≥ 0**
$\Delta e \leq 0$	$\Delta e(gap) \geq 0$ $E(\pi') \leq 0$ E cov ≤ 0	$\Delta e(gap) \leq 0$ $E(\pi') \geq 0$ E cov ≤ 0
$\Delta e \geq 0$	$\Delta e(gap) \leq 0$ $E(\pi') \leq 0$ E cov ≥ 0	$\Delta e(gap) \geq 0$ $E(\pi') \geq 0$ E cov ≥ 0

As a final illustration, consider changes in the slope of the yield curve, another financial variable that proved to be significant for both growth and inflation forecast errors. Even though only lagged values were significant in most of the estimates, it is difficult to predict the likely sign of the regression coefficients, because the hypothetical effects are ambiguous.[43]

With regard to real growth, there is some empirical evidence (Estrella and Mishkin (1996) and Bernard and Gerlach (1996)) that a steepening of the yield curve reduces the probability of future recessions. If this effect is not taken into account in the forecasting model growth will underpredicted and the estimated regression coefficient for the yield spread will be positive. However, a steepening of the yield curve could also indicate that markets are expecting a future rise in short-term interest rates and hence lower output growth and if this is not accounted for in the model, a negative regression coefficient is to be expected. Similarly, a negative coefficient may be found if demand is more sensitive to long-term rates than to short-term rates and this effect is ignored.

The expected signs for the estimated coefficients are equally ambiguous in equations analysing forecast errors for inflation. A steepening of the yield curve could indicate that expectations of inflation have worsened and if this is ignored in the forecast, we can expect a positive regression coefficient. However, a steeper yield curve could also reflect expectations of a future tightening of monetary policy and hence lower inflation. If the forecaster ignores this development, inflation will be overpredicted and the regression coefficient negative.

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[43] An additional reason for the ambiguous sign is that the effect of, for instance, a steepening of the yield curve depends on whether it is caused by higher long-term rates or by lower short rates.

Annex B

Original and revised forecast errors

United States

Items	1989	1990	1991	1992	1993	1994	1995	Σ
Real growth								
Original	-0.5	-1.3	-2.1	0.4	0.7	1.0	-1.0	-2.8
Revised (*i*)	-0.7	-1.9	-2.9	0.2	0.6	1.4	-1.5	-4.8
Revised (Δe)	-0.2	-1.7	-1.6	0.4	1.0	0.9	-1.1	-2.3
Revised i_s	0.0	0.0	-2.4	-1.1	-0.2	0.0	-1.0	-4.7
Revised i_l	-1.4	-1.5	-0.9	-0.3	-0.4	1.5	-1.4	-4.4
Revised Δe	4.5	-3.8	4.8	0.4	0.1	-2.5	-1.3	2.2
Inflation								
Original	-0.4	-0.3	-0.9	-0.1	-0.1	-0.3	-0.1	-2.2
Revised (*i*)	-0.5	-0.5	-1.1	-0.1	-0.1	-0.2	-0.2	-2.7
Revised (Δe)	-0.3	-0.5	-0.7	-0.1	0.0	-0.3	-0.1	-2.0

Japan

Items	1989	1990	1991	1992	1993	1994	1995	Σ
Real growth								
Original	0.4	1.1	0.7	-1.1	-2.2	0.0	-1.6	-2.7
Revised (*i*)	0.6	1.0	0.4	-1.3	-2.3	0.1	-1.8	-3.3
Revised (Δe)	0.4	0.7	0.7	-1.1	-1.5	0.0	-1.4	-2.2
Revised i_s	0.7	1.0	-1.0	-1.5	-0.7	-0.3	-1.4	-3.2
Revised i_l	-0.3	1.1	-1.5	-0.7	-0.8	0.5	-1.6	-3.3
Revised Δe	-7.3	-6.5	-0.2	1.4	16.0	3.4	2.2	9.0
Inflation								
Original	0.5	-0.7	-0.3	-0.2	-0.7	-0.6	-1.1	-3.1
Revised (*i*)	0.5	-0.7	-0.2	-0.2	-0.6	-0.5	-1.0	-2.7
Revised (Δe)	0.5	-0.8	-0.3	-0.2	-0.5	-0.5	-1.0	-2.8

Germany

Items	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**Σ**
Real growth								
Original	1.4	1.3	0.7	0.3	-2.3	2.1	-1.1	2.4
Revised (i)	2.1	1.6	-0.2	0.0	-2.7	2.9	-1.4	2.3
Revised (Δe)	1.3	1.9	0.3	0.7	-2.2	2.2	-0.4	3.8
Revised i_s	2.5	0.1	0.2	0.4	-0.5	0.4	-0.5	2.6
Revised i_l	0.8	1.0	-0.8	-0.5	-0.7	1.2	-0.6	0.4
Revised Δe	-0.5	2.7	-1.6	2.6	0.6	0.8	3.6	8.2
Inflation								
Original	0.6	0.4	0.2	0.9	-0.7	-0.6	0.2	1.0
Revised (i)	0.6	0.5	0.1	0.9	-0.7	-0.6	0.1	0.9
Revised (Δe)	0.5	0.5	0.1	1.0	-0.7	-0.6	0.2	1.0

France

Items	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**Σ**
Real growth								
Original	0.6	-0.3	-1.1	-0.7	-2.6	1.8	-0.9	-3.2
Revised (i)	0.8	-0.3	-1.4	-0.7	-2.7	2.1	-0.9	-3.1
Revised (Δe)	0.5	0.2	-1.6	-0.3	-2.7	2.2	-0.6	-2.3
Revised i_s	1.8	-0.1	-0.8	1.2	0.4	0.8	1.3	4.6
Revised i_l	0.4	0.7	-1.1	-0.2	-1.2	1.9	-0.1	0.4
Revised Δe	-0.1	2.9	-2.6	3.4	0.1	2.5	1.8	8.0
Inflation								
Original	0.6	-0.4	-1.0	-0.7	-0.3	-0.6	-0.2	-2.5
Revised (i)	0.7	-0.5	-1.0	-0.6	-0.2	-0.6	-0.2	-2.3
Revised (Δe)	0.6	-0.1	-1.3	-0.5	-0.3	-0.4	0.2	-2.2

Italy

Items	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**Σ**
Real growth								
Original	-0.3	-1.2	-1.0	-1.1	-1.5	0.5	0.3	-4.3
Revised (i)	0.4	-1.3	-1.5	-0.8	-2.5	1.1	0.4	-3.1
Revised (Δe)	-0.2	-0.7	-1.3	-1.4	-3.1	0.3	-0.9	-7.3
Revised i_s	1.9	-1.2	-0.9	3.2	-2.3	0.6	1.8	3.1
Revised i_l	2.3	1.6	0.5	2.8	-0.4	1.9	0.0	8.7
Revised Δe	1.4	0.8	-0.5	-3.3	-9.0	-2.0	-7.5	-20.1
Inflation								
Original	2.3	1.9	0.3	-1.1	-0.9	-0.5	1.9	3.9
Revised (i)	2.4	1.9	0.1	-0.9	-0.9	-0.5	2.0	4.1
Revised (Δe)	2.2	2.3	0.0	-1.3	-2.3	-0.7	0.8	1.0

United Kingdom

Items	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**Σ**
Real growth								
Original	-0.8	-0.5	-2.9	-2.8	0.7	0.9	-1.0	-6.4
Revised (i)	-0.4	-0.5	-3.4	-2.9	0.6	1.0	-1.0	-6.6
Revised (Δe)	-1.2	-0.2	-3.3	-3.2	0.9	0.8	-1.7	-7.9
Revised i_s	2.1	0.3	-2.5	-0.6	-0.7	0.0	0.0	-1.4
Revised i_l	0.3	1.8	-1.4	-0.2	-0.7	1.5	-0.4	0.9
Revised Δe	-4.0	3.0	-2.4	-3.6	1.9	-1.1	-5.1	-11.3
Inflation								
Original	0.6	0.3	0.0	0.2	-1.6	-0.9	0.1	-1.2
Revised (i)	1.0	0.3	-0.3	0.2	-1.6	-0.9	0.1	-1.2
Revised (Δe)	0.0	1.1	-0.7	0.0	-1.7	-0.8	-0.6	-2.7

Canada

Items	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**Σ**
Real growth								
Original	-1.0	-1.5	-2.6	-2.4	-1.0	0.9	-2.0	-9.6
Revised (i)	-1.1	-1.5	-3.2	-2.6	-1.0	1.2	-2.2	-10.4
Revised (Δe)	-0.4	-1.9	-2.0	-3.5	-1.2	0.0	-2.2	-11.2
Revised i_s	1.8	1.4	-2.6	-0.8	0.1	0.7	0.6	-1.4
Revised i_l	-1.1	1.4	-0.5	0.0	0.2	1.5	-0.3	1.3
Revised Δe	4.8	-0.9	2.8	-7.5	-3.0	-5.0	-1.4	-10.2
Inflation								
Original	0.9	-2.0	-2.0	-1.7	-1.1	-1.2	-0.4	-7.5
Revised (i)	0.9	-1.9	-2.1	-1.8	-1.0	-1.1	-0.4	-7.4
Revised (Δe)	1.2	-2.1	-1.8	-2.2	-1.2	-1.5	-0.5	-8.1

Notation: *Original* : Original forecast errors for respectively output growth and inflation;
Revised (i) : Forecast errors for output growth and inflation for simulations using actual interest rates;
Revised (Δe) : Forecast errors for output growth and inflation for simulations using actual exchange rates;
Revised i_s : Forecast errors for short-term interest rates;
Revised i_l : Forecast errors for long-term interest rates;
Revised Δe : Forecast errors for exchange rate changes.

Bibliography

Andersen, P. S. and W. White (1996): "The Macroeconomic Effects of Financial Sector Reforms: An Overview of Industrial Countries", in *Macroeconomic Policies and Structural Reform,* OECD, Paris, pp. 59-103.

Artis, M. J. (1988): "How Accurate Is the World Economic Outlook? A Post Mortem on Short-term Forecasting at the International Monetary Fund". *Staff Studies for the World Economic Outlook*, IMF, Washington, pp. 1-49.

Artis, M. J. (1996): "How Accurate are the IMF's Short-term Forecasts? Another Examination of the World Economic Outlook". IMF *Working Paper*, No. 96/89.

Balke, N. S. and M. A. Wynne (1996): "Are deep recessions followed by strong recoveries? Results for the G-7 countries". *Applied Economics,* pp. 889-97.

Ball, L. and D. Croushore (1995): "Expectations and the Effects of Monetary Policy". Federal Reserve Bank of Philadelphia, *Working Paper*, No. 95-22.

Barrionuevo, J. M. (1992): "How Accurate Are the *World Economic Outlook* Projections?" *Staff Studies for the World Economic Outlook,* IMF Washington, pp. 28-46.

Baumgartner, J. and R. Ramaswamy (1996): "Inflation Targeting in the United Kingdom: Information Content of Financial and Monetary Variables". IMF *Working Paper,* No. 96/44.

Bernard, H. and S. Gerlach (1996): "Does the Term Structure predict Recessions? The International Evidence". BIS *Working Papers*, No. 37.

Blanchard, O. (1993): "Consumption and the Recession of 1990-91". *American Economic Review*, May, pp. 270-4.

Borio, C. E. V., N. Kennedy and S. D. Prowse (1994): "Exploring aggregate asset price fluctuations across countries: measurement, determinants and monetary policy implications". BIS *Economic Papers,* No. 40.

Campbell, B. and S. Murphy (1996): "Who forecasts best? An empirical Analysis of Private-sector Forecasters". *Canadian Business Economics,* Spring, pp. 3-17.

Catão, L. and R. Ramaswamy (1995): "Recession and Recovery in the United Kingdom in the 1990s: A Vector Autoregression Approach". IMF *Working Paper*, No. 95/40.

Cecchetti, S. (1995); "Inflation Indicators and Inflation Policy". NBER *Working Paper,* No. 5161.

Croushore, D. (1996): "Inflation Forecasts: How Good Are They?" Federal Reserve Bank of Philadelphia, *Business Review,* May/June, pp. 15-25.

Estrella, A. and F. Mishkin (1996): "The yield curve as a predictor of recessions in the United States and Europe", in *The Determination of Long-term Interest Rates and Exchange Rates and the Role of Expectations,* BIS *Conference Papers,* Vol. 2, pp. 324-40.

Fillion, J.-F. (1994): "L'endettement du secteur privé au Canada: un examen macroéconomique". Bank of Canada, *Working Paper*, No. 94-7.

Fisher, P. G. (1993): "Housing and consumption in the United Kingdom", in *Changes in the Business Cycle and the Implications for Monetary Policy*, C.B. 392, Bank for International Settlements, pp. 299-327.

Granger, C. W. J. (1996): "Can we improve the perceived quality of economic forecasts?" *Journal of Applied Econometrics*, pp. 455-76.

Hamilton, J. D. and G. Lin (1996): "Stock Market Volatility and the Business Cycle". *Journal of Applied Econometrics*, pp. 573-94.

Holden, K. and J. Thompson (1997): "Combining forecasts, encompassing and the properties of UK macroeconomic forecasts". *Applied Economics*, Vol. 29, pp. 1447-58.

Horioka, C. Y. (1996): "Capital gains in Japan: Their magnitude and impact on consumption". *The Economic Journal*, pp. 560-77.

Inoue, K., K. Ishida and H. Shirakawa (1996): "Volatility in Japanese financial asset prices: causes effects and policy implications", in *Financial Market Volatility: Measurement, Causes and Consequences*, BIS Conference Papers, Vol. 1, pp. 334-63.

Kaku, K. and K. Fukuda (1993): "The recent cyclical developments and implications for monetary policy in Japan", in *Changes in the Business Cycle and the Implications for Monetary Policy*, C.B. 392, Bank for International Settlements, pp. 169-98.

Lamont, O. (1995): "Macroeconomic Forecasts and Microeconomic Forecasters". NBER *Working Paper*, No. 5284.

Laster, D., P. Bennett and I. Geoum (1997): "Rational Bias in Macroeconomic Forecasts". *Federal Reserve Bank of New York Staff Reports*, No. 21.

Longworth, D. J. and S. S. Poloz (1993): "The changing nature of economic cycles: implications for the conduct of monetary policy", in *Changes in the Business Cycle and the Implications for Monetary Policy*, C.B. 392, Bank for International Settlements, pp. 63-82.

McNees, S. K. (1987a): "Forecasting Cyclical Turning Points: The Record in the Past Three Recessions". *New England Economic Review*, March/April, pp. 31-40.

McNees, S. K. (1987b): "Consensus Forecasts: Tyranny of the Majority?" *New England Economic Review*, November/December, pp. 15-21.

McNees, S. K. (1992a): "The 1990-91 Recession in Historical Perspective". *New England Economic Review*, January/February, pp. 3-22.

McNees, S. K. (1992b): "How Large Are Economic Forecast Errors?" *New England Economic Review*, July/August, pp. 25-42.

McNees, S. K. (1995): "An Assessment of the "Official" Economic Forecasts". *New England Economic Review*, July/August, pp. 13-23.

McNees, S. K. and L. K. Fine (1994): "Diversity, Uncertainty and Accuracy of Inflation Forecasts". *New England Economic Review*, July/August, pp. 33-44.

Montplaisir, M.-C. (1995): "Effets des variables financières dans la courbe IS". *Bank of Canada Memo*, No. FN-95-141.

OECD (1993): "How accurate are Economic Outlook projections?" OECD *Economic Outlook*, June, pp. 49-54.

Pain, N. and A. Britton (1992): "National Institute Economic Forecasts 1968-91: Some Tests of Forecast Properties". *National Institute Economic Review*, August, pp. 81-93.

Stark, T. (1997): "Macroeconomic Forecasts and Microeconomic Forecasters". Federal Reserve Bank of Philadelphia, *Working Paper*, No. 97-10.

Steindel, C. (1993): "Changes in the US Cycle: shifts in capital spending and balance sheet changes", in *Changes in the Business Cycle and the Implications for Monetary Policy*, C.B. 392, Bank for International Settlements, pp. 329-47.

Stockton, D. J. (1993): "The Business Cycle in the United States: Evaluating Traditional and Alternative Paradigms". Board of Governor of the Federal Reserve System, *Memo*.

Tallman, E. W. and N. Chandra (1997): "Financial aggregates as conditioning information for Australian output and inflation". Reserve Bank of Australia *Research Discussion Paper*, No. 9704.

Tzavalis, E. and M. R. Wickens (1996): "Forecasting inflation from the term structure". *Journal of Empirical Finance*, pp. 103-22.

Woodford, M. (1994): "Nonstandard Indicators for Monetary Policy: Can Their Usefulness Be Judged from Forecasting Regressions?", in N. G. Mankiw (ed.) *Monetary Policy*, NBER and University of Chicago Press, pp. 95-115.

Theil, H. (1961): *Economic Forecasts and Policy*, North Holland, Amsterdam.

Zarnowitz, V. (1992): "Twenty-two Years of the NBER Quarterly Economic Outlook Surveys: Aspects and Comparisons of Forecasting Performance". NBER *Working Paper*, No. 3965.

Zickler, J. K. (1993): "Some aspects of the recent cyclical performance of the US economy", in *Changes in the Business Cycle and the Implications for Monetary Policy*, C.B. 392, Bank for International Settlements, pp. 367-86.

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