FORECASTING WITH MACROECONOMETRIC MODELS: A REPORT FROM THE TRENCHES[1]

by *Ullrich Heilemann*[2]

Econometric models are a widely used and powerful tool in macroeconomic analysis and forecasting. Admittedly, their acceptance by the scientific community has had some hard times during the seventies and eighties: a general decline in the reputation of macroeconomics, the *Lucas* critique, and failures of the model community to make their often opaque practice transparent had left their marks. Closer looks at the criticism, however, revealed its limited relevance, and the „new/old macroeconomic consensus" (*Blinder, Zarnowitz*) of the early 1990s seems to have restored much of the lost credibility. A lack of transparency, however, still diminishes acceptance and credibility of the results, at least within the academic community[3]. The apparent deficit in model transparency has a number of causes, a major one being the fact that the literature on the practice of macroeconometric forecasting is still sparse (cf. e.g., Klein, Young 1980, pp. 75ff., Adams 1986, pp. 106ff.) and, given the new technical opportunities for model and forecast analysis, it is also somewhat outdated. One explanation for this is that economic deliberations in the model industry back such disregard (Daub 1987, pp. 73ff.) and it may still take some time until the industry realises that transparency is the models' biggest asset.

This paper describes in detail the production of a macroeconometric forecast, complementing and enlarging on two earlier papers on the subject (Heilemann 1985, 1990). The model used is the business cycle model of the Rheinisch-Westfälisches Institut für Wirtschaftsforschung (RWI) which has been applied for forecasting since 1978. The forecast examined is the autumn 1996 forecast for 1996 and 1997. To meet

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3 Policy makers and policy making institutions are less sceptical or simply overcome any doubts by using a multitude of macro models – beside their own ones (Blinder 1998, pp. 11ff.).

the criticism of a lack of transparency, the paper transcends the usual framework by analysing the accuracy of the forecast in detail. While forecasts once used to start with such an examination, not many resources are committed to this nowadays (for what is still an outstanding example of a forecast analysis, cf. Sapir 1949; the difficulties of error analysis in not-model based forecasts is illustrated in Fintzen, Steker 1999; for the routine examination of the RWI-model forecast, see for example Rheinisch-Westfälisches Institut für Wirtschaftsforschung (Hrsg.) 1998, pp. 17ff.).

The fact that this paper is being presented at the annual conference of the *Deutsche Statistische Gesellschaft* calls for two remarks, both related to *Karl-Heinz Raabe* (1974). Firstly, the Statistische Gesellschaft has a tradition of dealing with the practical side and problems of economic forecasting (e.g., Stäglin 1998, Seidler 1975), questions which are usually ignored in textbooks as well as in methodical tracts. I hope to demonstrate the importance of the subject in the following. The second remark concerns an important part of what Raabe termed „empirische Analyse mit sukzessiver Annäherung" – or the „iterative VGR Prognose" [iterative NA forecast]. The paper will show that this iterative approach has much in common with the econometric model approach in a literal as well as in a general sense. Probably the iterative approach in the latter sense is characteristic of any forecast. It definitely was part of the mathematical (!) astrologers' method (Grafton 1999, pp. 162ff.) and will also be part of any autoregressive time series models used for detailed macroeconomic forecasts.

The paper is organised as follows. The next section (I) displays the analytical foundations of econometric forecasting and error analysis. Section II briefly presents the model used and the macroeconomic situation in late 1996. The process of producing the forecast is described in section III, including the *ex post* evaluation and the exploration of the size and nature of its forecasting errors. The paper ends with a summary and conclusions (IV). The subtitle of the paper announces a report from the trenches and I hope you forgive me that the paper is rather dense and brief, and, equally important, that I abstain from generalisations. History may be made in the trenches but it is written in the study.

I. Analytical foundations

A *simplified* form of an econometric model can be represented as follows:

(1) $y_t = f\left(y_t, y_{t-i}; x_t, x_{t-j}; \beta; e_t\right)$

where:

$f = (f_1, ..., f_N)$:	vector of N functional relationships;
y_t:	vector of N endogenous variables;
y_{t-i}:	vector of lagged endogenous variables, $1 \le i \le m$;
x_t:	vector of exogenous variables;
x_{t-j}:	vector of lagged exogenous variables, $1 \le j \le n$;
$ß = (ß_1, \ldots, ß_N)$:	matrix of estimated structural parameters;
e_t:	vector of error terms (with the usual assumptions).

Forecasts with this system of equations are made by inserting the predetermined (exogenous and lagged endogenous) variables, assuming $e_t = 0$ and solving the model for the periods $2 > 0$:

(2) $y_{t+k} = f\left(y_{t+k}, y_{t-i+k}; x_{t+k}, x_{t-j+k}; \beta\right).$

With rare exceptions, macroeconometric models are nonlinear and interdependent and have to be solved by iteration methods such as the *Gauss-Seidel* or the *Newton-Raphson* method. However, given the capacity of modern computers and the more or less linear reactions of most models, this no longer poses a problem.

For a number of reasons this basic scheme of econometric forecasting is (usually) modified: there may be, *first*, actual data or superior outside estimates available for some of the endogenous variables to replace model estimates[4]; *second*, policy measures intended for which the model lacks the appropriate instruments (exogenous variables); *third*, an equation may be misspecified, may have systematic bias etc., so that the assumption $e_t = 0$ for the forecast period appears as unreasonable and is replaced. All this leads to a broadening of the basic forecasting scheme:

(3) $y_{t+k} = f\left(y_{t+k}, y_{t-i+k}; x_{t+k}, x_{t-j+k}; x^a{}_{t+k}; \beta\right)$

where:

$x^a{}_{t+j}$: vector of supplements to the absolute term;

or, more specifically:

4 For example, in Germany the annual negotiated wage rate can be reliably predicted from the wage settlements of the first four to five months of the year; *bridge equations* (Greene, Howrey, Hymans 1986, pp. 97ff.) or survey data like consumer sentiment indices may be used to exploit their informational content for superior estimates of the first data of the forecasting period, e.g., in the price sector.

(4) $y_{t+k} = f\left(y_{t+k}, y_{t-i+k}; x_{t+k}, x_{t-j+k}; x^{o}_{t+k}; x^{s}_{t+k}; \beta\right)$

where:

x^{o}_{t+k}: vector of supplements on account of *a priori* information or „objective considerations" (Intriligator, Bodkin, Hsiao 1996, p. 520) on economic policy, data etc.

x^{s}_{t+j}: vector of supplement on account of misspecification („subjective considerations").

These additions are made in various stages of the forecasting process. While the first ones are usually made at its start, the second ones are typically made in later stages, in particular when the results contradict macroeconomic reasoning or outside information. All this makes the process of forecasting to an *iterative* procedure similar - though to a much smaller extent and, of course, much quicker - to the procedures of the so-called informal GDP model forecasts (for Germany see e.g. Raabe 1974; general: Zarnowitz 1992, pp. 385ff.). Usually, the modifications are made in the form of *additions* to the constant term („adds") so that the basic model reactions are not disturbed. Of course, other („reaction"-)parameters could also be changed, but this would make the results much more difficult to control.

II. The RWI short term model

The RWI-business cycle model is a medium-sized, quarterly model, which has been used for short-term forecasting (six to eight quarters) and simulation since the late 1970s. The version examined here consists of 41 stochastic equations and 86 identities, which together form an interdependent („DID-type"), weakly non-linear model (details on this and the following: Heilemann 1998; for a listing of a current equation system, see Heilemann, Barabas 1996, pp. 429ff.). In macroeconomic perspective, it can be partitioned into five sectors: origin (5 stochastic equations; 17 definitions), demand (8; 24), prices (8; 12), income distribution (6; 13), and government (14; 20). The list of exogenous variables includes policy-determined variables, such as the *Social Security Contribution Rate*, *Government Construction Outlays*, and *Interest Rates* on the one hand, and internationally determined variables, such as *World Trade* (volume index) and *Import Prices*, on the other hand. The theoretical foundations of the equations are, as for most applied econometric models, somewhat eclectic, including neo-classical and Keynesian, as well as monetarist elements. The architecture of the model, however, is in the *Keynes/Klein* tradition. With respect to the roles played by demand and money (interest rates) and the stability of the private sector, the model may be labelled as post-Keynesian, or, with respect to the relevance of monetary factors, to fiscal and monetary „shocks“, to the supply side elasticity, to the symmetrical reaction of the (modified) *Phillips* curve, to the reactions of wages to changes of macroeconomic demand or to „rational“ price expectations, as a „new/old consensus“-model (Blinder 1992, pp. 191ff.).

The model is re-estimated twice a year from seasonal unadjusted data; the sample period is the same for all equations and, to omit cyclical bias, covers only the last 40 quarters of the data available („moving window“). For the current study the sample period is 1986-3 to 1996-2, with West German data up to 1990-2, and thereafter *all German* data with a number of one time and permanent dummy variables in most equations.[5] The parameters are estimated by ordinary least squares (OLS). As a sector-ordered incidence matrix reveals, the model, like most others models of this size, has comparatively few within-block and between-block relationships, and the former are more numerous than the latter. Even with this kind of ordering the blocks are more or less recursive.

The model's forecasting accuracy has been widely examined and is part of the published spring forecasts with the model (e.g. Rheinisch-Westfälisches Institut für Wirtschaftsforschung (Hrsg.) 1998, p. 17), ex post and ex ante, in general as well as in particular situations. It was seen as not being outside expectations based on ex post performance and of macroeconomic forecasts in general.

With regard to the intention of the present study, it should be emphasised that in terms of the general structure of the model, the specification of the single equations and their selection, the model is very much short-term oriented: the supply side is, so to speak, recursive to demand and not restricted by the (given) production potential; the sample period reflects only the last two cycles and the selection of specifications is made with the eight quarters forecast horizon in mind. The model's long-term properties and its determinants are of interest but as with most short-run models the impact and interim multipliers are of greater importance (Thomas 1995, p. 405).

III. The 1997 forecast

The process of forecasting with econometric models is, like macroeconomic forecasting in general, both a *recursive* and an *interdependent* process. Usually it takes several

5 A complete listing of equations, estimation results etc. (model-version no. 44) is available from the RWI upon request.

Table 1

Forecast accuracy[1] of the exogenous variables
1996 and 1997

		1996	1997	average[2]
Public construction outlays, rates of change	a	10,7	10,1	4,8
	b	8,7	8,7	4,0
	c	6,7	8,7	2,8
	d	1,1	6,8	1,5
Social security, contribution rates	a	-0,5	-0,3	0,2
	b	0,0	-0,1	0,1
	c	0,1	0,1	0,1
	d	0,1	0,1	0,1
World exports (volume index) 1980=100, rates of change	a	1,0	-2,3	1,8
	b	1,0	-2,2	1,4
	c	-0,2	-2,8	1,1
	d	0,3	-1,7	0,5
Price index of imports, rates of change	a	2,2	-0,9	2,9
	b	0,9	-1,6	2,4
	c	0,0	-1,3	0,9
	d	-0,4	0,4	0,4
Short term interest rate, percent	a	1,2	0,8	1,1
	b	0,8	0,0	0,6
	c	-0,2	-0,1	0,5
	d	-0,1	0,0	0,0
Long term interest rate, percent	a	1,3	1,2	0,8
	b	0,7	0,7	0,6
	c	0,3	0,3	0,3
	d	0,1	0,0	0,1

Source: Heilemann 1998, p. 85 and own computations. It mean: a: spring forecast of the year anteceding; b: autumn forecast of the year anteceding; c: spring forecast of the current year, d: autumn forecast of the current year. - 1) Forecast minus actual data. - 2) Average of absolute differences 1981-3 to 1997-4.

rounds until the final forecast is reached. Here, the process is broken up into five stages: (1) examination of the previous forecast; (2) structural analysis of the newly estimated model; (3) survey of the starting conditions and the setting of the exogenous variables and assumptions; (4) production of the forecast proper; (5) „after the fact“ evaluation of the forecast.

(1) Examination of the previous forecast

The examination of the previous forecast (made in spring 1997, covering 1996-1 to 1997-4) is basically the same as what will be done later under (5) so it can be kept brief here. As tables 1, 2 and 4 (see below) disclose, the assumptions for the exogenous variables for 1996 were pretty accurate, while at least some of those for 1997 showed considerable errors (compared with their long term average): *Public Construction Outlays* and *Interest Rates* were overestimated, while the international development (*World Trade, Import Prices*) was much underestimated. Though the error of the original forecast of GDP (rate of growth) with 0.6 percentage points is much below the usual error (1.0), correcting for faulty assumptions (table 4, below), *increases* it to 1.2 percent, mainly as a consequence of the reduced compensation of the errors with *Private Consumption* and *Fixed Investment* by those of *Exports*.[6] All in all, the forecast accuracy of the spring forecast was unusually high, though not exactly for the right reasons.

(2) Structural analysis of the newly estimated model

The second phase starts with the inspection of the estimation results for single equations in a structural analysis. It comprises all 41 stochastic equations and all parameters - reaction parameters as well as statistics. The results are examined from a long range perspective (moving 40 quarters-windows), thus lowering the importance of temporary deteriorations in the econometric/statistical quality of the equations. Of course, given the few innovations possible with a two quarter shift of the moving window, the changes which turn up are usually rather small. As an example of this kind of examination, the figure presents elasticities, R^2, DW statistic, explanatory contributions, beta-coefficients) for the *Private Consumption* function from 1960 to 1989 (subsequent data suffer in substance from the economic effects of German unification in *West* Germany and in quality from the statistical consequences of European integration (e.g., intra-EU trade)). The inspection of the estimation results with the new data did not reveal any

6 As set out below, this kind of statement, though very popular, is formally not correct.

Figure

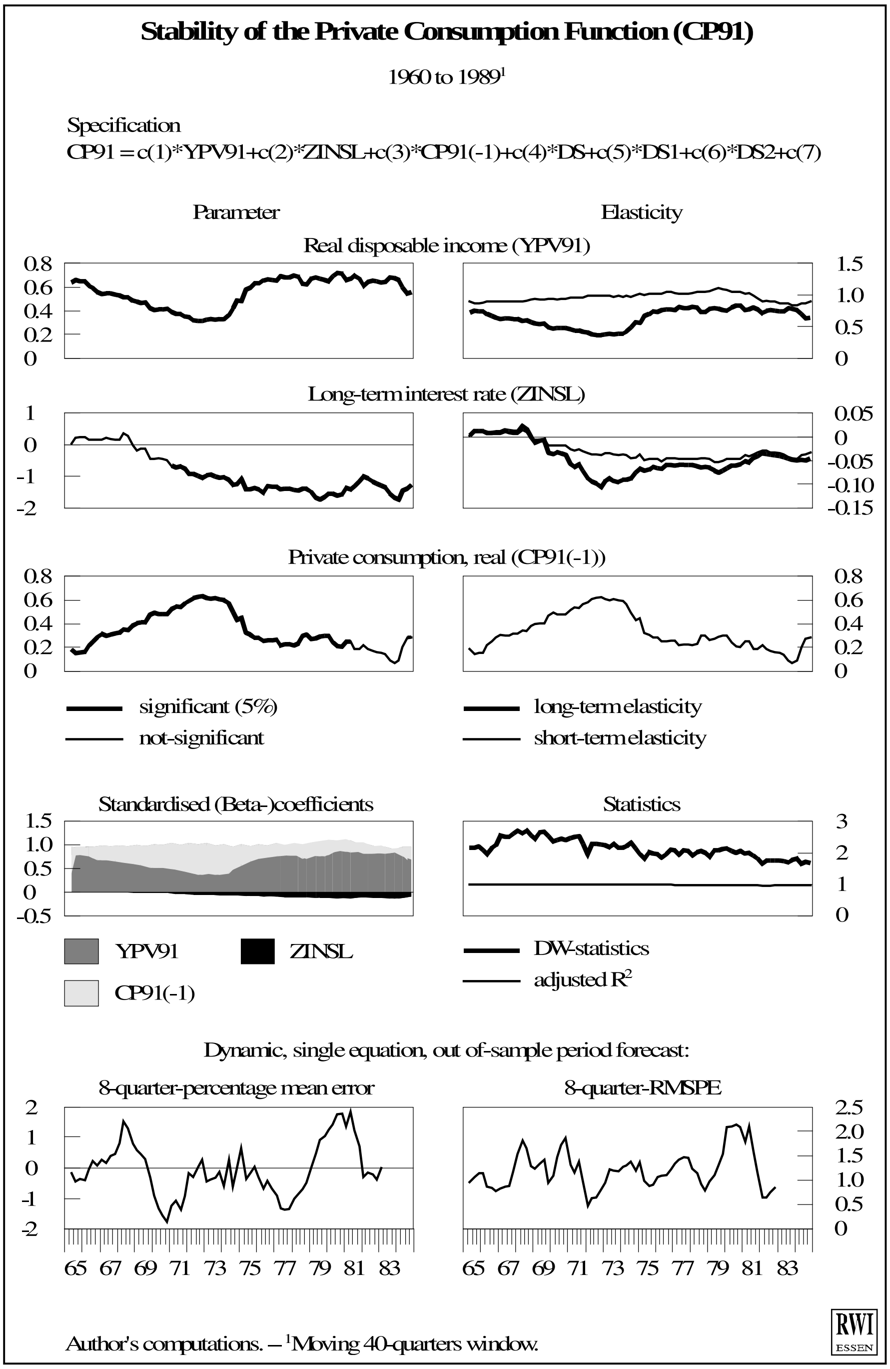
Stability of the Private Consumption Function (CP91)
1960 to 1989[1]
Specification
CP91 = c(1)*YPV91+c(2)*ZINSL+c(3)*CP91(-1)+c(4)*DS+c(5)*DS1+c(6)*DS2+c(7)
Parameter
Elasticity
Real disposable income (YPV91)
Long-term interest rate (ZINSL)
Private consumption, real (CP91(-1))
significant (5%)
not-significant
long-term elasticity
short-term elasticity
Standardised (Beta-)coefficients
Statistics
YPV91
ZINSL
CP91(-1)
DW-statistics
adjusted R2
Dynamic, single equation, out-of-sample period forecast:
8-quarter-percentage mean error
8-quarter-RMSPE
65 67 69 71 73 75 77 79 81 83
Author's computations. – [1]Moving 40-quarters window.
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Table 2

Forecast accuracy[1] of the endogenous variables

1996 and 1997, rates of change

		Exogenous variables estimated 1996	estimated 1997	estimated average[2]	actual 1996	actual 1997	actual average[2]
Employed, in 1000	a	1047	1117	549	843	1226	534
	b	828	962	417	728	975	486
	c	372	434	212	375		190
	d	128	57	130	118		141
Private consumption, real	a	1,8	1,4	0,8	0,9	1,7	0,8
	b	1,9	1,9	0,8	1,7	1,7	0,8
	c	1,8	0,4	0,6	1,6		0,7
	d	0,8	0,0	0,3	0,5		0,3
Fixed investment, real	a	4,4	2,6	3,4	-0,2	1,8	2,5
	b	3,7	4,4	2,7	-0,5	5,4	2,2
	c	-2,0	5,0	1,9	-1,6		1,5
	d	0,0	0,9	0,7	-1,0		0,9
Exports, real[4]	a	0,5	-4,9	3,4	0,1	-2,8	1,6
	b	1,3	-3,4	2,6	0,7	-0,6	1,6
	c	-1,4	-3,5	2,1	-1,1		1,7
	d	-0,8	-1,3	0,6	-0,7		0,8
GNP, real[4]	a	1,6	0,0	1,2	0,2	0,2	0,8
	b	1,5	0,6	1,0	0,3	1,2	0,7
	c	-0,1	0,2	0,5	0,0		0,5
	d	0,3	-0,2	0,2	0,0		0,3
Deflator Private consumption	a	-0,2	-0,2	0,4	-0,1	-0,7	0,4
	b	-0,1	-0,3	0,3	-0,5	-0,5	0,3
	c	-0,5	-0,9	0,3	-0,6		0,2
	d	-0,2	0,0	0,1	-0,2		0,1
Government deficit, bill. DM	a	48,4	-26,1	25,5	55,0	-19,9	26,1
	b	62,0	-24,1	33,0	38,9	-26,1	32,1
	c	-4,0	-11,1	25,2	-10,8		24,5
	d	2,0	-24,1	7,5	-9,2		5,0

Source: Heilemann 1998, pp. 87, 89 and own computations. It mean: a: spring forecast of the year anteceding; b: autumn forecast of the year anteceding; c: spring forecast of the current year, d: autumn forecast of the current year. - 1) Forecast minus actual data. - 2) Average of absolute differences 1981-3 to 1997-4.

Table 3

Expost forecasting accuracy of the RWI-model forecast for 1996/97

	In-sample[1]			Out-of-sample[2]		
	RMSPE			RMSPE	Annual absolute error	
	1987-3/1996-2			1996-3/1997-4	1996	1997
	Type of model solution:					
	36 quarters		6*6 quarters	6 quarters		
	Single equation	Static simulation	Dynamic	Dynamic		
GDP, origin						
Wage and salary earners	–	0,3	0,4	2,4	0,5	2,3
Productivity per hour	–	0,7	0,7	3,6	-0,1	-1,4
GDP, real	–	0,7	0,7	1,5	0,1	1,1
Demand, real						
Private consumption	0,4	0,9	1,0	1,7	0,5	1,4
Government consumption	1,1	1,1	1,1	1,1	-0,4	0,0
Gross fixed capital formation	–	1,7	1,7	5,3	-0,6	5,1
Machinery	4,1	3,2	3,6	6,4	-0,6	7,5
Construction	–	1,4	1,4	4,9	-0,6	3,6
Non-residential building	*2,3*	*2,4*	*2,4*	*12,9*		
Housing	*2,1*	*2,1*	*2,1*	*4,0*		
Change in inventories, in bill. DM	3,7 [2]	4,2 [2]	4,4 [2]	4,1 [2]	7,5	-13,5
Net exports, in bill.DM	–	4,5 [2]	4,7 [2]	4,5 [2]	-4,0	-8,0
Exports	1,7	1,7	1,8	2,5	-1,0	-0,6
Imports	1,2	2,2	2,2	0,9	-0,1	-0,2
GDP	–	0,7	0,7	1,5	0,1	1,1
Price deflators, 1991 = 100						
Private consumption	0,3	0,3	0,3	0,6	-0,2	-0,6
GDP	–	0,4	0,4	0,7	0,3	0,0
GDP, income						
Income						
Gross wage and salary income	–	0,8	0,9	3,0	0,7	2,5
Gross profits/assets	–	4,0	3,9	5,8	-1,5	-2,4
National income	–	1,0	1,0	1,7	0,1	1,0
Net wage income						
– Depent personal services	–	0,9	0,9	3,3	0,7	2,8
– Profits/assets	–	4,8	4,7	7,4	-3,0	-2,8
Government						
Gross income	–	1,1	1,1	1,7	-0,2	1,5
Expenditures	–	1,1	1,0	1,7	0,5	1,1
Net financial investment in bill. DM	–	5,2 [2]	4,9 [2]	5,9 [2]	-17,3	-14,2

Author‘s computations. – 1) Root mean square percentage error. – 2) Root mean square error.

noteworthy changes – neither as to the reactions nor as to the statistical quality of the equations.

The single equation analysis is followed by an examination of the (complete) model's static and six quarters dynamic simulation characteristics (table 3). As to be expected, compared with the single equation results the *fit quality* of most equations is much reduced, though in some cases (aggregation) gains are observed (e.g., for *Fixed Investment*). Those variables primarily explained by predetermined variables (e.g., Exports, Distributed Profits, Government Consumption), of course, do not exhibit any differences from the single equation results. The differences between the static and the six quarter dynamic simulation results are small and after four quarters[7] both are very much the same. Although for the data reasons mentioned above the quality of the stochastic equations had somewhat suffered, the present results gave no cause for respecifications.

Analyses of model multipliers and model elasticities were not made this time, though they are part of general model inspections.

(3) Survey of the starting conditions and the setting of the exogenous variables and of other assumptions

The general economic environment had been set out in detail in the autumn *Gemeinschaftsdiagnose* [*Joint Diagnosis*] (Arbeitsgemeinschaft 1996). It may be summarised as follows: in 1996 the German economy was still in the early phase of a long but weak upswing, mostly driven by exports. The expansion was slower than usual in this phase of the cycle which can be attributed to the investment boom during unification, government efforts to meet the Maastricht criteria, the aftermaths of a strong Deutschmark and the rather high real interest rate (see, for example, Rheinisch-Westfälisches Institut für Wirtschaftsforschung (Hrsg.) 1997, pp. 127ff.).

The values fixed for the exogenous variables were the same as those used for the RWI model in the Gemeinschaftsdiagnose. Their deviation from the spring forecast with the model can be seen in table 4 where the values of the previous model forecast and the *new* values of exogenous variables are shown under columns A and B (changes of these new values under the following columns are due to changes in the data base). Major revisions were made for *Public Investment*, a consequence of greater attention paid by policy to the Maastricht criteria, and for the *Interest Rate*, but only the former were of particular importance for the economic development within the next 18 months.

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7 The RWI-model is a system of difference equations of 15th order but 90 percent of the lags are within the four quarters range.

Table 4

Forecasts with the RWI- model

1996 and 1997; rates of change against previous year in percent

	A		B		C		D		E		F		G	
	1996	1997	1996	1997	1996	1997	1996	1997	1996	1997	1996	1997	1996	1997
Assumptions														
Public construction outlays	-0,9	0,2	-4,9	-1,2	-5,7	3,5	-6,5	-1,2	-8,9	-13,1	-6,8	-9,9	-6,8	-9,9
Social security, contribut. rates	20,3	20,7	20,3	20,9	20,3	20,7	20,3	20,9	20,3	21,0	20,3	21,0	20,3	21,0
World exports (volume index)	5,8	7,5	6,3	7,6	6,0	7,5	6,3	7,6	6,4	9,8	5,9	9,8	5,9	9,8
Price index of the imports	0,6	2,1	0,2	1,4	0,8	2,1	0,2	1,4	0,6	3,0	0,7	3,0	0,7	3,0
Short term interest rate, percent	3,2	4,1	3,3	3,3	3,3	4,1	3,3	3,3	3,3	3,3	3,3	3,3	3,3	3,3
Long term interest rate, percent	5,9	6,3	5,7	5,8	5,9	6,3	5,7	5,8	5,6	5,1	5,6	5,1	5,6	5,1
Forecast														
GDP origin														
Wage and salary earners	-0,1	0,6	-0,1	0,7	-0,8	0,9	-0,8	0,9	-0,8	0,9	-1,3	-1,2	-1,3	-1,4
Productivity per hour	1,9	1,7	1,9	1,7	3,1	2,1	3,1	2,0	3,1	2,3	2,6	3,6	3,0	3,6
GDP, real	1,3	2,2	1,3	2,2	1,7	3,0	1,7	2,8	1,6	3,3	1,1	2,3	1,4	2,2
Demand, real														
Private consumption	3,1	1,6	3,1	1,8	2,0	2,0	2,1	2,1	2,0	1,9	1,3	0,0	1,4	0,2
Government consumption	1,3	-0,1	1,3	0,0	2,2	-0,2	2,2	-0,2	2,2	-0,2	2,0	0,5	2,6	-0,4
Gross fixed capital formation	-2,8	2,8	-3,1	3,1	-0,9	4,9	-0,8	4,6	-1,2	5,1	-1,5	0,6	-1,2	0,2
Machinery	1,8	5,5	2,1	5,8	2,0	9,0	2,3	8,8	2,0	11,3	2,3	3,6	1,9	3,9
Construction	-5,6	1,0	-6,2	1,3	-2,6	2,3	-2,7	2,0	-3,1	1,1	-3,9	-1,3	-3,1	-2,2
Change in inventories, bill. DM	25,0	33,2	25,1	33,5	32,7	43,3	33,0	42,9	32,5	44,8	28,4	34,4	24,0	57,0
Net exports, bill. DM	-7,6	3,1	-5,4	1,3	-7,9	5,9	-7,9	2,8	-6,1	17,0	-5,5	51,5	0,3	31,1
Exports	3,5	5,8	4,0	5,2	3,9	7,8	4,1	7,3	4,2	9,9	4,8	11,7	5,1	10,7
Imports	3,7	4,4	3,9	4,3	2,9	6,1	3,1	5,9	3,0	7,1	3,2	4,8	2,8	7,0
GDP	1,3	2,2	1,3	2,2	1,7	3,0	1,7	2,8	1,6	3,3	1,1	2,3	1,4	2,2
Price deflator, 1991 = 100														
Private consumption	1,4	1,7	1,3	1,5	1,8	1,8	1,7	1,6	1,8	1,7	1,9	2,0	2,0	1,9
GDP	1,1	1,1	1,0	1,0	1,4	1,3	1,4	1,1	1,4	1,0	1,1	0,4	1,0	0,6
GDP income														
Income														
Wage income	3,3	3,6	3,0	3,3	2,8	3,8	2,7	3,5	2,4	2,9	1,1	0,5	1,0	0,2
Profits/assets income	-2,3	2,7	-1,4	3,1	3,5	6,0	4,3	5,6	4,5	8,4	5,9	7,9	5,5	8,9
National income	1,7	3,3	1,7	3,3	3,0	4,4	3,1	4,1	3,0	4,5	2,4	2,6	2,3	2,7
Net wage income														
Net profits/assets income	-3,1	4,0	-2,0	4,3	2,6	6,8	3,5	6,3	3,7	9,3	6,0	10,1	6,1	10,7
Government														
Deficit, bill. DM	-138	-128	-138	-119	-133	-137	-132	-126	-136	-122	-132	-101	-126	-102
Revenues	1,2	3,0	0,9	3,2	1,2	3,6	1,1	3,6	0,8	3,4	0,5	2,0	0,5	1,9
Expenditures	-9,8	2,2	-10,0	1,9	-10,0	3,5	-10,1	3,0	-10,2	2,4	-10,5	0,1	-10,8	0,4

Author‘s computations and official data. A: Forecast Nr. 43; B: old sample period (1986-1 to 1995-4), new assumptions; C: new sample period, old assumption; D: new sample period, new assumptions (Forecast No. 44); E: like D with revised assumptions; F: sample period 1988-1 to 1997-4 (Forecast No. 47), revised assumptions; G: actual data (Spring 1998).

Having fixed the values of the exogenous variables, the forecasting process could, in principle, start. As laid out before, however, a certain amount of additional information has to be included. As table 5 reveals, this mostly comprises tax reductions (ca. 9 bill. DM net) and cuts in government expenditure (about 12 bill. DM). While the effects of these measures in relation to GDP are not too impressive, their consequences for the level and structure of government deficit (about 0.3 percent of the GDP/deficit ratio) are. A stronger intervention is the 0.5 reduction of the *Negotiated Wage Rate* (changes against previous year) to 2.2 percent, because of strong evidence that wage policy could be expected to be much more employment-directed than the model's function had suggested (3.5 percent).

Here and in most previous cases the effects of the various policy measures on short run macroeconomic activity are all in all rather small, rarely exceeding 0.2 percent of GDP. Given the lags of macroeconomic reactions it could be argued that their observation and inclusion is not indispensable. In addition, their inclusion is often also arbitrary as well as to the measures to be included – those which are discussed in the ruling parties, or those which have been passed by the cabinet, or those which have been enacted? – as to the amounts and to the datings. The amounts often pose difficult problems, e.g. when the government expects revenues from a tax hike without taking the macroeconomic repercussions into account (as it usually does); the difficulties of the latter result from the quarterly distribution of the expected extra revenues.[8]

Nevertheless, for the present model, these „objective considerations" have proved to be necessary: firstly, because professional readers of the forecast, in particular when they look beyond GDP or inflation, want to know which policies have been included and how; secondly, even if one tends to ignore most of these measures one has to examine them first; third, over the years the process of inclusion gives hints as to improvements, enlargements and corrections of the model's informational content and architecture.

(4) Production of the forecast

The forecast proper starts with a number of test runs to gain an impression of the effects of the newly set assumptions (here: the exogenous variables, old „adds"). First, the old model version is re-run with the new assumptions and, second, the new version is run with old and then with new assumptions. As table 4 displays, the consequences for the

[8] Of course, if the model's tax equations exactly mirrored the tax code, this would not be a problem, but the tax equations are short cuts in which these kind of changes have to be introduced in rather simple ways. Happily, after a few periods, the newly estimated equations correct automatically.

forecast vary: While the new assumptions (table 4, column B) do not change the picture much, the „new sample period" (1987-3 to 1996-1 with old assumptions) (C) does so to considerable degree. This does not only hold for real GDP but also, of course, for Employment, Prices, and the Government Deficit. As to the composition of GDP, the most important changes are to be registered within the investment and the foreign trade section.[9]

The final, published forecast (new model version, new assumptions, and policy adds - D) renders a picture of the German economy in 1997 very similar to that shown in C: a considerable increase of real growth in 1997, mainly to be attributed to Fixed Investment, including Changes in Stocks and Net exports. Inflation would still be moderate and Employment improves slowly.

Comparing this picture with those of major macroeconomic forecasters, the differences are small: The *Gemeinschaftsdiagnose*, published on October 29, 1996 (Arbeitsgemeinschaft 1996), had forecast, based on very similar assumptions, GDP growth rates of 1.5 percent in 1996 and 2.5 percent in 1997, and inflation rates (consumption deflator) of 2.0 percent and 1.5 percent; the *Sachverständigenrat* [Council of Economic Experts] forecast, published on November 18, 1996, expected the same rates of growth for real GDP, and 1.75 percent for inflation in 1996 and 1997 (Sachverständigenrat 1997, Ziffer 215ff.); finally, the *Jahreswirtschaftsbericht der Bundesregierung* [Annual Economic Report of the Federal Government] issued on January 29, 1997 expected a real growth of 2.5 percent and an inflation growth of 1.75 percent (Bundesregierung 1997, Ziffer 122ff.).

(5) The evaluation of the forecast

The evaluation starts with a comparison of the forecast with observed data, which in the present case means the data earliest released by the *Statistische Bundesamt* [Federal Statistical Office], here taken from the 1998 spring Gemeinschaftsdiagnose (Arbeitsgemeinschaft 1998).

The result may appear to be not all too impressive (table 4, columns D, G): the GDP growth has been missed by 0.6 percentage points, mainly as a consequence of a gross overestimation of Private Consumption (nearly 2 percentage points) and Fixed Investment (4.4 percentage points), fortunately partially offset by an even more severe underestimation of the Changes in Stocks and of Net Exports. The balance for Employ-

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9 Since 1998 the check of the various forecasts also includes a cyclical classification of the quarterly forecast results, cf. Heilemann, Münch 1998. Table 6 (Appendix) reveals that the various forvasts did hardly affect the picture of a very strong upswing-phase from 1996-3 to 1997-4.

Table 5

Modifiying the 1997 forecast for Germany

billion DM

	1997	1997 quarter 1	2	3	4
Surplus of Deutsche Bundesbank					
Earned income of government	*8,5*	–	*8,5*	–	–
Tax reforms					
Income taxes on wages and salaries	*-8,4*	*-2,1*	*-2,1*	*-2,1*	*-2,1*
Increase of child allowance/benefit	-3,8	-1,0	-1,0	-1,0	-1,0
Abolishment of property tax	-5,3	-1,3	-1,3	-1,3	-1,3
Others	0,7	0,2	0,2	0,2	0,2
Income taxes on enterprise and property					
Abolishment of property tax	-3,5	-0,9	-0,9	-0,9	-0,9
Excise and other „indirect“ taxes	*1,6*	*0,4*	*0,4*	*0,4*	*0,4*
Reform of motor vehicle tax	2,1	0,5	0,5	0,5	0,5
Abolishment of trade tax on business capital	-3,7	-0,9	-0,9	-0,9	-0,9
Increase of real property transfer tax from 2 to 3 percent	3,2	0,8	0,8	0,8	0,8
Changes of CPI in percent					
Reform of motor vehicle tax	0,1	0,1	0,1	0,1	0,1
Received property transfers					
Amendment of inheritance (gift) tax	1,6	0,4	0,4	0,4	0,4
Personal property/entrepreneurial income					
Amendment of inheritance (gift) tax (by 25vH)	0,4	0,1	0,1	0,1	0,1
Balancing the budget					
Government consumption	*-8,3*	*-2,1*	*-2,1*	*-2,1*	*-2,1*
Transfers	*-3,5*	*-0,9*	*-0,9*	*-0,9*	*-0,9*
Other modifications	-	-	-	-	-

Source: Rheinisch-Westfälisches Institut für Wirtschaftsforschung (Hrsg.) 1996. Modified variables in italics.

ment is, of course, even more unpleasant because of an *Okun's Law* employment barrier (1 to 1.5 percent growth of real GDP): instead of an increase, the economy experienced a further severe drop in employment, so there is also some evidence of a steep increase of productivity, not uncommon in the early upswing phase of the cycle. The forecasts for the Deflator of Private Consumption, which grossly overestimated the development because of both the lower wage settlements and the higher productivity, are equally disappointing. The Government Deficit for 1997 was overestimated by more than 25 percent - certainly an outcome of a number of additional measures to meet the Maastricht criteria by a more restrained expenditure policy than assumed.[10]

What are the reasons? First of all it should be noted that though the size of the errors seems disappointingly high, the errors still lie more or less within the margins which reasonably could be expected from the *ex post* performance of the current model version (table 3) as well as from past *ex ante* forecasting experience with the model in general (table 2). It is nevertheless rewarding to look for „exogenous" and „endogenous" reasons for the failures.

It is beyond the possibilities here to look at the causes for these deteriorations of the single equations in detail, though some reasons or causes are obvious (see „Assumptions" in columns D and E, table 5): the lower construction outlays of the government sector, the increases of social security contributions and the much lower wage increases. All in all, policy impulses introduced in the forecast outside exogenous variables (table 3) amounted to about 10 bill DM, which „reduced" real GDP growth in 1997 by 0.2 percentage points.[11]

Unfortunately, although this is not totally new or uncommon (see Evans et al., pp. 1053ff.; Heilemann 1985, pp. 699ff.), repeating the forecast with observed data for the exogenous variables (including the negotiated wages)

(5) $$y_{t+k} = f\left(y_{t+k}, y_{t-i+k}; x_{t+k}, x_{t-j+k}, x^{A}{}_{t+k}, x^{s}{}_{t+k}; ß\right)$$

where

x^A: vector of exogenous variables, *actual/observed* data.

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[10] The rate of change of Government Expenditures was overestimated by 2.6 percentage points (1981/1997 average error: 2.1), Government Revenues by 1.7 (1.5).

[11] It is, of course, extremely difficult - if possible in some cases at all - to validate these amounts.

renders an even more *inferior* picture (table 5, column E). The GDP forecast for 1997 is now 1.1 percentage points off the mark! Numerically, this can be attributed to a further deterioration of the *Fixed Investment* forecast, which was only partly balanced by improvements of the *Change of Stocks* and *Net Exports*. The errors of Employment and Inflation are hardly affected, which is at least in the first case, arguing in an implicit production function context, somewhat surprising. Although it is beyond the possibilities here to look at the causes for these deteriorations of the single equations in detail, some deliberations on this will follow in a moment.

Before presenting these, the results up to now should be compared with those for competing forecasts. Unfortunately, the Gemeinschaftsdiagnose abstains from analysing its forecasting accuracy and the forecast analysis of the Sachverständigenrat (1997, p. 157) is not very specific on this. Restricted to GDP and the *Deflator for Private Consumption*, the (real) GDP forecasts of 2.5 percent [rounded] of both the Gemeinschaftsdiagnose and of the Sachverständigenrat showed an error of 0.3 [0.5 rounded], while the error of the model was 0.6 (D). As to inflation, the Gemeinschaftsdiagnose and Sachverständigenrat expected an increase in the *Deflator for Private Consumption* of 1.5 percent and 1.75 percent respectively, while the model forecast was 1.6 percent and the actual value 1.9 percent. Alas, the forecasts of the Gemeinschaftsdiagnose and of the Sachverständigenrat – certainly a major shortcoming of the „informal GDP model" – cannot be corrected for flaws in their assumptions. Assuming that both were based on similar assumptions as the model forecast, which certainly holds for the Gemeinschaftsdiagnose, previous ranking would not be affected. In any case, the two informal forecasts as well as the two model forecasts lie well within the margins set by past experiences (Heilemann 1998a, pp. 84ff., Heilemann 1998b, pp. 86ff.). A performance which may be respected more if we take account of the various policies to meet the Maastricht criteria which were not allowed for in the exogenous variables.

Given the performance as the model with actual values for the exogenous variables, some lessons for the forecast accuracy of the various variables seem at hand. However, given the simultaneous and recursive links between macroeconomic variables, in particular the former, one has to be careful with determining their forecast rank or of the size of their errors.[12] Although these difficulties could be reduced by subsequent exogenization of endogenous variables, this is beyond the scope of this paper. What seems obvious is that the unusually large forecast errors for Private Consumption and for Fixed

12 Formally speaking, multivariate/multiperiod macroeconomic forecasts are „konjunktive Prognosen [associated forecasts]", even those of VAR models (definitions!).

Investment were responsible for a large part of the GDP errors. To illustrate just this point: an exogenization of Private Consumption reduced the 1997 GDP forecast from 3.3 to 2.5 percent, though the accuracy gains were, of course, not equally distributed within the model, and some variables such as *Net Exports* or *Change in Stocks* even experienced deteriorations – underscoring the compound character of macroeconomic forecasts.

Some lessons about changes in economic reactions can be learned from the ex post forecast 1988-1 to 1997-4, i.e. including the forecast period. The accuracy for this simulation (table 5, column F) has greatly improved, and Private Consumption and Fixed Investment in particular are now nearly perfectly met. The same holds true for the forecasts of *Inflation*, *Employment*, distribution and even the *Government Deficit*. This indicates that there may have been some small changes in the economic reactions as represented by the behavioural equations, underlining the need to use as up to date a sample period as possible, and in doing so to validate the use of the moving window technique (more on this in Barabas, Heilemann, Münch 1994 with the RWI-model).

Could we have done better? Of course, there are infinite ways to improve forecasts with hindsight. Restricted to the present model version, an exploration the possibilities of exploiting the information content of residuals suggests itself.

The exploitation of past error structures for forecasts has a long tradition in macroeconometric forecasting[13]. A widely known pattern is the *Cochrane-Orcutt* (CO) correction of parameters to eliminate serial correlation in the residuals (see for example Intriligator, Bodkin, Hsiao 1996, pp. 140f.). Correcting all equations with the exceptions of *Private Consumption*, *Negotiated Wage Rate*, and *Depreciation* where signs of parameters had changed, resulted, however, only in marginal improvements of the forecast accuracy: The GDP-error decreased by 0.1 percentage points and that of the *Government Deficit* by 1.5 bill DM.

Some remarks on the time and cost framework of the econometric model forecasts. Given the model, the preparation of the forecast as described here takes about two person weeks (net). It started on October, 7 and the final forecast (Rheinisch-Westfälisches Institut für Wirtschaftsforschung (Hrsg.) 1996a) was issued on November 13, 1996. It should, however, be noted that the production can draw heavily on in-house expertise as to the evaluation of the data and their possible flaws, the fixing of the exogenous varia-

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13 For some time in the 1970s it was also used by the *Deutsche Bundesbank* in its semi-annual model, though over the years the results seem to have been not all too impressive and CO-correction was dropped (Heilemann 1981, pp. 89ff.).

bles and the additional policy assumptions, and, of course, as to the general economic environment and the future picture of the economy as set out in our bi-annual reports. The costs of this and of the forecast proper add up to about 10,000 DM.

IV. Summary and conclusions

The paper demonstrates that forecasting with a medium sized macroeconometric model in practice is a multistage, interdependent process. It requires not only the inclusion of a mass of outside information on exogenous and also endogenous variables - in this respect it is not all too different from what has to be performed within the informal GDP model approach. Generalisations on this practice, sometimes termed as *art* or *tender loving care* (tlc), however, are difficult to establish, given the very different scope of macroeconomic models and their diverse predispositions for this kind of interference.

With respect to accuracy, the model's 1997 forecast of real GDP and of Inflation is somewhat *less* accurate than rival forecasts by the Gemeinschaftsdiagnose or by the Sachverständigenrat. However, the differences are small and do not affect the general picture of a moderate upswing in 1997. In particular, the consequences for economic policy would not have been affected either by the differences between the various forecast errors or by their magnitudes.

Though the errors are of regrettable size, it should be realised that they are well within the margins that could reasonably be expected from past experience. As the re-run of the forecast with the actual values for exogenous variables reveals, wrong assumptions, in particular for the 1997 *Public Construction Outlays*, *World Trade* and *Long Term Interest Rates*, are mostly responsible for the forecast errors; unfortunately there are not only 1st type errors but also those of the 2nd type such as the over-estimating of the consequences of Maastricht consolidation for *Government Consumption*. But, of course, proper endogenous errors are to be registered too, though they seem to outweigh each other: over-estimating of *Imports* and over-estimating of *Changes of Stocks*. It may be, however, somewhat consoling that the Gemeinschaftsdiagnose and the Sachverständigenrat erred with similar magnitudes - not only with respect to GDP, but also with respect to the structure of the forecast of the demand side. However, time is a great consoler I am afraid. The next generation of PhD students measuring forecast accuracy on the base of the recent release of NA data with the new NA concept (ESA 95) will find that the 1997 GDP forecasts were off the mark so much (September 1999: 1.5 percent!) that it is time for a basic overhaul of GDP forecasting techniques and economic theory. Though this would be a wrong judgement, let them try! (they will do it anyway.)

From a methodical perspective, the paper was intended to demonstrate the rich possibilities of macroeconometric model analysis – *ex post* and *ex ante*. As to ex ante or structural analysis, the technical progress over the last decade has facilitated this greatly: the examination of equation stability or multiplier checks are now a matter of minutes. With regard to ex post analysis, in principle it would be preferable to leave this to third parties - as in the ESRC Macroeconomic Modelling Bureau project for forecast analysis in the UK (Wallis (ed.) 1985). Given the importance of this kind of analysis for the production of new forecasts and the usual publication delay with third parties' reports, it has to be an indispensable part of any model forecast. Finally, though most of the practice shown here is limited to the econometric model approach, informal forecast methods (GDP model) could perform some of it, too. It should not be completely ruled out that one might even learn from practice. Putting it in an other way, and referring to the paper by *Raabe* a last time here, the macroeconometric model approach can do everything *every* other approach can. Of course, not every step can claim the reputation of econometrics and this paper shows that there is still a lot to be done. Unfortunately, the principal transparency of the econometric model approach one of its main assets, does not have a high priority in the forecasting community. This was already the case with 16th century astrologers (Grafton 1999, pp. 130ff.) and there is not much evidence that it will change in the next century.

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Appendix

Table 6

Cyclical classification of the forecasts

		classification[3]													
Forecast[1]	Probability[2]	1996				1997									
		3		4		1		2		3		4			
		Phase	Probability	Phase	Probability	Phase	Probability	Phase	Probability	Phase	Probability	Phase	Probability		
A	a	down	0,481	up	0,968	up	0,953	up	0,969	up	0,691	up	0,967		
	b	*up*	*0,331*	*ltp*	*0,027*	*ltp*	*0,037*	*ltp*	*0,022*	*ltp*	*0,188*	*ltp*	*0,023*		
B	a	down	0,548	up	0,929	up	0,973	up	0,987	up	0,902	up	0,991		
	b	*up*	*0,240*	*ltp*	*0,061*	*ltp*	*0,022*	*ltp*	*0,010*	*ltp*	*0,066*	*ltp*	*0,006*		
C	a	up	0,875	up	0,963	up	0,983	up	0,977	up	0,797	up	0,945		
	b	*ltp*	*0,078*	*ltp*	*0,033*	*ltp*	*0,015*	*ltp*	*0,018*	*ltp*	*0,153*	*ltp*	*0,045*		
D	a	up	0,815	up	0,914	up	0,989	up	0,989	up	0,933	up	0,815		
	b	*ltp*	*0,111*	*ltp*	*0,076*	*ltp*	*0,009*	*ltp*	*0,009*	*ltp*	*0,054*	*ltp*	*0,011*		
E	a	up	0,751	up	0,843	up	0,949	up	0,973	up	0,768	up	0,896		
	b	*ltp*	*0,130*	*ltp*	*0,138*	*ltp*	*0,041*	*ltp*	*0,022*	*ltp*	*0,195*	*ltp*	*0,029*		
F	a	up	0,896	up	0,818	up	0,989	up	0,995	up	0,987	up	0,997		
	b	*ltp*	*0,078*	*ltp*	*0,147*	*ltp*	*0,009*	*ltp*	*0,004*	*ltp*	*0,011*	*ltp*	*0,003*		
G	a	up	0,820	up	0,951	up	0,921	up	0,980	up	0,977	up	0,981		
	b	*ltp*	*0,145*	*ltp*	*0,042*	*ltp*	*0,049*	*ltp*	*0,017*	*ltp*	*0,022*	*ltp*	*0,014*		

Author‘s computations and official data. - 1) A: Forecast Nr. 43; B: old sample period (1986-1 to 1995-4), new assumptions; C: new sample period, old assumption; D: new sample period, new assumptions (Forecast No. 44); E: like D with revised assumptions; F: sample period 1988-1 to 1997-4 (Forecast No. 47), revised assumptions; G: actual data (Spring 1998). - 2) a: highest probability for quarter to be classified in the corresponding phase; b: secound highest probability. - 3) down: downswing phase; ltp: lower turning point phase; up: upswing phase; (utp: upper turning point phase). For details see Heilemann, Münch 1998.