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WORKING PAPER

BUSINESS CYCLE PROPERTIES OF FINANCIAL INDICATORS IN GERMANY

NICO VALCKX

Department of Financial Economics

nr. 96/21
October 1996

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BUSINESS CYCLE PROPERTIES OF FINANCIAL INDICATORS IN GERMANY.

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Abstract.

In recent years, central banks of major countries have paid increasing attention to the behaviour of financial markets for the design of monetary policy. In this context, it is hypothesised that informationally efficient markets may signal changes of growth and inflation perspectives and that policymakers might use this information for the implementation of monetary policy. The aim of this paper is to investigate the indicator properties of a whole set of financial variables for Germany. We use many econometric techniques and find that the results vary with the technique under consideration. The most robust findings concern the significance of the yield curve and yield gap for forecasting output growth, the significance of share prices for predicting inflation and output growth, the usefulness of market interest rates for monetary policy and the limited information in nominal money growth for inflation and output growth.

Key words : Econometric modeling; Indicator variables; Monetary policy.

JEL Classification : C51; E37; E43; E58.

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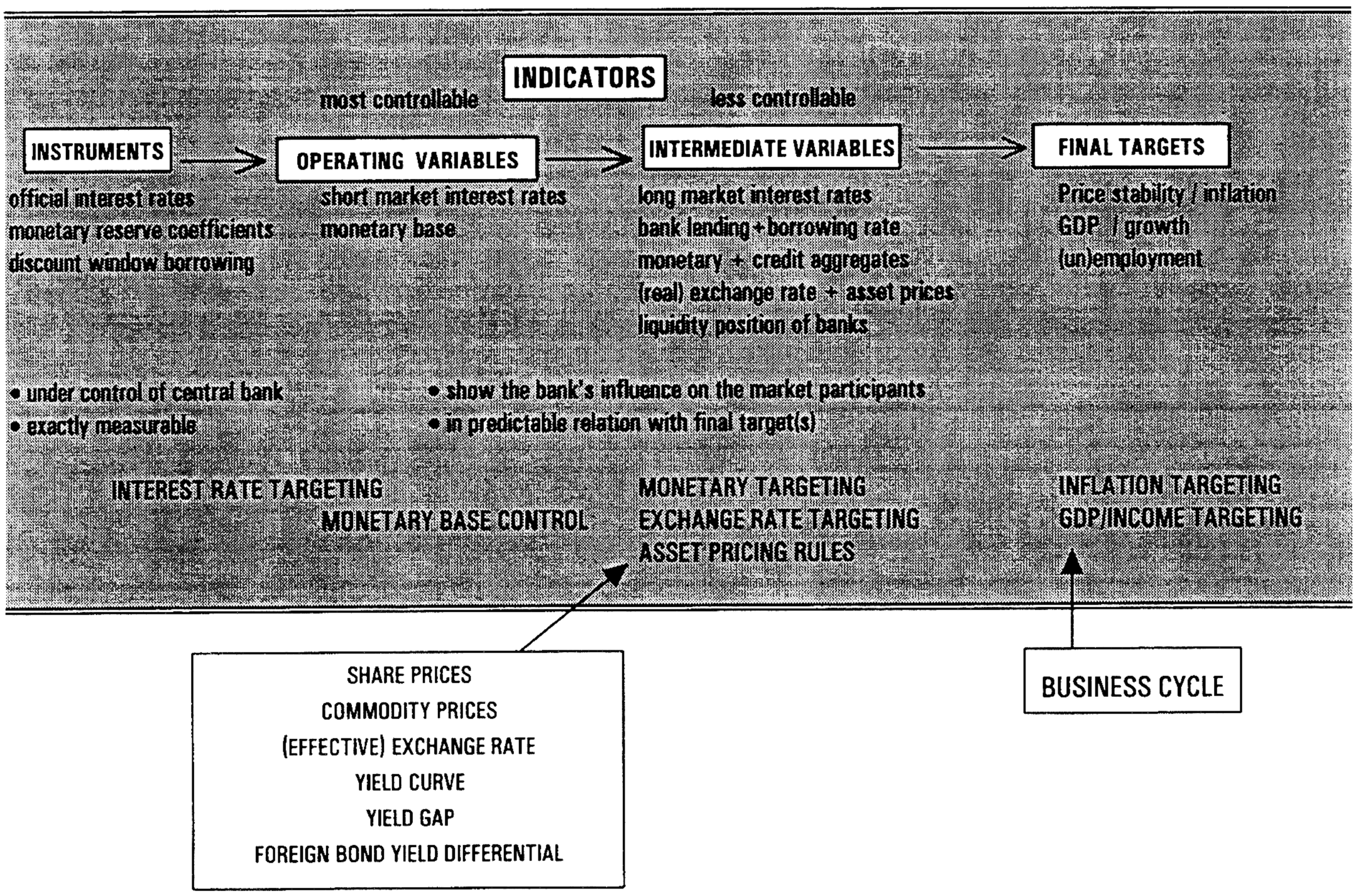
BUSINESS CYCLE PROPERTIES OF FINANCIAL INDICATORS FOR GERMANY.

1. Introduction.

In recent years, increasing attention has been paid to the design of monetary policy and to the use of rules in policy formulation. Traditionally, central banks operate by observing a set of indicators and intermediate targets and set their instruments accordingly, so as to reach their final goals : controlling inflation and achieving non-inflationary economic growth. An interesting area of research is to investigate whether financial markets give additional information for the guidance of monetary policy. As is frequently argued, informationally efficient markets incorporate all the available information concerning future growth and inflation perspectives. A change in the market sentiment therefore could signal changes of growth and inflation perspectives. As can be seen in figure 1, indicators provide the central bank with a way to deal with the uncertainty regarding the link between instruments and final objectives. Financial indicators typically are intermediate variables, which stand in a predictable relation with final objectives and are -to some degree- controllable by the bank.

Figure 1: The monetary policy framework.



The aim of this paper is to investigate whether financial market data give important business cycle information that is not captured by other leading indicators. In our empirical research, we characterize business cycles by the behavior of inflation and real GNP growth over time. Most research has been done for the USA. We will look at evidence for European countries, especially Germany. Why Germany? As table 1 indicates, Germany is the biggest European country, with 23% of PPP GDP and a vote of 22.5% in the EMI capital. Furthermore, many other EU-countries share a high similarity with Germany from a business cycle perspective, as is shown in figure 2.

Figure 2 : Correlation of industrial production and inflation with Germany (Source: UBS 1995)

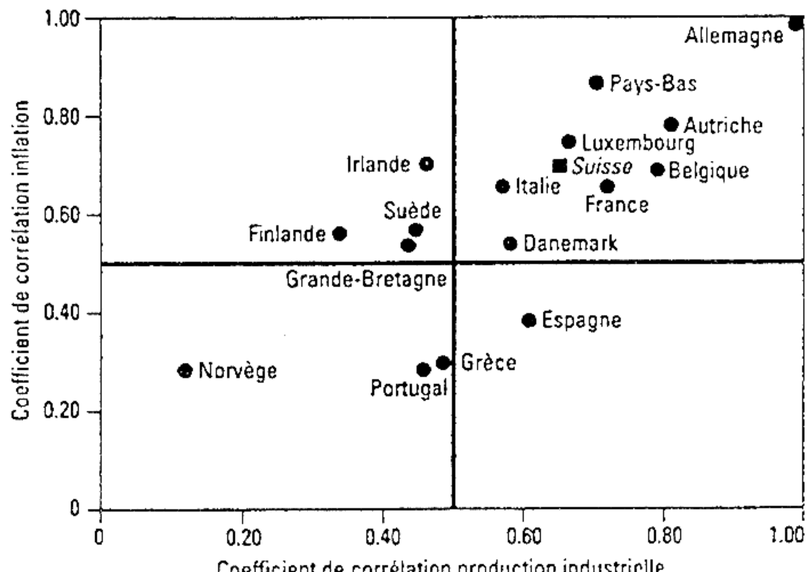


Table 1: Share of EU-countries in the European GDP and EMI

	MIL 1991 PPP GDP: 1995	in %	EMI Contributions 1995	in %
DEU	1,413,882	22.99%	138,808,404	22.55%
FRA	1,091,124	17.74%	104,644,800	17.00%
ITA	1,018,128	16.55%	97,565,912	15.85%
GBR	970,261	15.78%	94,488,252	15.35%
ESP	514,034	8.36%	54,476,907	8.85%
NLD	262,771	4.27%	26,161,252	4.25%
SWE	147,523	2.40%	17,857,642	2.90%
BEL	178,361	2.90%	17,235,643	2.80%
AUT	143,753	2.34%	14,162,957	2.30%
GRC	82,116	1.34%	12,311,159	2.00%
PRT	93,841	1.53%	11,387,902	1.85%
DNK	99,283	1.61%	10,464,542	1.70%
FIN	78,044	1.27%	10,160,382	1.65%
IRE	48,515	0.79%	4,924,381	0.80%
LUX	8,576	0.14%	923,360	0.15%
Total :	6,150,214 USD	100.0%	615,573,495 ECU	100.0%
Own calculations, based on OECD data and EMI (1996)				

A horse race -including all indexes and variables in the same regression- is run to investigate the explanatory power of auction price variables, financial spreads and money and a short-term interest rate. Financial indicators are specifically interesting because they are immediately available -in real time. The value of alternative methods will be explored. We will look at results from probit analysis, regression, VAR and cointegration.

The paper is organized as follows. Section 2 covers theoretical arguments on the relation between financial markets and business cycles. Section 3 reviews the existing -mainly US- evidence, while in section 4 estimates of inflation and economic growth are presented. Section 5 concludes.

2. Theoretical expectations.

According to the dividend discount model, *equity prices* can be seen as the discounted value of future expected payoffs (Guild 1931). Equity prices vary over time because of changes in the underlying payoff structure or discount rate. Changes in expected payoffs relate to changes in expected corporate profits. Rising payoffs therefore signal better output conditions, as does a lower discount rate, which may be caused by lower inflation risk.

Market interest rates negatively affect the business cycle. A rise in interest rates makes it more attractive to postpone consumption, e.g., because of higher borrowing and lending costs and a higher rate of intertemporal substitution, and so output will tend to decrease. Another influence on economic activity runs via larger funding costs on investment decisions which may be delayed after a rise in the interest rates, caused by higher inflationary expectations.

Exchange rate changes have an impact on the quantity exported and imported. A high real exchange rate means that home products become more competitive in foreign markets and hence output will rise. Also, in the monetary approach, the exchange rate equals the discounted value of future fundamentals relative to a foreign country. A rise in the exchange rate therefore could signal a weakening of the country's fundamentals relative to the foreign country and indicate poorer relative output perspectives and higher inflation.

Commodity prices provide instantaneous information about the state of the economy. The argument in favour of using commodity prices in formulating monetary policy follows from the fact that they are traded in continuous auction markets. A criticism of this argument however is that they are subject to large, market-specific shocks (speculation) that do not have macroeconomic implications (Cody & Mills 1991). The solution to this problem may be aggregation over several commodities or using an index. The influence on business cycles is as follows. Industrial commodities represent an important cost factor in the production proces. Rising commodity prices therefore confront the firms with a more expensive supply which will –at a given demand schedule– lead to lower production and higher (cost-driven) inflation.

Futhermore, a number of yield spreads can be derived from the above mentioned information. Reasons why they may be useful for predicting future inflation and output growth are that such assets are imperfect substitutes for

each other. Differences in yields will therefore reflect factors as liquidity, default risk, inflation and regulations (Davis & Fagan 1995).

The *yield curve* measures the difference between long-term bond yield and short term market interest rates. According to the expectations theory of interest rates, the term structure has predictive power for forecasting real economic growth and inflation. The yield curve flattens and is inverted when the economy goes toward a recession. The expectations hypothesis equates the yield on an n-period bond and a sequence of one-period bonds. It works via *policy anticipation*: if policymakers act to reduce short-term interest rates in recessions, market participants who expect a recession would also expect low rates. So, the yield curve picks up the financial market's estimate of future policy. Another possibility is that *current monetary policy* may shift both the yield curve and future output. Tight monetary policy may raise short-term interest rates, flattening the yield curve and leading to slower future growth. The *risk premium* provides another reason why the yield curve may be a useful predictor: the premium itself holds information. Recessions may make people uncertain about future income and employment and about future interest rates. The risk premium on a longer term bond reflects this information (Haubrich & Dombrosky 1996).

The *yield gap* measures the difference between dividend yield and government bond yield on domestic equities. The dividend yield will reflect market expectations of future profitability which is related to expectations of future output growth (Davis & Fagan 1995). If dividend yield exceeds the fixed yield on government bonds, then this will boost investments and economic activity.

The *default spread* measures the difference between corporate bond yield and government bond yield. Reasons why the spread would widen in anticipation of cyclical downturns include the possibility that a widening spread is (a) an indicator of tight monetary policy, (b) a reflection of anticipations of business bankruptcies and (c) a result of corporations growing cash requirements as the business expansion nears its peak (Friedman & Kuttner 1994).

The *foreign bond yield differential* is defined as the difference between domestic and foreign government bond yield. It should capture inflation differentials between countries assuming a Fisher equation with a unique world-wide real interest rate. Changes in the foreign bond yield differential could *ceteris paribus* be used to signal perceived changes of the domestic inflation rate.

3. Existing literature.

There exists a large number of studies that document the indicator properties of the yield curve for economic growth and inflation :

- Estrella & Hardouvelis (1991) find that the slope of the yield curve has extra predictive power over and above the predictive power of lagged output growth, lagged inflation, the index of leading indicators and the level of real short-term interest rates. The slope outperforms survey forecasts both in-sample and out-of-sample.
- Jorion & Mishkin (1991) find strong evidence that the term structure does have significant ability to forecast changes in inflation at long maturities for Britain, West Germany, Switzerland and US, as Mishkin (1990) and Fama (1990) for the US.
- Estrella & Mishkin (1995 a) examine the performance of various financial variables such as interest rates and interest rate spreads, stock prices, currencies and monetary aggregates as predictors of subsequent U.S. recessions. Results of probit analysis show that stock prices are useful with 1-2 quarter horizons, as are some well-known macroeconomic indicators (leading indicators, GDP-growth previous quarter). Beyond two quarters, the slope of the yield curve emerges as the best choice. A model containing stock prices and the yield curve is about the best that can be constructed from financial variables for out-of-sample prediction. Bernard & Gerlach (1996) provide further evidence of the potential usefulness of term spreads as indicators for 8 OECD countries.
- Estrella & Mishkin (1995 b) examine the relationship of the term structure to monetary policy instruments and to subsequent real activity and inflation in both Europe (Germany, Italy, France, UK) and the US. The results show that monetary policy is an important determinant of the term structure spread, but is unlikely to be the only one. In addition, there is significant predictive power for both real activity and inflation.
- Sauer & Scheide (1995) examine whether the term structure contains any information with respect to real domestic spending over and above what is already contained in other monetary variables such as real money and terms of trade shocks for Italy, France and Germany. The monetary variables are Engle-Granger

cointegrated with the output variable for Germany. Further evidence with error-correction specifications indicates that Germany is the only country where the term structure contains significant information not already captured by real money or the terms of trade.

- Davis & Fagan (1995) examine whether financial spread variables such as the yield curve, the foreign bond yield differential and the yield gap, contain useful information about future inflation and output growth beyond money and interest rates for EU-aggregates. Bivariate regression results (distributed lags) provide evidence in favour. Granger causality tests indicate that only the yield curve contributes significantly in the growth equation and marginally in the GDP deflator equation. Obviously, other spreads just pick up the effect of omitted lagged dependent variables. Multivariate Granger causality tests with lags of the dependent variables, all spreads, money and interest rates, indicate that exclusion of the spreads cannot be rejected. However, there appears to be a high degree of multicollinearity. Next, addition of each indicator to an estimated ECM model shows that the yield curve contains some additional information for forecasting output growth. Finally, a VAR model was estimated. It appeared that money, the short-term interest rate and the spread variables entered strongly in a variety of equations for both financial and real macroeconomic variables. The spread variables however explain little of the variance in future inflation and output growth. Out-of-sample forecasting for 1993 and 1994 offers inconclusive evidence regarding performance of VARs with and without spreads. Davis & Fagan conclude that the spread variables considered are unable to play a predominant role in monetary policy in the EU as a whole.
- Gerlach (1995) studies the usefulness of spreads between interest rates of different maturities as indicators of inflation and future real interest rates in Germany, using monthly data. He finds that the spreads contain considerable information about future inflation, but none about the path of real interest rates. The medium-term segment appears to be most informative.

Some studies examine the relationship between inflation and other leading indicators :

- Cody & Mills (1991) find that responding to unexpected commodity price movements would have lowered the average rate of inflation and reduced its variability, while the path of growth would be relatively unchanged. Their findings are based on a monthly VAR (1959-1987, USA) including M2, the Fed funds rate, the consumer price index, the index of industrial production and the CRB commodity price index.
- Webb & Rowe (1995) created a leading indicator for inflation consisting of 7 series which were selected from a set of potential indicators and which had the largest correlation coefficients with inflation. This set contains labor utilization, money and interest rates, commodity prices and other indicators. Their index is helpful in recognizing major changes in inflation rates, but often does not anticipate turning points. Another check was to test for additional predictive power of lagged values of inflation in a bivariate VAR. It was found that the index contains significant predictive value beyond that contained in the inflation series itself.
- Garner (1995) examines five leading indicators[1] for forecasting U.S. inflation. Graphical inspection shows that they are primarily useful as a signal or confirmation of an inflation turning point. Regression analysis however fails to attribute to them any additional predictive information over the 1983-94 sample, when other variables, such as lagged inflation, unemployment and capacity utilization, are included in the regression.
- Fuhrer (1993) uses a monthly VAR model to explain US inflation and real activity and to test the additional value of commodity prices, term structure and trade-weighted dollar. Neither commodity inflation nor exchange rates provide a significant reduction in the average forecast error for either inflation or unemployment/growth in industrial production. The majority of the improvements may be attributed to the interest rate variables but this is rather because of their role in the standard monetary transmission mechanism. In all cases, more than 80 % of the explanatory power for each of the policy targets comes from the information in lagged policy targets. Another test was to see whether contemporaneous information on indicators improves the current forecast of targets. It appears that adding contemporaneous observations on all the indicators decreases the average forecast error for inflation and real activity but that statistically reliable indicators of policy targets are relatively scarce : only the fed funds, T-bond and BAA corporate bond rate and M2 growth enter significantly only in the unemployment regression.
- Bernanke (1990) compared several interest rates and spreads. He found the paper-bill spread to be the best predictor of nine economic avtivity measures.
- Blomberg & Harris (1995) test eight commonly used commodity indices for forecasting inflation (change) through VAR models (also included were the unemployment rate, a constant and a time trend). They conclude that the commodity-consumer price connection has broken down in the more recent period (1987-94) and argue that this shift primarily reflects the diminished role of traditional commodities in US

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[1] The indicators are the price of gold, the Commodity Research Bureau index of commodity futures prices, the Journal of Commerce index of industrial materials prices, the Center for International Business Cycle Research leading inflation index and the PaineWebber leading index

production and the sterilization of some inflation signals by offsetting monetary policy actions. Adding monetary variables and the dollar exchange rate to the models helps eliminate some perverse findings. Furlong and Ingenito (1996) arrive at the same conclusions including some other series.

Summarizing, the following econometric specifications are used in the literature :

1. PROBIT, estimating the chance of recession as a function of the indicators considered. Using this technique, however, gives no indication of how severe the recession might be.
2. OLS, regressing inflation or output growth on the indicators considered. The difficulty with this approach is that there might occur opposite movements in the short run, which may be countered in the long run, caused by non-stationarity of the variables.
3. VAR models, which do not suffer from non-stationarity, contrary to OLS, and which allow us t do some nice sensitivity analyses via variance decomposition and impulse response functions.
4. Cointegration analysis using multivariate techniques of error correction modelling, which allows for short run deviations from a long run equilibrium relationship.

Using one or more of these techniques, most authors find evidence in favour of their hypotheses. However, no serious attempts have been made to compare the predictive power of all indicators in a multivariate setting using all the above mentioned techniques. Until now, most research is concerned with partial comparisons of spreads or studies of the usefulnes of e.g. money for output univariately (see Feldstein & Stock (1994) for a survey thereof and Garratt & Scott (1996) for recent UK evidence). We will in our own research compare the different approaches to see to what degree the conclusions are robust with respect to to specification, country and time period.

4. Data and methodology.

In this paper, we will present evidence on the relationship between several financial indicators and future output and inflation for Germany. The period studied is 1960:1 – 1994:4, on a quarterly. First, figures 3 to 6 display inflation and real GNP growth as they evolve over time. Table 2 gives some summary statistics of inflation and real growth. Inflation clearly follows a cyclical pattern, with generally low inflation rates in the 1960s and 1980s. The 1970s are characterized as a high inflation period. Real GNP growth is secularly declining from a 5.6% high in the 1960s to less than 2% in the 1990s.

Figure 3 and 4 : Inflation plot and histogram.

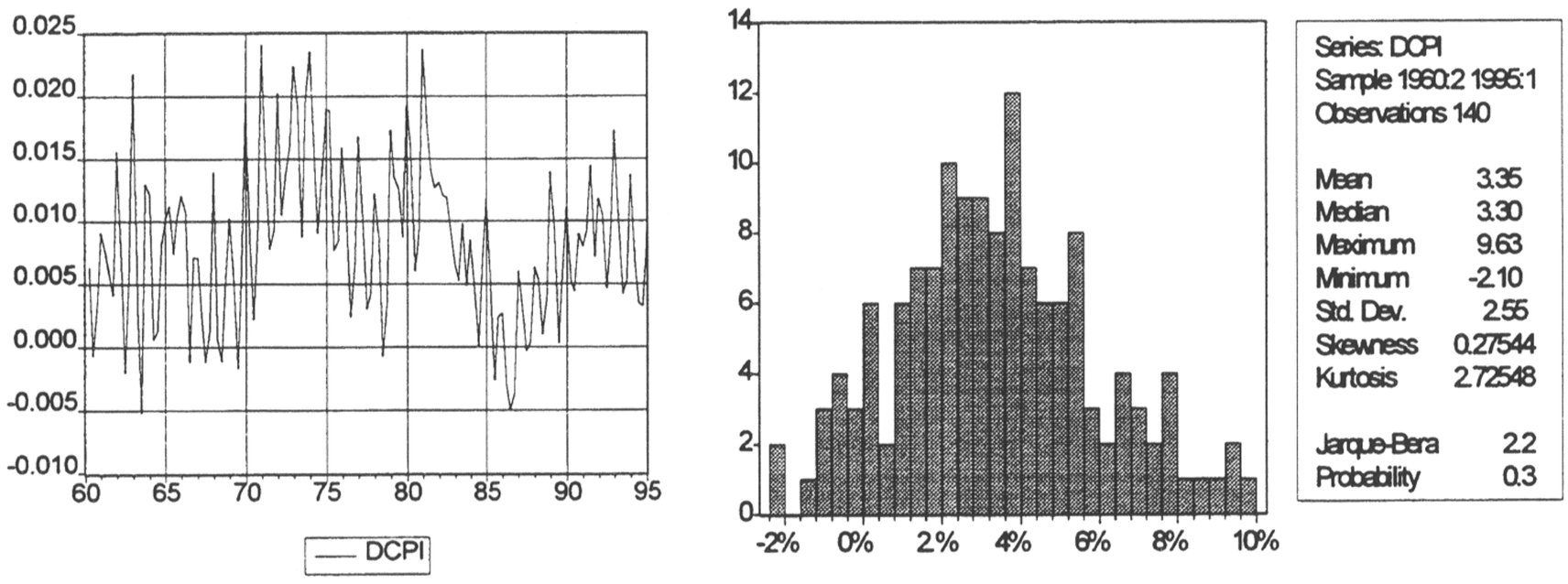

Figure 5 and 6 : Real growth plot and histogram.

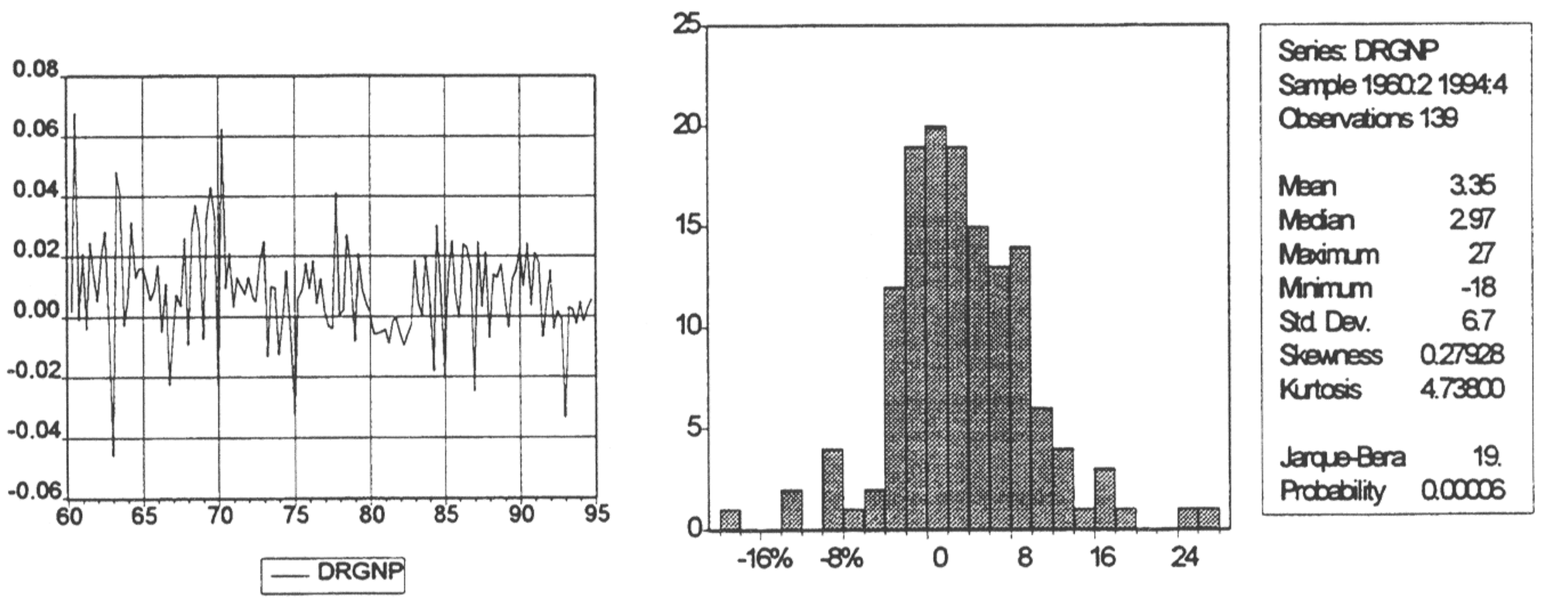

Table 2 : Summary statistics of inflation and real GNP growth.

	Inflation				Real growth			
	Mean (stdev)	Median	Max	Min	Mean (stdev)	Median	Max	Min
1960s *	2.4% (2.3%)	2.4%	8.7%	-2.3%	5.6% (8.3%)	5.2%	27%	-18%
1970s *	4.9% (2.5%)	4.7%	10%	-0.3%	3.3% (6.4%)	3.5%	25%	-13%
1980s *	2.8% (2.6%)	2.4%	9.5%	-2.0%	2.0% (5.4%)	1.6%	12%	-9.9%
1990s **	3.4% (1.5%)	3.6%	6.9%	1.5%	1.8% (5.2%)	1.3%	9.8%	-13%

Source: own calculations, based on IFS data
Definition: quarter-to-quarter changes expressed on a yearly basis and averaged over 10* (5**) years.

We will further proceed in four ways to assess the usefulness of financial variables for predicting and explaining the inflation and real growth data from above. First, we implement probit analysis, second, we examine regression analysis, third, we consider VAR and fourth, we present stationarity and cointegration evidence. As a benchmark, we also consider money as an indicator of inflation and output growth[2].

Table 3 contains the names and descriptions of the series used, as well as the informational lag for each variable, in months. All series come from the IFS CD-ROM.

Table 3 : Indicator series and their information lag.

Symbol	Description	Information lag (months)
	Interest rates and spreads	
GBY	Government bond yield	0
ITBR	Interbank rate (proxy for discount rate)	0
YC	Government bond yield - call rate spread	0
FBYD	Foreign bond yield differential : GBY_{GERM} - GBY_{US}	0
YGAP	Yield gap : dividend yield - GBY	0
	Stock and commodity prices	
SHP	Industrial share prices	0
CP	Industrial countries commodity price index	0
	Monetary aggregates	
M0	Monetary base	1
M1	M1	1
M2	M2	1
RM0	Monetary base deflated by CPI	1
RM1	M1 deflated by CPI	1
RM2	M2 deflated by CPI	1
	Individual macroeconomic indicators	
NEER	Nominal effective exchange rate	1
GNP(-1)	Real GNP growth, previous quarter	3
CPI	Consumer Price Index : inflation	1

Note : all variables except interest rates and spreads are growth rates.

4.A. Probit - analysis.

First, in order to quantify the predictive power of the variables considered with respect to future recessions and inflation surges, we use a probit equation in which the variable being predicted takes only two possible values. The methodology outlined is the same as in Estrella & Mishkin (1995 a). The dependent variables are constructed like in Artis e.a. (1995 a and b).

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[2] Theoretically, a higher quantity of money can be seen as an indication of inflation and output growth via the Fisherian quantity theory of money : Mv=P.Y, assuming a constant velocity (v) of money.

Specifically, the dependent variable in the model is

$RECES_t$, resp. $INF_t = 1$ if the economy goes into recession or experiences an inflation surge [3] in quarter t

$= 0$ otherwise.

More specifically, Artis e.a. date a recession, resp. inflation upswing, according to four principles:

1. Peaks must always follow throughs and vice versa.
2. The duration of a recession or an inflation upswing must last for at least nine months.
3. The turning point must be the most extreme value between two adjacent regimes.
4. If there are two equal values satisfying conditions 1 to 3, then the most recent one is chosen.

Figure 7 : Recessions and industrial production (year to year growth rate)

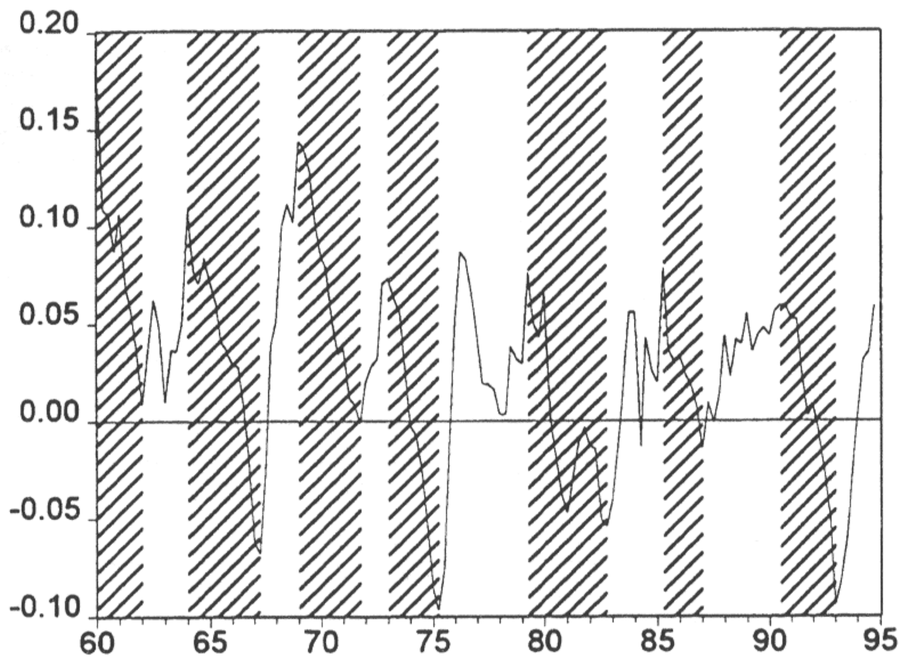
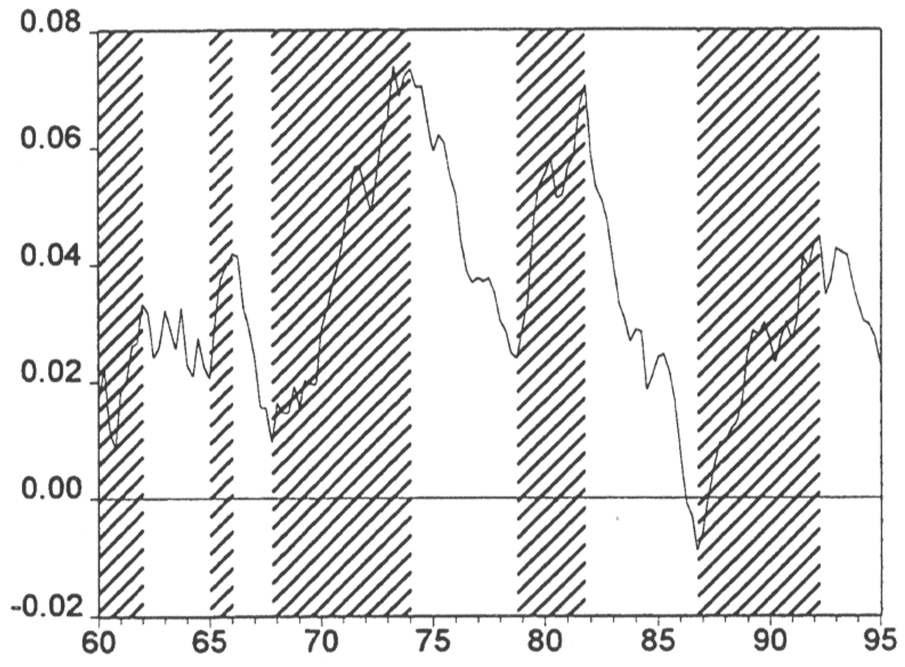


Figure 8 : Inflation cycle and inflation (year to year growth rate)



Figures 7 and 8 show the resulting production and inflation cycles for Germany. Recessions occured in 56 % of the cases. Periods of rising inflation occured in 54 % of the cases. As can be seen, these simple rules capture quite well the broad movements in output and inflation. Inflation upswings can be seen in the early and mid-1960s, the early and late 1970s and in the late 1980s and the beginning of the 1990s. Periods of recession arised in 1960-62, half the 1960s, end 1960s/beginning of 1970s, after the two oil crises, halfway the 1980s and at the beginning of the 1990s. Only the period 1962:1-1965:1 is somewhat contentious for dating the inflation cycle, as is 1962:1-1964:1 for production. As the percentages indicate, a transformation of the data toward an equal probability of zero or one is not very much needed. We therefore do not undertake such a rescaling.

The probit equations have the general form

$$P[RECES_{t+k} = 1] = F(\alpha_0 + \alpha_1 X_{1t} + \alpha_2 X_{2t} + \ldots)$$

$$P[INF_{t+k} = 1] = F(\beta_0 + \beta_1 X_{1t} + \beta_2 X_{2t} + \ldots)$$

where the α and β coefficients are statistically estimated and F is the standard normal distribution function. A weighted sum of one or more explanatory variables, observed at the end of quarter t, is used to predict whether at k quarters ahead $RECES_{t+k}$ or INF_{t+k} will be 1 or 0.

In this paper, we examine many variables with predictive power for recessions and with predictive horizons from 1 to 16 quarters ahead for Germany. Contrary to Artis e.a. (1995 b), we do not take a centered moving average of our independent variables, for it is the purpose of our exercise to explore what business cycle information is contained in instantanous price changes. Averaging over a year or more would make business cycles dependent of events that occurred in the far past and would introduce complex autocorrelation patterns.

We introduce a few summary measures of the predictive power of a given variable with a given horizon. The principal measure of goodness of fit is a pseudo R^2 developped in Estrella (1995). A value close to 0 indicates

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[3] Recession is defined in Estrella & Mishkin (1995 a), who used data from the Center for International Business Cycle Research (for the European countries) and NBER (for the US). A simpler methodology was followed by Rozendaal, Zewuster & Himmelbauer (1992). They defined a recession as the period starting with two consecutive quarters of negative GDP-growth and ending with two consecutive quarters of positive growth. Artis e.a. (1995 a and b) date recessions according to the four principles mentioned. Its correlation with Bernard & Gerlach (1996) who also used Artis' construct is 0.61 (we also dated 1985:2-1987:1 as a recession).The correlation between our recession indicator and Estrella & Mishkin's is only 0.30 for the period 1973-1994, due to differences in starting and ending points, though both measures broadly cover the same reference cycles.

that the variables in the model have little explanatory power, a value close to 1 indicates a good fit. The formula used is

$$\text{pseudo } R^2 = 1 - \left(\frac{\log L_e}{\log L_c}\right)^{\frac{-2}{N}\log L_c},$$

where L_e is the value of likelihood of the estimated model and L_c is the value of a model containing only the constant term α_0. We also give a t-statistic for significance as well as the significance level.

Table 4 contains the results for in-sample prediction of recession k quarters ahead for models with one variable only. A key question is whether our financial series can provide useful predictions over and beyond the results obtained with traditional monetary and real variables.

Table 4: Measures of fit and t-stats for probit modes - variables by themselves

Recessions = 1 : 1960-1994		k = quarters ahead									
Variable :		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**12**	**16**
d(SHPR)	t-stat	-2.06**	-1.52	0.02	0.61	1.29	1.48	0.86	1.26	-0.40	-0.88
	R^2	3.1%	1.7%	0.0%	0.3%	1.3%	1.7%	0.6%	1.2%	0.1%	1.6%
CP	t-stat	-1.87*	-1.77*	-1.72*	-1.65	-1.60	-1.59	-1.61	-1.60	-2.19**	-3.13***
	R^2	2.5%	2.3%	1.3%	1.1%	1.0%	1.0%	1.0%	1.0%	3.8%	8.0%
d(CP)	t-stat	-0.40	0.34	0.49	0.97	1.16	0.90	0.88	0.64	0.92	-0.36
	R^2	0.1%	0.1%	0.2%	0.7%	1.0%	0.6%	0.6%	0.3%	0.7%	1.0%
d(NEER)	t-stat	0.92	0.40	-0.60	-44.00	-1.19	-1.15	-0.86	-1.61	0.31	0.63
	R^2	0.6%	0.1%	0.3%	0.1%	1.1%	-0.5%	0.6%	2.1%	1.0%	0.3%
YC_CAL	t-stat	-3.30***	-2.63***	-1.80*	-1.07	0.03	1.41	2.54***	3.50***	2.71***	1.24
	R^2	8.2%	5.2%	2.4%	0.8%	0.0%	1.5%	5.0%	9.8%	5.9%	2.2%
YGAP	t-stat	-4.63***	-4.15***	-3.06***	-1.79*	-0.44	0.80	1.80	2.87***	3.74***	2.69***
	R^2	17.7%	13.9%	7.2%	2.4%	0.1%	0.5%	2.5%	6.5%	11.7%	6.9%
FBYD	t-stat	2.78***	2.33**	1.73*	1.06	0.49	0.08	-0.28	-0.42	0.34	0.99
	R^2	6.5%	4.8%	3.0%	1.5%	99.2%	0.6%	0.6%	0.6%	0.1%	0.8%
GBY	t-stat	4.07***	3.26***	2.05**	0.76	-0.56	-1.89*	-3.00***	-3.53***	-4.06***	-2.59**
	R^2	13.3%	8.2%	3.2%	0.4%	0.2%	2.7%	7.1%	10.1%	14.2%	6.4%
ITBR	t-stat	4.90***	4.07***	2.99***	1.92*	0.51	-1.32	-2.76***	-3.53***	-3.93***	-2.48***
	R^2	21.4%	13.7%	7.0%	2.8%	0.2%	1.3%	6.0%	10.3%	13.5%	6.0%
d(RGNP-1)	t-stat	1.13	2.48***	1.70	1.57	2.51***	1.49	1.35	1.50	0.41	-0.36
	R^2	1.0%	4.8%	2.2%	1.9%	5.0%	1.7%	1.4%	1.7%	0.1%	0.1%
d(M0)	t-stat	-0.96	-1.04	-1.46	-1.34	-1.36	-0.47	-0.64	0.38	0.50	0.05
	R^2	0.7%	0.8%	1.5%	1.3%	1.4%	0.2%	0.3%	0.1%	0.2%	0.9%
d(RM0)	t-stat	-1.61	-1.51	-1.66	-1.74	-1.59	-0.51	-0.51	0.45	0.89	0.54
	R^2	1.9%	1.7%	2.0%	-0.7%	1.9%	0.2%	0.2%	0.2%	0.6%	1.2%
d(M2)	t-stat	0.37	0.69	0.27	0.57	0.57	0.65	0.41	1.12	0.24	0.37
	R^2	0.1%	0.3%	0.1%	0.2%	0.2%	0.3%	0.1%	1.0%	0.0%	1.0%
d(RM2)	t-stat	-0.34	0.11	-0.07	0.04	0.19	0.50	0.43	1.10	0.61	0.79
	R^2	0.1%	0.0%	0.0%	0.0%	0.0%	0.2%	0.1%	0.9%	0.3%	1.4%

Note: Statistically significant at *** : 1%, ** : 5%, * : 10%.

The recession forecasting results are quite disappointing. Not a single variable is statistically significant over the whole horizon. Furthermore, there appear sign reversals difficult to explain, e.g., in the yield curve, the yield gap and interest rates. Share prices only seem to contain important business cycle information for the next quarter, suggesting short-termism among stockholders (a hypothesis that runs counter to the hypothesis of the German long-term stockholdership). Higher commodity prices are weakly predicting upturns in the short run, and significantly in the long run, contradicting our hypothesis of cost-push recession. Exchange rate changes bear no relation with future real developments. The yield curve and yield gap indicate that up to three (four) quarters, higher values give rise to a lower probability of recession, in line with our expectations. In the long run however, a steeper yield curve or higher yield gap lead us to conclude the opposite. This cannot be easily explained in terms of higher lending or borrowing costs affecting business investments, as the sign of interest rates is negative in the long run, for they also suffer from this sign reversal problem. However, when we re-run the exercise with data starting in the 1970s, the sign reversals disappear [4]. Lagged real GNP growth only explains a small fraction of future chance of recession. Traditional monetary aggregates (narrow and broad, real and nominal) are not at all recession indicators.

[4] The results are not reported here because of brevity. See the appendix for more details.

Our results for forecasting recessions are in line with those of Estrella & Mishkin (1995 a) for Germany only for the short term. They use a quarterly sample from 1973 to 1994 and found a very significant relationship between recession and yield curve lagged one year, with an R^2 of 57.7%. Our results are more modest in terms of R^2. However, using a restricted data set (1973-1994) yields more comparable results (see appendix). Comparing our results with those of Estrella & Mishkin (1995 b) for the US (1959Q1-1995Q1) then yields similar conclusions, although for Germany, we find that there is little to be gained from multivariate probit analysis, as opposed to the US, where a combination of yield curve and stock prices does dominate any other forecasting model.

Table 5 reports the results from multivariate probit recession forecasts. Significant variables from the univariate analysis were combined and additional significance tests were performed by adding the other financial and non-financial indicators. Most of the improvement in R^2 occurs in the short and medium term, reaching 38%. In the long run, the additional explanation is not very much higher than that of some indicators taken individually. The findings suggest that share prices give additional information about the occurrence of recessions when combined with other indicators. The sign however, is against our expectation, except for 12 and 16 quarters ahead. Higher commodity prices signal upturns in the near future, as in table 4. A higher yield gap consistently indicates a significant probability of economic recoveries. In the very long run, however, the relationship alters to the opposite. We have no straightforward explanation herefor. A steeper yield curve predicts a lower chance of recession for the next quarter. In the medium and long run, the relationship alters, as in table 4. Long and short term interest rates also contribute significantly in forecasting recessions, apart from the information contained in the yield curve (which is measured slightly differently, so that we can include separate interest rates in the regression as well). Higher long term interest rates seem to boost the economy, while higher (policy-controlled) short rates lead toward recessions. Note that there appear no sign reversals in the interest rates over the forecasting horizons, as opposed to table 4. Finally, lagged GNP growth adds information to the probit models up to five quarters.

Table 5 : Mutivariate probit forecasts for recessions (t-stats and pseudo R^2)

Recessions = 1 : 1960-1994	k = quarters ahead									
Variables	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**12**	**16**
Constant	2.86***								4.30***	3.45***
d(SHPR)			3.16***	3.28***	3.74***	3.85***	3.19***	2.43***	-2.09**	-2.09**
CP	-4.85***	-3.68***	-2.10**							
YC_CAL	-4.05***		1.79*	3.35***		2.55***	2.93***	3.82***		
YGAP	-4.65***	-3.04***	-3.95***	-3.74***	-4.02***	-4.08***	-3.95***	-2.67***	4.15***	3.27***
GBY		-2.20**	-3.91***	-5.15***	-4.29***	-4.75***	-4.05***	-2.86***		
ITBR		3.65***	2.47***	3.89***	1.88*	2.23***				
d(RGNP-1)		3.47***	2.04*	1.67*	2.65***					
pseudo R^2	38.6%	38.2%	33.4%	30.3%	22.0%	22.2%	19.0%	17.4%	15.2%	10.5%

Note : Statistically significant at *** : 1%, ** : 5%, * : 10%.

Table 6 contains the results for in-sample prediction of inflation surges k quarters ahead. Again, the explained variation in terms of R^2 is very low, reaching 25% at most (12 horizons ahead, short term interest rate). Share prices nor changes in the effective exchange rate are related to inflationary regimes. Higher commodity prices imply a relatively small chance of inflation upturns in the near future. In the long run, a steeper yield curve and higher yield gap seem to point toward a statistically significant probability of entering high inflation periods. Higher interest rates on the contrary reduce the potential of inflationary disturbance. This might well be a consequence of the central bank's interest rate policy, acting when inflation is expected to rise. Real money growth does have inflationary implications in the longer run (4 to 8 quarters ahead), with narrow money being a slightly better predictor of rising inflation periods than broad money. Also, a higher real growth in the recent past forecasts inflation surges in the near future and up to 6 quarters. Furthermore, the results suggest that higher inflation in the recent past is indicating future inflation slowdowns, being highly significant from 5 quarters ahead.

A comparison with findings of the literature is difficult. Only Artis e.a. (1995 b) investigated the inflation cycle. In their work for the UK, interest rates nor the yield curve appeared as leading indicators of inflation, contrasting with our results for Germany. The exchange rate did not enter significantly into their design, as is the case for Germany. Commodity prices and M0 were more significant than in our study. Industrial production or real growth -as in our study- have the same importance. Their other real variables (vacancies, unemployment and retail sales) were not considered here as was neither another nominal variable, import prices. Compared with

Fama (1990) and Mishkin (1990), we also find that the yield curve conveys more information about inflation when the forecast horizon is extended.

Table 6 : Measures of fit and t-stats for inflation probit models - variables by themselves

Inflation upswing = 1 : 1960-1994		k = quarters ahead									
Variable :		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**12**	**16**
d(SHPR)	t-stat	-0.86	-0.86	0.04	0.83	0.70	1.35	1.83	1.43	-0.33	0.90
	R^2	0.5%	0.5%	0.0%	0.5%	0.4%	1.4%	2.5%	1.6%	0.1%	0.7%
CP	t-stat	-1.29	-1.41	-1.55	-1.66	-1.76	-1.71	-1.60	-1.55	-1.76	-2.08**
	R^2	1.2%	1.4%	1.8%	2.0%	2.3%	2.2%	1.9%	1.8%	2.4%	3.5%
d(CP)	t-stat	2.15**	2.29**	2.10**	1.93**	0.68	0.02	0.62	0.20	-0.61	-1.15
	R^2	3.6%	4.2%	3.4%	2.8%	0.3%	0.0%	0.3%	0.0%	0.3%	1.1%
d(NEER)	t-stat	-0.33	0.11	-0.31	-0.61	0.13	0.28	0.17	0.79	0.26	0.56
	R^2	0.1%	0.0%	0.1%	0.3%	0.0%	0.1%	0.0%	0.5%	0.1%	0.3%
YC_CAL	t-stat	-0.60	0.19	0.93	1.21	1.70	1.89*	1.91*	2.25**	4.18***	4.92***
	R^2	0.3%	0.0%	0.6%	1.1%	2.2%	2.7%	2.8%	4.0%	15.0%	23.8%
YGAP	t-stat	-0.47	0.84	2.22**	3.32***	3.88***	4.41***	4.84***	5.01***	4.79***	3.81***
	R^2	0.2%	0.5%	3.7%	8.6%	12.1%	16.1%	19.9%	21.6%	20.2%	12.6%
FBYD	t-stat	1.13	0.70	0.25	-0.11	-0.34	-0.57	-0.93	-1.08	-1.39	0.99
	R^2	0.9%	0.4%	0.0%	0.0%	0.1%	0.2%	0.7%	0.9%	1.5%	0.8%
GBY	t-stat	-1.10	-2.39**	-3.34***	-3.96***	-4.36***	-4.80***	-5.14***	-5.11***	-4.90***	-2.93***
	R^2	0.9%	4.3%	8.7%	12.5%	15.6%	19.5%	23.1%	23.1%	21.9%	7.2%
ITBR	t-stat	0.32	-1.17	-2.12**	-2.61***	-3.25***	-3.66***	-3.83***	-4.00***	-5.17***	-4.64***
	R^2	0.1%	1.0%	3.4%	5.3%	8.4%	10.9%	12.2%	13.6%	25.6%	21.2%
d(RGNP-1)	t-stat	2.49***	2.44***	2.99***	2.57***	2.59***	2.28**	1.35	1.36	1.58	0.22
	R^2	4.7%	4.6%	7.1%	5.2%	5.3%	4.1%	1.4%	1.4%	2.0%	1.3%
d(M0)	t-stat	0.46	0.28	1.08	1.68	1.88*	1.96**	1.25	0.58	-0.78	0.19
	R^2	0.2%	-2.9%	0.9%	2.2%	2.8%	3.1%	1.2%	0.3%	0.5%	0.0%
d(RM0)	t-stat	0.31	0.53	1.40	2.26**	2.78**	2.97***	2.23**	1.49	0.50	1.23
	R^2	0.1%	0.2%	1.5%	4.1%	6.4%	7.5%	4.0%	1.8%	0.2%	1.2%
d(M2)	t-stat	0.97	0.09	-0.20	1.32	1.35	0.65	0.34	1.35	0.48	0.90
	R^2	0.7%	0.0%	0.0%	1.3%	1.4%	0.3%	0.1%	1.4%	0.2%	0.7%
d(RM2)	t-stat	0.78	0.33	0.20	1.86*	2.21**	1.69*	1.32	2.08**	1.53	1.77
	R^2	0.4%	0.1%	0.0%	2.7%	3.8%	2.2%	1.4%	3.5%	1.8%	2.6%
Inflation(-1)	t-stat	0.33	-0.87	-1.31	-2.35**	-3.44***	-3.80***	-3.47***	-3.02***	-3.79***	-3.30***
	R^2	0.1%	0.5%	1.3%	4.2%	9.2%	11.5%	9.6%	7.2%	11.9%	9.3%

Note : Statistically significant at *** : 1%, ** : 5%, * : 10%.

Table 7 presents evidence of multivariate probit regressions in which the significant variables from the univariate analysis were combined, as in table 5. Insignificant variables were deleted from the probit regressions. The fraction of future inflation surges explained lies higher than in any of the univariate models, except for the 7 and 8 quarters ahead horizon. The best fit notably appears to be that for the ultra long run, with 32% explained of the inflation regimes' variance. The results are generally in line with those from table 6. Only here, rising commodity prices signal greater probability of inflation upswings in the short and medium term. A larger foreign bond yield differential significantly reduces the probability of inflation going up in the very long run. The most recent inflation figures are found to contribute significantly to the multivariate probit especially in the medium term.

Table 7 Multivariate probit forecasts of inflationary regimes (t-stats and pseudo R^2)

Inflation upswing = 1 : 1960-1994	k = quarters ahead									
Variables	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**12**	**16**
Constant			2.65***		3.32***	4.38***	5.17***	5.14***	2.52***	
d(CP)	2.07**	2.05**		2.13**						-2.09**
YC_CAL									2.80***	5.40***
YGAP			-2.10**							4.10***
FBYD									-2.33**	-1.95**
GBY	-2.17**		-3.06***		-2.90***	-3.68***	-5.14***	-5.11***	-3.37***	
ITBR	2.05**									
d(RGNP-1)	2.73***	2.15**	2.30**	2.84***	1.80*					
Inflation(-1)				-2.35**	-1.64*	-1.88*				
R^2	10.8%	7.7%	16.2%	11.9%	19.7%	22.1%	23.1%	23.1%	29.8%	32.1%

Note : Statistically significant at *** : 1%, ** : 5%, * : 10%.

4.B. Regression analysis.

The design of the regression analysis closely follows the procedure outlined in Davis & Fagan (1995). Table 8 presents the R^2 statistics from simple regressions of inflation and GNP growth on a polynomial distributed lag of the indicator variables. These measures should be seen as crude descriptive statistics of the association between the indicators and the variables of interest. In this simple bivariate context, output growth and inflation appear to be lowly correlated with any of the variables. Past values of monetary growth and interest rates perform better than any of the other variables for output growth. The yield curve and yield gap also perform moderately better. In terms of inflation, the yield gap outperforms money and interest rates[5]. A strange finding here is the negative sign of money in the inflation regression. The positive influence of interest rates on inflation seems to indicate their indicator role rather than their role of determinant which should be negative. These data provide only weak evidence that financial variables contain useful information about the future course of inflation and output growth for the period 1960-94 as a whole. We also considered two specific subsamples. The first covers the floating exchange rate regime (1973-94) and the second covers the EMS period of monetary stability in Europe (1980-94). The results remain robust with repect to the specific time period. Noteworthy however is the significance of the effective exchange rate over the two subsamples in explaining inflation : DEM-appreciation leads toward lower domestic inflation since 1973.

Table 8 : R^2 from distributed lag regressions (%).

	GNP growth			CPI inflation		
	1962:1994	1973:1994	1980:1994	1962:1994	1973:1994	1980:1994
Yield curve	(+) *** 8.3	(+) *** 8.4	(+) *** 10.8	(-) *** 4.4	0.6	(-) *** 15.1
FBY differential	0.0	0.0	0.0	(+) * 1.8	(+) *** 15.4	(+) * 4.0
Yield gap	(+) *** 6.9	(+) ** 6.2	(+) ** 6.1	(-) *** 20	(-) *** 27	(-) *** 30.7
Δ Commodity prices	(-) ** 3.0	(-) ** 3.4	0.0	(+) *** 12.7	(+) *** 16.7	(+) *** 9.0
Δ Share prices	(+) ** 2.7	(+) ** 4.6	(+) ** 5.6	(-) *** 6.6	(-) *** 15.2	(-) *** 15.8
Δ Exchange rate	0.0	0.0	0.0	0.0	(-) *** 18.7	(-) *** 19.0
Monetary growth	(+) *** 9.6	(+) *** 10.9	(+) *** 11.7	(-) *** 11	(-) *** 18.8	(-) *** 21.4
Interest rates	(-) *** 8.9	(-) *** 11.0	(-) *** 10.5	(+) *** 18	(+) *** 16.9	(+) *** 26.6

Note : Table reports the sign and statistical significance of the coefficients for each variable and the R^2 (%).
Coefficients significant at *** : 1 % ; ** : 5 % ; * : 10 %.
The estimation is based on a distributed lag regression on current and past values of the indicator considered covering 8 quarters with a first degree polynomial, with a constraint at the near end or the far end of the distribution.

However, the results found in the bivariate approach may also reflect the omission of other variables. To check whether this is true, we test whether these spreads retain their information when other variables are added. Firstly, we add own lags of inflation and GNP growth. Table 9 reports the significance levels and F-stats for the exclusion of each indicator variable in equations comprising four lags of the indicator and of the dependent variable.

Table 9 : Bivariate F-tests

	GNP growth	CPI inflation
Yield curve	2.70 **	1.15
FBY differential	0.52	0.40
Yield gap	5.0 ***	2.5 **
Δ Commodity prices	1.76	1.75
Δ Share prices	5.85 ***	2.55 **
Δ Exchange rate	0.22	0.33
Monetary growth	3.20 **	0.75
Interest rates	3.90 ***	4.05 ***

Significant at *** : 1 % ; ** : 5 % ; * : 10 %
The estimation is based on a regression including four lags of the indicator and of the dependent variable.

The yield gap is found to be significant in the output and inflation equation. None of the other spreads except the yield curve are significant in explaining future inflation or output growth. Share prices and interest rates are significant in both equations and monetary growth is significant in explaining GNP. It appears that, in contrast with the previous test, monetary growth is just picking up the effect of lagged dependent variables in the

[5] From now on, interest rates refer to the long-term series (GBY) and money refers to RM2.

inflation equation. Concluding, once the influence of lagged dependent variables is allowed for, the variables contain some additional information useful for independently forecasting the final variables. However, the contrasts between the results of this and the previous test suggest that the correlation between the foreign bond yield differential, commodity prices, the exchange rate and future output/inflation growth reflects the fact that these variables are picking up the effect of omitted variables and once this influence is allowed for, these variables contain little additional information useful for forecasting the final variables.

A further step is to examine whether this conclusion holds when the analysis is extended to include still more variables. Table 10 presents the results of a regression of the final variable on its own lags and two lags of all financial variables as well as money and interest rates. Exclusion of each variable and of spread and auction variables jointly was then tested. It appears that the yield curve contains some useful information for forecasting inflation and output growth and interest rates similarly contain information for forecasting inflation. This remarkable difference with the previous table can be explained in terms of the different number of lags considered. Because of a degrees of freedom problem, we had to restrict ourself to using two lags instead of four (as in table 8). However, the equations are badly affected by a high degree of multicollinearity, which tends to bias the results anyway.

Table 10 : Multivariate F-tests

	GNP growth	CPI inflation
Yield curve	3.27 **	3.89 **
FBY differential	1.66	1.47
Yield gap	2.01	0.98
All spreads	2.00 *	4.06 ***
Δ Commodity prices	0.98	1.07
Δ Share prices	0.17	0.39
Δ Exchange rate	0.76	0.39
All auction prices	0.61	0.64
Monetary growth	0.57	1.60
Interest rates	1.74	7.22 ***

Significant at *** : 1 % ; ** : 5 % ; * : 10 %
Estimation based on a regression including two lagged dependent variables and two lags of each indicator.

A rough estimate of this multicollinearity bias might be obtained by looking at the bivariate correlations between the explanatory variables used in this study. In appendix, summary statistics and estimates of the autocorrelations for each series are given.

Concluding, we can say that financial spreads and interest rates contain some useful information for forecasting future inflation and output growth using regression. The correct specification of the relationship cannot be set exactly, because of non-stationarity of the series. It might well be the case that in the short run, the series' behaviour are divergent but nonetheless share common long run comovements. A way to incorporarte these dynamics is via the use of vector autoregression and cointegration estimation.

4.C. VAR.

A VAR system is the reduced form of a linear dynamic simultaneous equation model in which all variables are treated as endogeneous. Each variable is regressed on lags of itself and on lagged values of all other variables in the information set (Judge e.a. 1988). The basic objective of the analysis here is to test the indicator properties of financial variables and money in relation to real GDP and inflation, and related policy analysis. The questions are : Do money and the financial variables contain information and do they have an indicator role? Do they improve the performance of a basic, dynamic VAR? And do spreads contain information in the presence of money or vice-versa? The procedure outlined is similar to that of Davis & Fagan (1995).

Here, a quarterly VAR was estimated (1960:1994). It included real GNP growth, inflation, the nominal effective exchange rate, broad money, share prices, commodity prices and financial spread variables : the yield curve, the yield gap and the foreign bond yield differential. Data were transformed to ensure stationarity, as indicated in table 11. In order to assess the series' stationarity, we performed unit root tests. The data suggest that most of the series are integrated of the first order. Notable exceptions are the interbank rate that is I(0) and M2 and RM2 that are I(2). The inflation rate is I(1).

The next step was testing for lag length using AIC and SC. These showed that three lags were acceptable for the data (see appendix table A4).

Table 11 : Unit root tests.

Series	Level	1st Difference	2nd Difference
Government bond yield	-3.27 **	-3.73 ***	
Interbank rate	-3.54 ***	-	
Yield curve (GBY - call rate)	-3.00 **	-6.12 ***	
Foreign bond yield differential	-1.38	-4.20 ***	
Yield gap	-3.19 **	-4.35 ***	
M0	0.15	-4.25 ***	
M1	0.33	-4.51 ***	
M2	-2.49	-2.28	-5.27 ***
RM0	0.12	-3.73 ***	
RM1	0.36	-4.23 ***	
RM2	-1.95	-2.39	-5.19 ***
Share prices	-0.01	-5.22 ***	
Industrial countries commodity index	-1.52	-5.00 ***	
NEER	-0.30	-4.70 ***	
Real GNP	-1.49	-3.38 ***	
Industrial production	-2.60 *	-4.37 ***	
CPI	-0.67	-2.23	-3.74 ***

t-statistics for the null hypothesis of a unit root in the levels, first difference or second difference of the series.
Based on augmented Dickey-Fuller tests with 8 autoregressive terms and a constant.
Significant at *** : 1 % ; ** : 5 % level ; * : 10 % level

Table 12 : VAR results : Germany, 1960 : 1994

	Inflation	Real GNP	Real M2	Inter-bank rate	Commodity prices	Share prices	NEER	Yield curve	FBY diff.	Yield gap
Inflation	(-) ***	(+) ***	(+) **	(-) *		(-) ***				(-) *
Real GNP	(+) **					(-) ***				(-) *
Real M2	(+) **			(-) **		(-) *				
Interbank rate		(-) **	(+) *	(+) ***				(+) ***		
Commodity prices					(+) ***	(-) *				(-) ***
Share prices	(-) **	(+) *				(+) *				(+) ***
NEER			(-) *				(+) **			
Yield curve					(+) *		(+) *	(+) *		
FBY diff.					(+) *	(+) ***	(+) **			(+) ***
Yield gap				(-) ***			(+) *		(+) *	(+) *
R^2 adj.	0.71	0.18	0.24	0.92	0.25	0.31	0.11	0.14	-0.003	0.45
F-statistic	11.63 ***	1.96 ***	2.34 ***	52.17 ***	2.43 ***	2.90 ***	1.52	1.68 **	0.99	4.60 ***
LM 1 lag	0.27	0.61	0.34	0.40	5.20 **	2.77 *	2.32	0.42	0.50	0.22
LM 2	0.45	8.92 ***	0.76	2.87	6.23 **	3.43	3.04	0.50	2.02	0.29
LM 3	1.70	9.52 **	1.12	17.87 ***	7.59 **	5.67	3.26	0.93	2.18	0.69
LM 4	4.90	17.74 ***	3.78	17.90 ***	8.51 *	6.87	4.93	5.64	2.93	0.95
ARCH (4 lags)	1.74	4.53	0.71	10.27 **	15.13 ***	3.14	11.32	15.63 ***	20.22 ***	1.50
Jarque Bera	2.97	1.78	416.2 ***	5.88 **	13.02 ***	8.40 ***	21.78 ***	16.31 ***	5.98 ***	0.29
RESET (4 lags)	2.12 *	0.99	1.03	2.50 **	2.67 **	0.23	24.91 ***	36.57 ***	0.46	7.44
White	51.9	44.1	63.2	82.8 **	53.2	63.8	93.4 ***	91.2 ***	64.3	68.8
Ljung-Box 1 lag	0.074	0.039	0.035	0.036	0.454	0.417	0.280	0.034	0.039	0.033
Ljung-Box 2	0.081	1.267	0.103	0.689	0.560	0.605	0.316	0.037	0.196	0.064
Ljung-Box 3	0.867	1.267	0.192	5.401	0.892	1.533	0.401	0.182	0.199	0.179
Ljung-Box 4	2.762	6.399	2.589	5.405	0.901	1.588	2.381	3.271	0.353	0.412

Notes : Table reports the sign and joint statistical significance of the coefficients for each variable.
Coefficients significant at *** : 1 % ; ** : 5 % ; * : 10 %.

The results are summarized in table 12. The VAR equations are not quite succesful overall with R^2 's generally below .25. Broad money and share prices enter significantly in the inflation equation and the short term interest rate and share prices enter significantly in the GNP growth equation. The financial variables enter significantly in a variety of equations for financial variables. As regards their sign, rising real output leads toward a rise in

inflationary perspectives, as does rising money growth and falling share prices. Short term interest rates have negative output effects. Rising equity prices lead toward an output growth as predicted by the theory.

The results suggest that higher real growth increases inflationary pressure, as does higher money growth. The only relevent financial indicator is share prices, with an expected negative sign in the inflation equation (because lower inflation risk leads to a lowering of the discount rate which has a positive effect on stock prices) and a positive one in the growth equation (capturing the income effect). Considering the other equations, it seems as if higher interest rates increase the money demand, a result opposite to the opportunity cost interpretation of money and interest rates. This result could be caused by the definition of our monetary aggregate, which is a broadly based one. The results for the short-term interest rate also imply the existence of an inverse Fisher effect with a higher inflation rate leading toward lower nominal interest rates, suggesting that real rates have fallen by a larger amount than inflation has risen. Another strange sign is that of GNP growth on equity prices. Higher growth seems to have negative effects on share prices. This could be due to the anticipation of a tighter monetary policy in the future as the economy goes toward full capacity.

The second part of table 12 presents some summary statistics. These include the R^2-statistic, the F-statistic (testing the joint significance of all variables), the Breusch-Godfrey LM-test for serial correlation of the first through fourth order, an ARCH-test for heteroscedasticity of the residuals, the value of the Jarque-Bera test for normality of the residuals, Ramey's RESET test (for misspecification), the White test for heteroscedasticity and the Ljung-Box Q-statistic (testing that all autocorrelations are zero and consequently, that residuals are white noise). In appendix, these tests will be discussed more extensively.

It appears that the inflation equation is well specified. The residuals appear to be white noise (see LM [no autocorrelation] and ARCH [no time-varying volatility]) and normally distributed (Jarque-Bera). The specification of the GNP equation is somewhat worse, with indications of higher order autocorrelation in the residuals. Most of the other equations' residuals seem not to be normal distributed. Test statistics therefore are biased but remain consistent due to our large sample.

A number of procedures were followed to further assess the information content of financial variables within the VAR.

First, block exogeneity tests were conducted. These are in fact multivariate generalizations of Granger-Sims test for causality. Testing for causality comes down to testing zero constraints on the coefficients of the VAR. The null hypothesis can be tested using an F-test with test statistic (Judge e.a. 1988):

$$\lambda = \frac{SSE_r - SSE_u}{p\hat{\sigma}} \approx F(p, T-2p-1)$$

with SSE_r : sum of squared errors with imposing zero restrictions

SSE_u : sum of squared errors without imposing zero restrictions

p : order of the VAR

σ : LS estimator of the variance of the residuals in the equation considered.

The F-test gave values which strongly reject the exclusion of the short term interest rate from the GNP-equation and of money and auction prices from the inflation equation. The results imply that financial spreads do not have predictive power for inflation and GNP growth forecasting.

Table 13 : Results of F- tests

Exogeneity of :	Inflation equation	GNP equation
spreads (yield curve, yield gap, FBY diff.)	0.75	0.40
auction prices (commodity and share prices, exchange rate)	1.86 *	1.11
real money	3.73 **	0.67
interbank rate	1.12	2.61 **
Significant at *** : 1 % ; ** : 5 % ; * : 10 %.		

The next step is to provide some quantitative estimates of the relationship between these variables and inflation and output growth. To do this, we need to orthogonalize the estimated VAR model to identify the effect of

shocks to the innovations of the variables in the VAR. We use the Cholseki decomposition[6]. In table 14 we report the variance decomposition of both inflation and output.

Table 14 : Decomposition of variance (%)

	Inflation		Output	
Quarters	**6**	**12**	**6**	**12**
Inflation	73.1	67.9	13.4	14.5
Real GNP	7.1	6.2	72.1	65.0
Real M2	7.6	9.4	2.1	2.6
Interbank rate	5.3	6.8	1.8	2.2
Commodity prices	0.15	0.21	2.7	5.8
Share prices	2.9	4.0	3.6	3.7
NEER	1.0	1.43	0.48	0.84
Yield curve	0.47	0.41	0.81	1.01
FBY diff.	1.42	2.12	2.0	2.0
Yield gap	1.04	1.54	1.07	2.3

The results suggest that output and inflation are the only variables with significant influence besides the commodity price index in the ouput variance decomposition. In the inflation variance decomposition, also real money and the short term interest rate seem to contribute significantly. In relation to the financial variables, spread variables explain not much of the variance in future inflation and output.

Table 15 : Responses of inflation and output to one standard deviation innovation in other variables

	Inflation		Output	
Quarters	**6**	**12**	**6**	**12**
Inflation	-.00126	.000711	-.000032	-.000477
Real GNP	.000427	-.000338	-.001862	.000089
Real M2	.000628	-.000432	-.001124	.000671
Interbank rate	.000154	-.000095	-.001111	.000417
Commodity prices	-.000006	-.000122	-.001023	-.00078
Share prices	.000211	-.000129	-.000139	.000417
NEER	.000303	-.000119	.000181	.000411
Yield curve	-.000074	.000036	.000008	-.000079
FBY diff.	-.000332	.000134	.000565	-.000414
Yield gap	-.000318	.000301	.000834	.000006

As regards the impulse responses in table 15 and figure 9, these show a cyclical effect of a shock to money on inflation, positive for two periods and then negative for two periods. A similar behaviour can be found in the interbank rate, share prices exchange rate and GNP series. Inflation itself has a rather low degree of autocorrelation. Rising commodity prices tend to lead towards lower inflation, contradicting its leading indicator role for inflation. A shock to the yield curve and the yield gap create identically timed cyclical changes in the inflation rate. As regards output, again, money growth produces a response of output growth that has a varying sign. The direction of the short rate and share prices effect is again the same as that of money growth. A slowing-down of inflation will lead most of the time towards higher output growth. Innovations to commodity prices seem to have negative output effects, in line with the intermediate goods' costs effect on output. Against all odds, positive shocks to the yield curve have negative effects on GNP growth in th long run and deviations to the foreign bond yield differential produce positive output effects most of the time. With respect to the exchange rate, the effect depends upon the horizon considered, but is mostly positive, indicating that a depreciation of the DEM will have a positive output effect in the long run. Perhaps, we should not pay too much attention to these last results because the innovations show offsetting behaviour and a regression towards zero. They neither enable us to draw economically important conclusions.

A final check of the robustness of the VAR-results was to split the sample and examine alternative sets of variables. The first subsample covered the floating exchange rate period (1973:1 to 1994:4) and the second covered the period of relative monetary stability in Europe with the EMS (1980:1 to 1994:4). Overall, the alternative time periods support the basic results for inflation variability and changes in output. However, real money no longer is significant in the inflation equation, whereas share prices and the foreign bond yield

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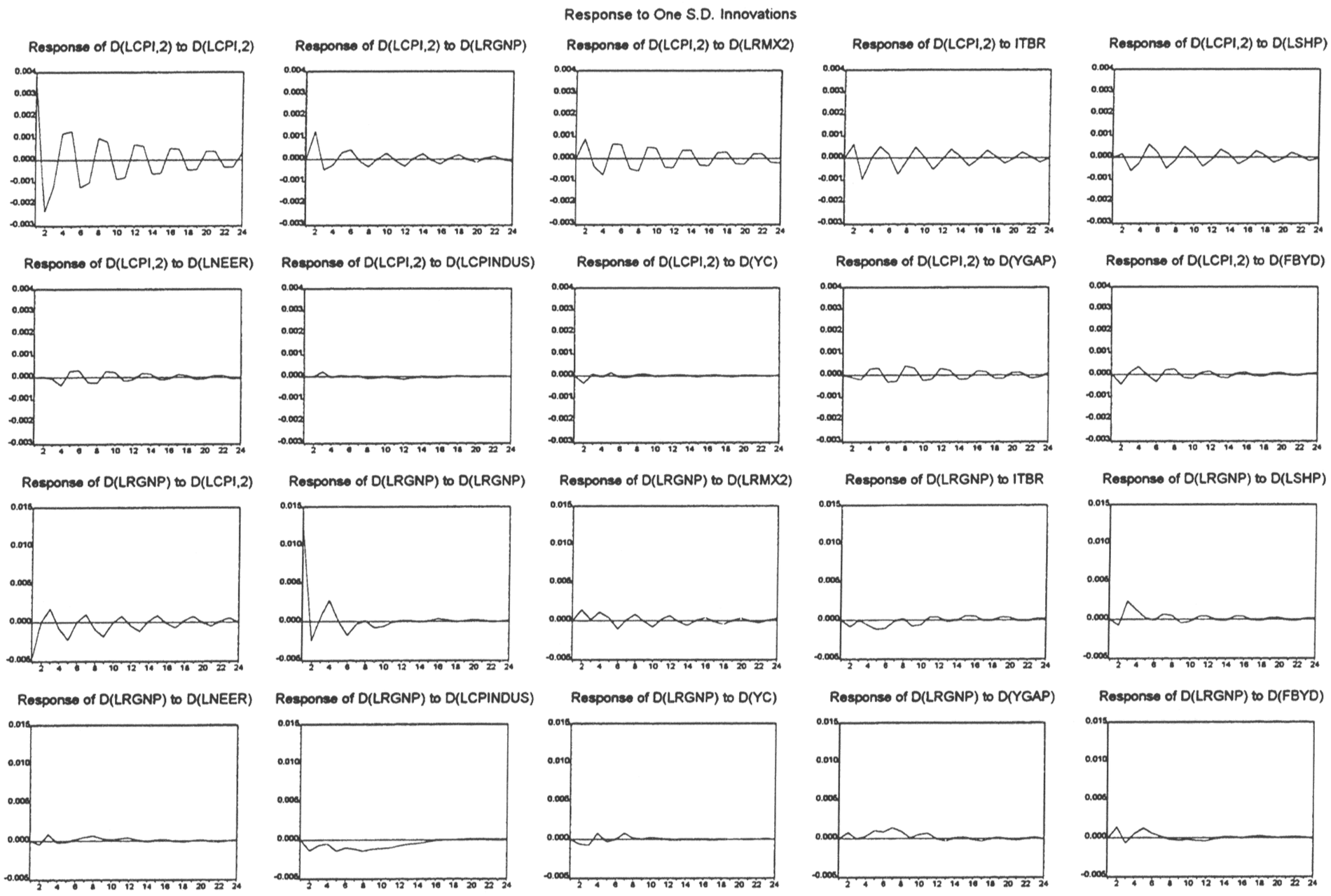
[6] A well-known problem is that the ordering used in this decomposition is triangular and that it is arbitrary. We therefore computed results with alternative ordering of the variables. The precise ordering appeared to have little influence on the results.

differential become significant in the 1973-94 period and 1980-94 period resp. The yield curve does not contribute significantly in explaining output fluctuations over the two subsamples. Changes in inflation, the yield gap and the interbank rate have a significantly negative influence on output fluctuations over both subsamples. Additionally, the foreign bond yield differential enters significantly in the 1980-94 subsample.

Figure 9 : Response of inflation and output growth to one st.dev. innovation of the variables



We also considered three alternative sets of variables. First, because there is some debate about the presence of a unit root in inflation (Webb 1994), we estimated the model using the inflation rate rather than its first difference. Second, we replaced the GNP with industrial production as an alternative measure of real economic activity. Third, we introduced narrow money instead of broad money in the models. Generally, these alternative variables support the basic results for inflation and real growth. Noteworthy however is the fact that in models with industrial production and inflation, only the interbank rate is significant in explaining inflation [period 1980-94] and output growth [all sample periods] and real money ceases to be significant [except for the combination of period 1962-94 with the change in the inflation rate and industrial production as relevant variables]. Broader money aggregates remain significant in either subsample and under either of the other specifications [using inflation and/or industrial production].

We can also compare our VAR-results with those of Davis & Henry (1994) for Germany and the U.K. There are however some differences, as mentioned sub 4.D. They find that the spreads are significant in virtually all the equations and that standard statistical tests are highly satisfactory. The variance decomposition shows a strong effect of the bank bond spread on prices and output and an effect of the other spreads that is smaller but comparable to money. This contrasts sharply with our results in which out of the financial variables only share prices were significant in the VAR and to a lesser degree in the variance decomposition. This result can be explained by the specification and inclusion of other variables in the VAR.

4.D. Cointegration.

Next, we examine cointegration of the series. An analysis incorporating long run equilibrium relations may be of more relevance than simple regression analysis, since information concerning longer run equilibrium relationships which may exert an important influence on the price level and output is being discarded. Confining

attention to short run dynamics may give a partial and misleading picture as Davis & Fagan (1995) also point out.

The components of a vector are said to be cointegrated if (1) all components are integrated of the same order and (2) there exists a linear combination that is integrated of a lower order. This linear combination represents the long-term equilibrium relationship among the cointegrating variables. Deviations from this equilibrium can occur, but are temporary, as there is a tendency to adjust toward the long-term relationship. Table 11 provided information on the order of integration of the individual series.

The method of analysis for cointegration employed here is that of Johansen (1991). In brief, the Johansen procedure of testing for cointegration begins with the definition of a general polynomial distributed lag model of a vector of variables X such as:

$$X_t = \Pi_t X_{t-1} + \cdots + \Pi_k X_{t-k} + e_t \qquad t=1,\ldots,T \qquad (1)$$

where X_t is the vector of the N variables of interest,
Π_i are NxN coefficient matrices
e_t is the i.i.d.N-dimensional vector with zero mean.

Equation (1) can be reparametrized into an ECM of the form:

$$\Delta X_t = \Gamma_i \Delta X_{t-1} + \cdots + \Gamma_{k-1} \Delta_k X_{t-k+1} + \Pi X_{t-k} + e_t \qquad (2)$$

where $\Pi = -I + \Pi_1 + \ldots + \Pi_i$, i=1...k.

The equilibrium matrix Π represents the long run response matrix and the rank of this matrix determines the number of cointegrating vectors. Writing the long run response matrix as $\Pi=\alpha\beta'$ where the rows of β form the r distinct cointegrating vectors and α represent the loading coefficients, then the linear combinations $\beta' X_{t-k}$ will be I(0) if there is cointegration (Spyrou 1996).

- If the rank of the matrix Π, r, is zero, then all the variables are I(1) and there are no cointegrating vectors.
- If r=N all the variables are I(0) and there are N cointegrating vectors.
- If 0<r<N, there will be r cointegrating vector or equivalently, N-r common stochastic trends.

Table 16 contains the results of the Johansen cointegration tests for a VAR with lag length 1 with the assumption of a linear deterministic trend in the data. Lag length 1 is optimal according to AIC and SC (see appendix table A3).

Table 16 : Johansen cointegration test

Sample : 1962:2 1994:4
Test assumption : linear deterministic trend in the data (constant, no trend)
Series : Δ(logCPI) Δ(logRM2) LogRGNP LogCP ITBR FBYD YGAP YC LogSHP LogNEER

Eigenvalue	Likelihood ratio	5 percent critical value	1 percent critical value	Hypothesized number of CEs
0.677	477.7	233.1	247.2	None **
0.587	329.5	192.9	205.9	At most 1 **
0.456	213.8	156.0	168.4	At most 2 **
0.313	134.2	124.2	133.6	At most 3 *
0.225	84.9	94.2	103.2	At most 4
0.143	51.5	68.5	76.1	At most 5
0.112	31.2	47.2	54.5	At most 6
0.066	15.6	29.7	35.7	At most 7
0.041	6.6	15.4	20.0	At most 8
0.008	1.1	3.7	6.7	At most 9

* (**) denotes rejection of the hypothesis at 5 % (1 %) significance level
L.R. test indicates 4 cointegration equations at 5 % significance level

The four significant cointegrating equations yielded the cointegrating coefficients as tabulated in table 17.

Table 17 : Cointegrating coefficients : 4 CEs.

Δ(logCPI)	Log RGNP	Δ(log RM2)	ITBR	LogNEER	LogSHP	Log CPINDUS	YGAP	YC_CAL	FBYD	C
Unnormalized cointegrating coefficients : 4 CEs										
-18.7	0.41	0.58	-0.12	-0.43	-0.15	0.12	-0.14	-0.12	0.01	
5.21	-0.11	-5.49	-0.14	-0.49	0.20	0.15	-0.14	-0.13	-0.002	
-20.9	0.21	-6.08	0.15	1.00	-0.38	-0.43	0.14	0.16	0.03	
-1.62	0.52	0.20	-0.03	-0.58	0.13	-0.10	-0.03	0.01	-0.02	
Normalized cointegrating coefficients : 4 CEs										
1	0	0	0	-0.0228*	0.0179*	-0.0017	0.0013*	0.0021*	-0.0018*	0.032
				(0.012)	(0.005)	(0.007)	(0.0007)	(0.001)	(0.0005)	
0	1	0	0	-0.942	0.263	-0.306	0.0096	0.101*	-0.047*	-19.4
				(0.58)	(0.22)	(0.34)	(0.03)	(0.04)	(0.02)	
0	0	1	0	-0.017	-0.007	0.023*	-0.0008	-0.003*	-0.0005	-0.011
				(0.02)	(0.009)	(0.014)	(0.0013)	(0.0018)	(0.001)	
0	0	0	1	4.03*	-0.68*	-1.78*	1.06*	1.07*	-0.0001	-7.32
				(0.77)	(0.30)	(0.44)	(0.04)	(0.06)	(0.03)	

Note : Standard errors in parentheses. * indicates significance at the 10% level

Cointegrated variables have an error-corrrection representation, in which the error-correction terms are based on the cointegration vectors. The error-correction model decribes a proces by which equilibrium errors are eliminated. In fact, the residuals lagged one period of the cointegrating vectors are included in the error-correction model. Table 17 presents evidence of a vector error correction model with four cointegrating vectors included.

Table 18 : Vector error correction model (1960:94, order one)

	Inflation	Real GNP	Real M0	Interbank rate	NEER	Share prices	Commodity prices	Yield gap	Yield curve	FBY diff.
CE 1	(-) ***	(+) ***	(-) ***					(-) ***		
CE 2	(+) ***			(+) ***				(+) **	(-) **	
CE 3	(+) ***		(-) ***	(-) **					(+) *	
CE 4	(-) *			(-) ***				(+) *	(-) *	
Inflation	(+) ***	(-) ***		(+) *		(+) **	(+) *			
Real GNP	(+) *	(-) *								
Real M2				(+) ***			(+) **			
Interbank rate	(+) ***			(+) ***		(-) *		(-) *	(-) ***	
NEER					(+) *	(-) *	(+) *			
Share prices	(+) ***	(-) *		(+) *		(+) *		(–) ***	(+) **	
Commodity prices				(+) **			(+) ***	(-) **		
Yield gap										
Yield curve										
FBY diff.	(-) *				(+) ***		(+) **	(+) **		
Constant	(-) *	(+) ***			(+) ***			(+) **		
R^2 adj.	0.70	0.26	0.66	0.53	0.08	0.18	0.25	0.41	0.22	0.05

Notes : Table reports the sign and statistical significance of the coefficients for each variable.
Coefficients significant at *** : 1 % ; ** : 5 % ; * : 10 %.

The results shown in table 17, though tentative, are encouraging. The cointegrating vectors appear strongly in several of the equations, as do the auction price variables. The conclusion is that auction prices have strong explanatory power when cointegrating relations are taken into account in a VECM framework and that their influence is mostly consistent with our theoretical expectations. Looking more closely at the inflation and growth equation, several remarkable points arise. Inflation seems to be largely a self-fulfulling process: when inflation is rising, it will keep rising, and when it is falling, it will tend to keep falling. A rise of the short term interest rate (interbank rate) is followed by rising inflation, possibly following the raised official rates when inflationary pressure is emerging. The sign of share prices in the inflation and growth equation is against our expectations. The positive sign in the inflation equation can be rationalized in the sense that shares are good

inflation hedges (when inflation rises, share prices rise, and thus, anticipating inflationary presssure, shares may start rising). This negative influence of share prices on future inflation and real growth must be tempered somewhat by noting that this variable significantly enters in the error correction forms and offsets this effect indirectly. The foreign bond yield differential enters negatively in the inflation equation, meaning that rising long term interest rates relative to the US lead to lower future inflation. This behavior is consistent with our explanation of short-term interest rates having a positive consequence for inflation, due to monetary policy actions. As these actions are credible, this will lead to a fighting of inflation. Long term interest rates, being a weighted average of short term rates over its maturity (cfr. the term structure hypothesis), anticipate that inflation will go down, as short rates will do, and therefore temporary rises of these rates are followed by declining inflation rates.

We can compare our result with that of Davis & Henry (1994) for Germany and the UK. They used a different sample (1974.2-1992.2) and included other variables as well (the current account balance [in % of GDP], the public sector deficit [in % of GDP], and the bank bond spread). The Johansen procedure indicated the presence of only one cointegrating vector against four in our case. Moreover, the vector was significant in the inflation and real exchange rate equation but not so in the output growth and in the interest rate equation. In addition, the yield curve and bank bond spread proved to be directly significant in the inflation and output equation, contrary to our result, in which the yield curve is significant only through the effect of the cointegration vectors. Interestingly, the R^2 's are of the same order of magnitude although different variables are used in the estimation.

We can further assess the information content of asset prices for the business cycle by investigating the impulse response functions and variance decomposition. Figures 10 to 13 present these results graphically.

Figure 10 : Variance decomposition of inflation differentials.

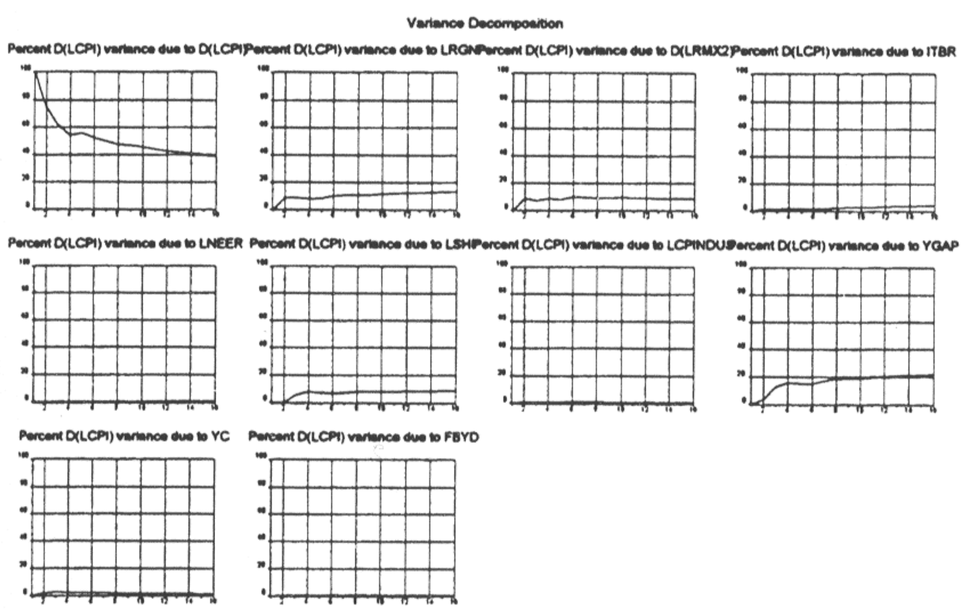
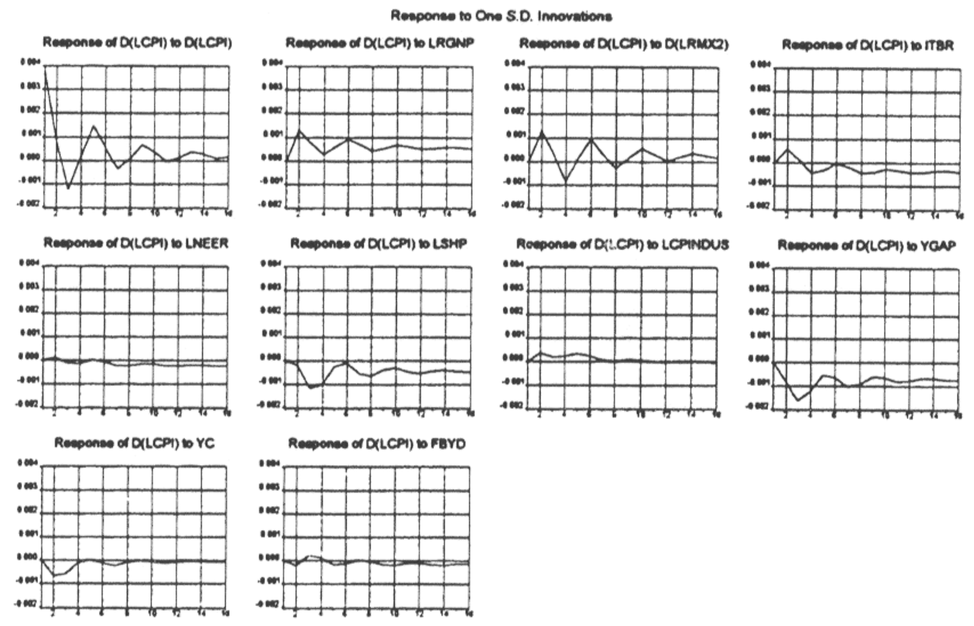


Figure 11: Impulse response function of inflation



As can be seen from figure 10, a large portion of the inflation behavior is self-explanatory. Up to 20% can be explained by the yield gap. Also real growth, money growth and share prices contribute significantly in the variance decomposition, to over 10%. From figure 11, we learn that the yield gap exerts a negative influence on inflation, as was postulated. Better corporate performance does not result in inflation but in better income statements (see figure 10). Our story about policy-induced interest rate movements is confirmed by the impulse response behavior. Shortly after interest rates are raised, inflation is rising too, as foreseen by policymakers, but it quickly declines afterwards, as policy is effectively combatting inflation. An innovation to share prices displays a negative overall impact on inflation, consistent with the lower inflation risk in higher prices. Movements in industrial commodity prices trigger a rise in inflation up to six quarters, confirming our cost-induced inflation hypothesis. The effect of money is generally positive, whereas the effect of the yield curve on inflation is more moderate and negative for four periods only, indicating that a better economic outlook does not fuel the inflation rate.

Regarding the variance decomposition of real growth, figures 12 and 13 reveal that real growth is also to a high degree self-explaining. To a lesser degree, also the interest rate, inflation, effective exchange rate, industrial commodity prices and foreign bond yield differential affect the real growth significantly negative (explaining about 20 to 10% of the variance), whereas the yield curve, yield gap and share prices exert a positive influence on real economic activity (by contributing in the variance decomposition about 5 to 10%). We clearly see that money growth does not add much to the variance decomposition and its innovation has neither much of an effect on real growth (only an increase of 50 basis points after 16 quarters [expressing its effect on a yearly basis]).

Concluding, these cointegration results and the therefrom derived variance decomposition and impulse response functions are both statistically and economically plausible and are acceptable fittings of the data. Moreover, from an econometric point of view, it is the most preferred technique by its virtue of capturing both common long run comovements and short run anomalous and divergent developments. When drawing a general conclusion about the usefulness of financial variables for business cycle forecasting, we would therefore tend to emphasize these last set of results most heavily.

Figure 12 : Variance decomposition of real growth

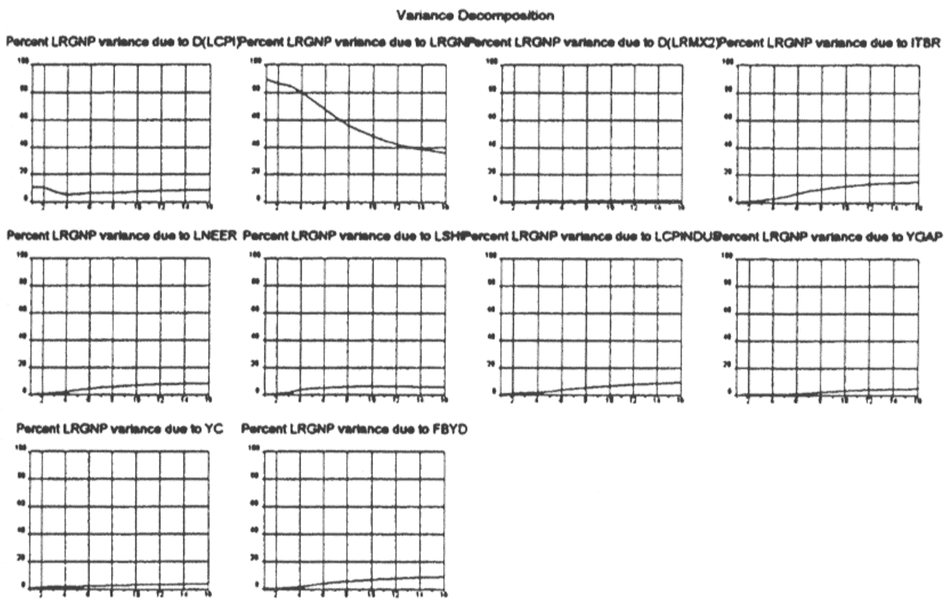
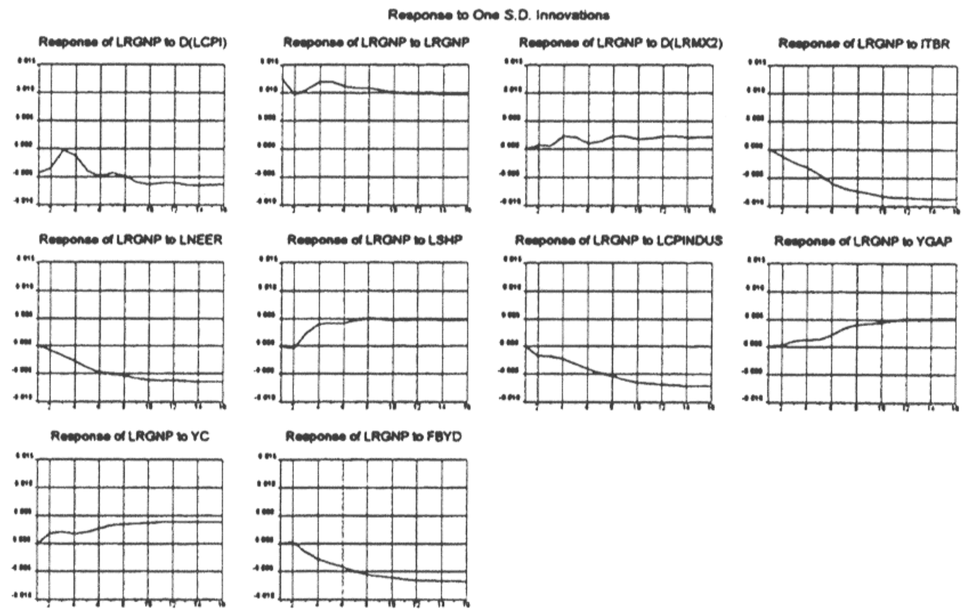


Figure 13: Impulse response function of real growth



5. Conclusion.

This paper has examined the usefulnes of financial variables for forecasting future values of inflation and output growth for Germany. The evidence obtained is mixed. Table 19 presents a summary of the results.

Table 19 : Summary results.

	Inflation						Output					
	Probit		Regression		VAR	VECM*	Probit		Regression		VAR	VECM*
	S	M	S	M			S	M	S	M		
Money			+		+	+			+			
Interest rates	++	++	++	++	+	+	±	++	+		+	++
Exchange rate			+									++
Share prices			+		+	+		±+	+		+	++
Commodity prices	+	±	+				+	+				++
Yield gap	++	±	++			+	±	+±	+			++
Yield curve	+	+		+			±	±	+	+		++
FBY diff.		+				+	+					++

Note : S : single variable analysis; M : multivariate analysis.
+, ++ : significant, resp. very significant explanatory variable, ± : sign reversals, but significant explanatory variables.
* : based jointly on regression estimates and variance decomposition and impulse response function coefficients

Depending upon the technique, we arrive at different conclusions. On the basis of probit analysis, it appears that some of the variables are indeed tightly correlated with future inflation and output evolution. Based on bivariate regression analysis, we get similar results. However, once additional variables are included in the regression analysis (see multivariate F-tests), these estimated relations appear to be weak. Besides interest rates, only the yield curve is shown to be a consistent predictor of future inflation and output growth. It is also notable that spread variables and auction prices are generally outperformed by a more traditional monetary indicator such as short-term interest rates. These conclusions appear to be robust and hold when one applies VAR models. Noteworthy is the high significance of share prices in the VAR and VECM which contrasts with its usefulness in regression and probit applications. Apparantly, stock prices seem to be more relevant when they are framed in the context of long run equilibrium relationships. The picture changes however when one looks at the results of the VECM. All financial indicators are contributing significantly in predicting output growth, whether directly via the variable's coefficient in the output equation or indirectly via the cointegrating vector or via its contribution in the variance decomposition and a satisfactory high coefficient in the impulse response. Regarding the inflation equation, besides money growth and interest rates, also share prices, the foreign bond yield differential and the yield gap add some value in its explanation.

What is the most preferable technique? The answer somewhat depends upon what one wants to study. Probit is useful for forecasting the chance of going into a recession ot inflationary regime, but does not account for the severity of the cycle. Regressions do take into account the size of the business cycle effects, but generally suffer from statistical deficiencies. These difficulties are resolved by VAR and VECM which –at least in the case of Germany as described here – provides an acceptable description of the economy.

As noted by Davis & Fagan (1995), this evidence does not rule out the possibility that spread variables or auction prices can acquire more predictive value in the future (for Europe) as financial integration and the EMU process will be completed and if securitisation of EU markets increases.

Appendix :

- **Probit results for recessions, period 1973-1994.**
- **Statistical characteristics of the macro and financial variables.**
- **Determination of the order of the VECM and VAR.**
- **VAR and VECM regression diagnostic figures for the inflation and GNP growth equations.**
- **Explanation of some summary statistics.**

Table A1 contains the results for in-sample prediction of recession k quarters ahead for models with one variable only for the period 1973-1994. At all horizons, the yield curve clearly outperforms traditional monetary aggregates. Nominal and broad monetary aggregates perform very weakly. Real and narrow money is somewhat more effective in predicting recessions. Neither the effective exchange rate nor the foreign bond yield differential have much predictive power for forecasting recessions. The short-term call rate signals recessions effectively with higher rates indicating a higher probability of recession. The yield gap and bond yield perform second best on intermediate horizons. The yield curve however, does a better job (with higher R^2) than its components, meaning that it has some value added. The sign indicates that the higher the yield curve spread, the lower the chance is of getting into a recession, as was expected. Lagged GNP growth only has significant predictive power up to 3 quarters. Share prices only succesfully indicate recessions at quarter 2, 4 and 5. Commodity prices (in levels or first differenced) neither seem to have significant effects of predicting recessions. Because of these poor significance levels, we do not explore the opportunities of multivariate probit analyses.

Our results for forecasting recessions are in line with those of Estrella & Mishkin (1995 a) for Germany. They use a quarterly sample from 1973 to 1994 and found a very significant relationship between recession and yield curve lagged one year, with an R^2 of 57.7%. Comparing our results with those of Estrella & Mishkin (1995 b) for the US (1959.1-1995.1) yields similar conclusions, although for Germany, we find that there is little to be gained from multivariate probit analysis, as opposed to the US, where a combination of yield curve and stock prices does dominate any other forecasting model.

Table A1 : Measures of fit and t-stats for recession probit models - variables by themselves

Recessions = 1 : 1973-1994		k = quarters ahead							
Variable		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
d(SHPR)	t-stat	-1.46	-2.15	-1.76	-2.27	-2.15	-0.94	-0.08	0.50
	R^2	2.5%	5.5%	3.5%	5.9%	5.3%	1.0%	0.0%	0.3%
CP	t-stat	1.82	1.84	1.74	1.58	1.35	1.04	0.82	0.65
	R^2	3.9%	4.1%	3.7%	3.0%	2.1%	1.3%	0.8%	0.5%
d(CP)	t-stat	-0.66	-0.19	0.10	0.44	0.95	0.74	0.62	0.22
	R^2	0.5%	0.0%	0.0%	0.2%	1.0%	0.6%	0.4%	0.1%
d(NEER)	t-stat	-0.46	0.03	0.12	0.47	0.47	0.47	0.69	-1.20
	R^2	0.2%	0.0%	0.0%	0.2%	0.3%	0.3%	0.5%	1.7%
YC_CAL	t-stat	-5.37	-5.36	-5.30	-5.31	-4.76	-4.04	-3.15	-2.11
	R^2	52.7%	58.8%	56.1%	46.9%	30.6%	20.4%	11.8%	5.1%
YGAP	t-stat	-2.49	-2.96	-2.95	-3.06	-2.83	-2.27	-1.45	-0.55
	R^2	7.3%	10.5%	10.3%	10.9%	9.3%	5.9%	2.4%	0.3%
FBYD	t-stat	1.45	1.67	1.80	1.74	1.59	1.38	1.00	0.52
	R^2	2.4%	3.2%	3.7%	3.5%	2.9%	2.2%	1.1%	0.3%
GBY	t-stat	2.68	2.71	2.74	2.51	2.20	1.55	0.72	-0.15
	R^2	8.5%	8.7%	8.8%	7.3%	5.6%	2.8%	0.6%	0.0%
ITBR	t-stat	4.97	5.27	5.33	4.95	4.39	3.51	2.42	1.28
	R^2	36.2%	42.1%	43.0%	35.0%	25.4%	14.7%	6.7%	1.9%
d(RGNP-1)	t-stat	-3.36	-2.35	-2.38	-1.64	-1.47	0.08	0.21	0.44
	R^2	14.1%	6.5%	6.6%	3.1%	2.5%	0.0%	0.0%	0.2%
d(M0)	t-stat	-0.66	-1.98	-1.85	-1.83	-0.71	-0.79	-0.95	-0.47
	R^2	0.5%	5.0%	4.2%	4.1%	0.6%	0.7%	1.0%	0.2%
d(RM0)	t-stat	-1.03	-2.18	-2.22	-2.23	-1.16	-1.07	-1.18	-0.63
	R^2	1.2%	6.1%	6.3%	6.3%	1.5%	1.3%	1.6%	0.5%
d(M1)	t-stat	-0.01	0.00	0.00	0.35	0.00	0.00	0.00	0.00
	R^2	0.0%	0.0%	0.0%	3.1%	0.0%	0.0%	0.0%	0.0%
d(RM1)	t-stat	-1.32	-0.39	-0.85	-1.02	-0.93	-0.93	-0.89	-0.35
	R^2	2.6%	0.2%	0.8%	1.1%	1.0%	0.9%	0.9%	0.1%
d(M2)	t-stat	-1.00	-0.67	-1.30	-0.65	0.17	0.62	0.30	0.61
	R^2	1.2%	0.5%	2.0%	0.5%	0.0%	0.4%	0.1%	0.4%
d(RM2)	t-stat	-1.29	-0.94	-1.66	-1.09	-0.31	0.25	0.00	0.37
	R^2	2.0%	1.0%	3.3%	1.4%	0.1%	0.1%	0.0%	0.2%

Note : Statistically significant at *** : 1 %, ** : 5 %, * : 10 %

Table A2 displays the correlation matrix for the state variables. The correlation matrices are computed for several different periods : part A covers the entire sample, part B covers the fixed exchange rate regime, part C covers the post-Bretton-Woods period and part D covers the EMS period. Ignoring the problem of overlapping observations, correlations greater in magnitude than 27% would be significant at the 5% level (two-tailed).

Table A2 : Correlation matrices for the economic and financial variables

Symbol	Inflation	Real GNP	Real M0	Interbank rate	NEER	ΔNEER	Share prices	Commodity prices	Yield gap	Yield curve
				A. 1960:1 - 1994:4						
Real GNP	-.500									
Real M0	-.413	.309								
Interbank rate	.477	-.289	-.256							
NEER	-.076	-.184	.043	.233						
ΔNEER	-.031	-.042	-.057	.044	.031					
Share prices	.016	.017	.045	-.127	.070	-.085				
Commodity prices	.161	.086	-.082	-.122	-.048	.099	-.122			
Yield gap	-.454	.185	.283	-.779	-.010	-.040	.381	.069		
Yield curve	-.218	.222	.132	-.798	-.511	-.027	.076	.101	.370	
FBY diff.	.140	.083	.410	.011	-.627	.040	-.181	.090	-.111	.171
				B. 1960:1 - 1972:4						
Real GNP	-.559									
Real M0	-.527	.574								
Interbank rate	.373	-.116	-.268							
NEER	.433	.039	.131	.579						
ΔNEER	.090	.036	.011	.164	.306					
Share prices	.057	.057	.095	-.181	-.021	.154				
Commodity prices	.399	.032	-.114	.019	.313	-.099	.022			
Yield gap	-.213	.104	.161	-.759	-.576	-.116	.500	-.153		
Yield curve	-.188	-.101	.104	-.825	-.419	-.150	.290	.059	.544	
FBY diff.	.046	-.313	-.242	-.013	-.345	-.408	-.210	-.003	-.197	.107
				C. 1973:1 - 1994:4						
Real GNP	-.461									
Real M0	-.387	.215								
Interbank rate	.528	-.321	-.245							
NEER	-.471	.037	.220	-.162						
ΔNEER	-.080	-.047	-.062	-.016	-.166					
Share prices	-.011	.014	.037	-.145	.049	-.162				
Commodity prices	.115	.124	-.078	-.155	-.146	.127	-.159			
Yield gap	-.543	.187	.300	-.776	.435	-.005	.377	.104		
Yield curve	-.218	.292	.120	-.764	-.322	.055	.047	.125	.277	
FBY diff.	.299	-.019	.034	.311	-.213	.195	-.189	.129	-.306	-.168
				D. 1980:1 - 1994:4						
Real GNP	-0.545									
Real M0	-0.428	0.245								
Interbank rate	0.657	-0.319	-0.246							
NEER	-0.298	0.143	0.346	-0.333						
ΔNEER	-0.332	0.0095	0.223	0.002	0.147					
Share prices	0.004	0.075	-0.039	-0.132	-0.1276	-0.129				
Commodity prices	-0.139	-0.031	0.134	-0.389	0.257	-0.106	0.001			
Yield gap	-0.586	0.192	0.2695	-0.813	0.467	0.104	0.362	0.373		
Yield curve	-0.52	0.369	0.164	-0.777	-0.073	-0.024	0.05	0.234	0.365	
FBY diff.	0.008	0.053	0.231	0.134	0.809	0.119	-0.134	0.022	0.07	-0.439

Table A3 displays the mean, standard deviation and autocorrelations for the state variables computed over the entire sample period, 1962:2-1994:4. The variables generally display mild autocorrelations. Inflation and GNP growth have seasonals at the 4-quarter lag. This autocorrelation in the state variables may imply the existence of an errors-in-variables problem[7] that will bias estimates of the loadings of the inflation and real activity variables on these variables and will bias downward estimates of the statistical significance (Chen, Roll & Ross 1986). Using a VAR framework may help to solve this problem somehow.

Table A3 : Mean, standard deviation and autocorrelations of the economic variables (1960:1 - 1994:4)

Variable	Mean	St.dev.	ρ_1	ρ_2	ρ_3	ρ_4	ρ_5	ρ_6	ρ_7	ρ_8
Inflation	0.85%	0.65%	0.420	0.006	0.383	0.691	0.303	-0.027	0.202	0.486
Δ Inflation	0.000094	0.70%	-0.133	-0.682	0.047	0.608	-0.041	-0.494	-0.040	0.482
Real GNP	0.79%	1.63%	-0.020	-0.079	0.215	0.332	-0.082	0.045	0.047	0.013
Real M0	1.10%	2.01%	0.247	0.073	0.126	0.003	-0.131	-0.113	0.011	-0.090
Interbank rate	6.45%	2.59%	0.915	0.781	0.625	0.487	0.324	0.182	0.066	-0.010
Δ NEER	0.703%	1.83%	0.186	-0.066	0.135	-0.044	-0.117	-0.057	-0.012	0.013
Share prices	0.841%	7.35%	0.293	-0.072	0.011	-0.009	-0.144	-0.161	-0.076	-0.009
Commodity prices	0.858%	4.88%	0.395	0.276	0.216	0.087	-0.152	-0.146	-0.164	-0.253
Yield curve	1.66	1.73	0.877	0.736	0.575	0.405	0.281	0.164	0.096	0.035
Yield gap	-7.42	1.40	0.894	0.759	0.639	0.511	0.352	0.219	0.121	0.042
FBY Diff.	-0.30	2.33	0.973	0.938	0.903	0.862	0.817	0.782	0.752	0.723

Table A4 : Determination of the length of the vector error correction model.

	Inflation				Real GNP			
Lag length	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
AIC	-11.02	-10.98	**-11.05**	-10.99	**-8.43**	-8.31	-8.31	-8.38
SIC	**-10.69**	-10.43	-10.28	-9.997	**-8.10**	-7.76	-7.54	-7.39
LOGL	551.11	558.28	572.96	578.64	381.32	383.41	393.44	407.82
LR	14.36	29.36	11.36		4.18	20.07	28.75	

The LR test examines whether the order p+1 or p is acceptable for the data;
it is χ^2 distributed with degrees of freedom the number of restrictions imposed; $\chi^2_{5\%}(10)= 18.31$; $\chi^2_{1\%}(10)=23.21$

According to table A4, the optimal lag length according to the AIC and SC for the GNP equation is one, as for the inflation equation based on the SC. The LR test indicates that the order of the VECM can be reduced from 3 to 2 and from 2 to 1 for GNP and from 4 to 3 and 2 to 1 for inflation. We therefore conclude that an order of one might be acceptable to the data.

Table A5 : Determination of the length of the VAR model.

	Inflation				Real GNP			
Lag length	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
LOGL	500.64	540.89	562.80	565.29	367.57	379.39	384.47	405.10
AIC	-10.31	-10.78	**-10.96**	-10.84	-8.28	-8.31	-8.23	**-8.40**
SIC	-10.07	**-10.31**	-10.28	-9.94	**-8.04**	-7.85	-7.55	-7.50
Likelihood ratio test °	80.50 ***	43.83 ***	4.97	-	23.65 ***	10.15	41.27 ***	-
LM 1	1.52	18.92 ***	0.27	9.48 ***	0.29	2.88 *	0.61	0.45
LM 2	25.52 ***	19.43 ***	0.45	11.06 ***	1.94	3.12	8.92 ***	13.72 ***
LM 3	25.92 ***	22.41 ***	1.70	14.79 ***	7.39 *	5.13	9.52 ***	14.01 ***
LM 4	34.32 ***	23.48 ***	4.90	16.31 ***	20.83 ***	14.99 ***	17.74 ***	14.25 ***
ARCH (4 lags)	8.27 *	1.19	1.74	1.21	10.48 **	5.18	4.53	5.06
Jarque Bera	1.97	2.10	2.97	2.99	22.56 ***	4.50 *	1.78	18.46

° The LR test examines whether the order p+1 or p is acceptable for the data;
it is χ^2 distributed with degrees of freedom the number of restrictions imposed; $\chi^2_{5\%}(10)= 18.31$; $\chi^2_{1\%}(10)=23.21$

For the VAR, the optimal lag length is not unambiguously determined here. Table A5 shows that minimization of the AIC and SC point towards different lag lengths being optimal : 4 vs 1 for GNP and 3 vs 2 for inflation. The likelihood ratio test gives mixed results as of 3 lags being needed for inflation and 4 for GNP. As inflation is voiced more often as the major concern for monetary policymakers, we choose a VAR(3).

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7 As the general impact of a failure adeqately to filter out the expected movements in an independent variable is to introduce an errors-in-variables problem.

Figure A1 : VAR (3) results for Germany 1960:1 - 1994:4

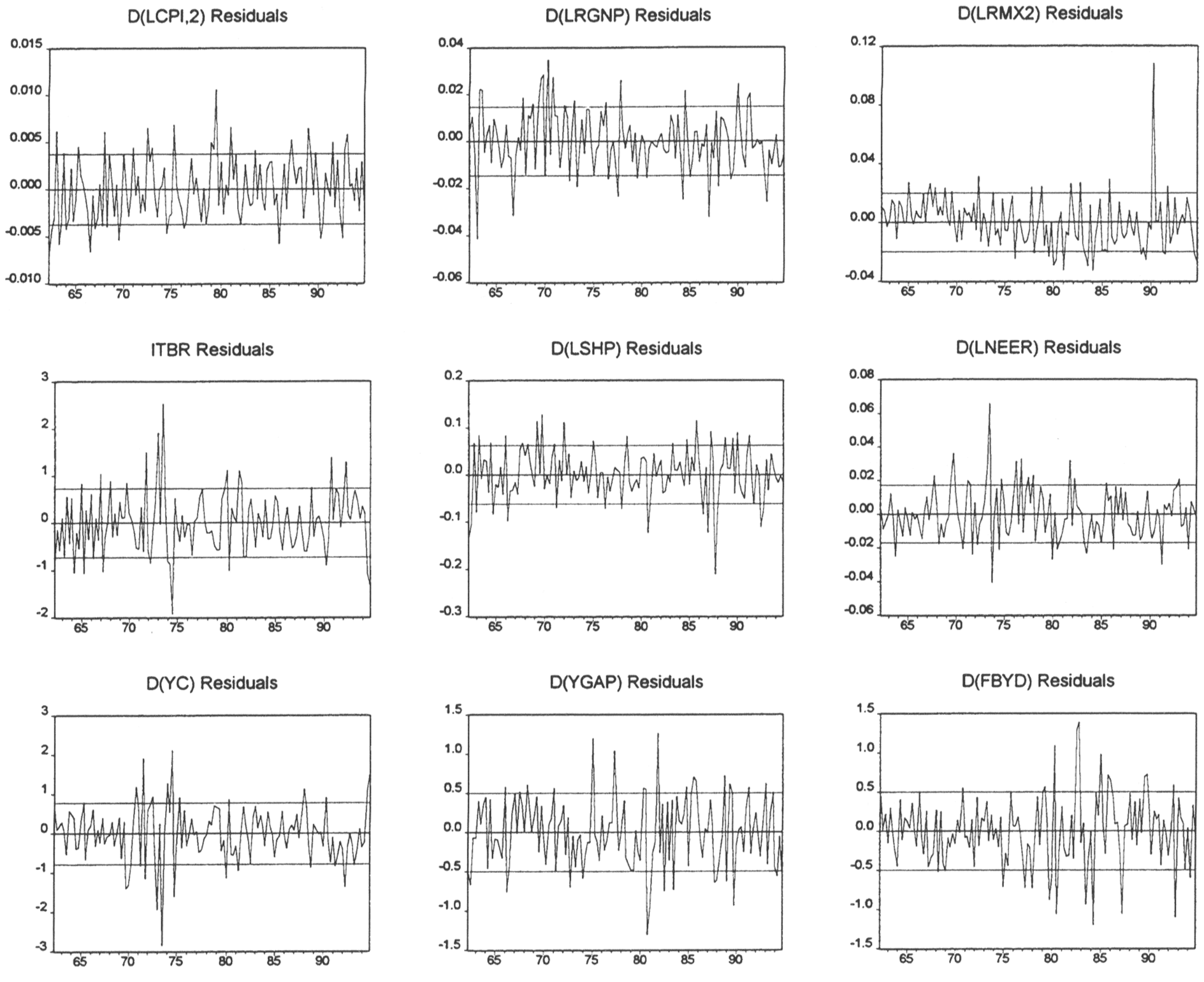


Figure A2 : Graphical results for the inflation change equation in the VAR(3).

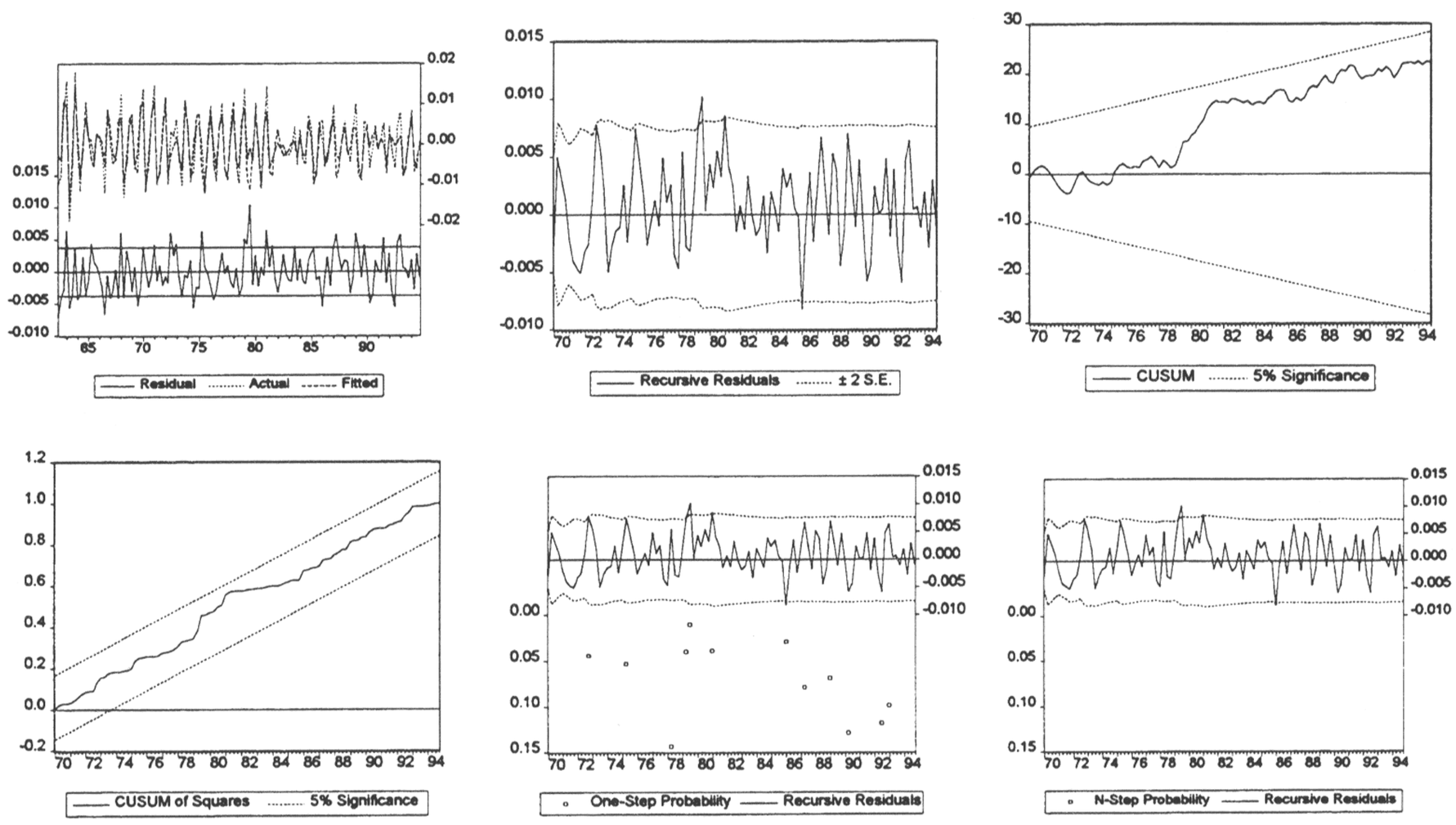


Figure A3 : Recursive residuals for the inflation change equation (*) in the VAR(3).

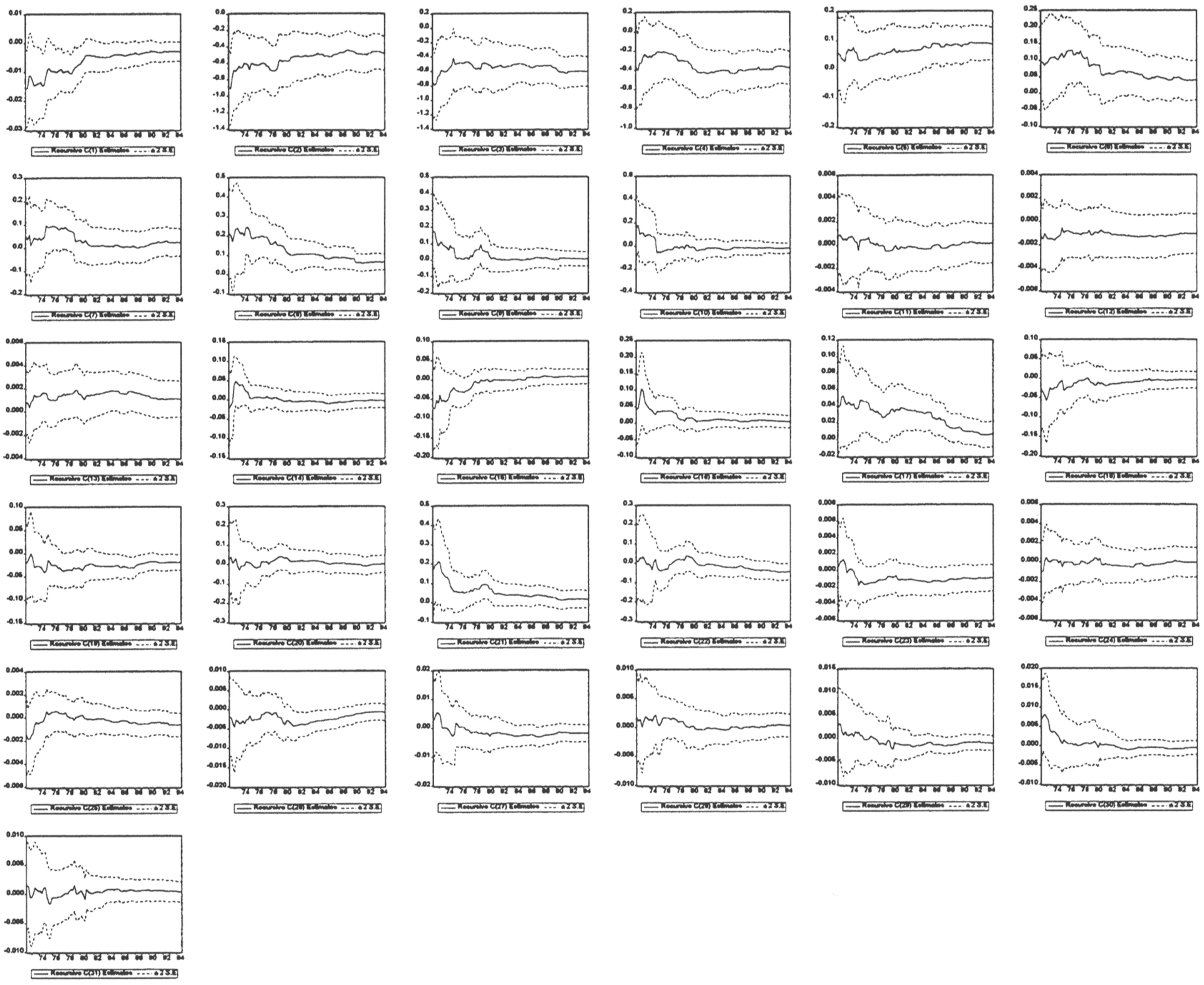


Figure A4 : Graphical results for the real GNP growth equation in the VAR(3).

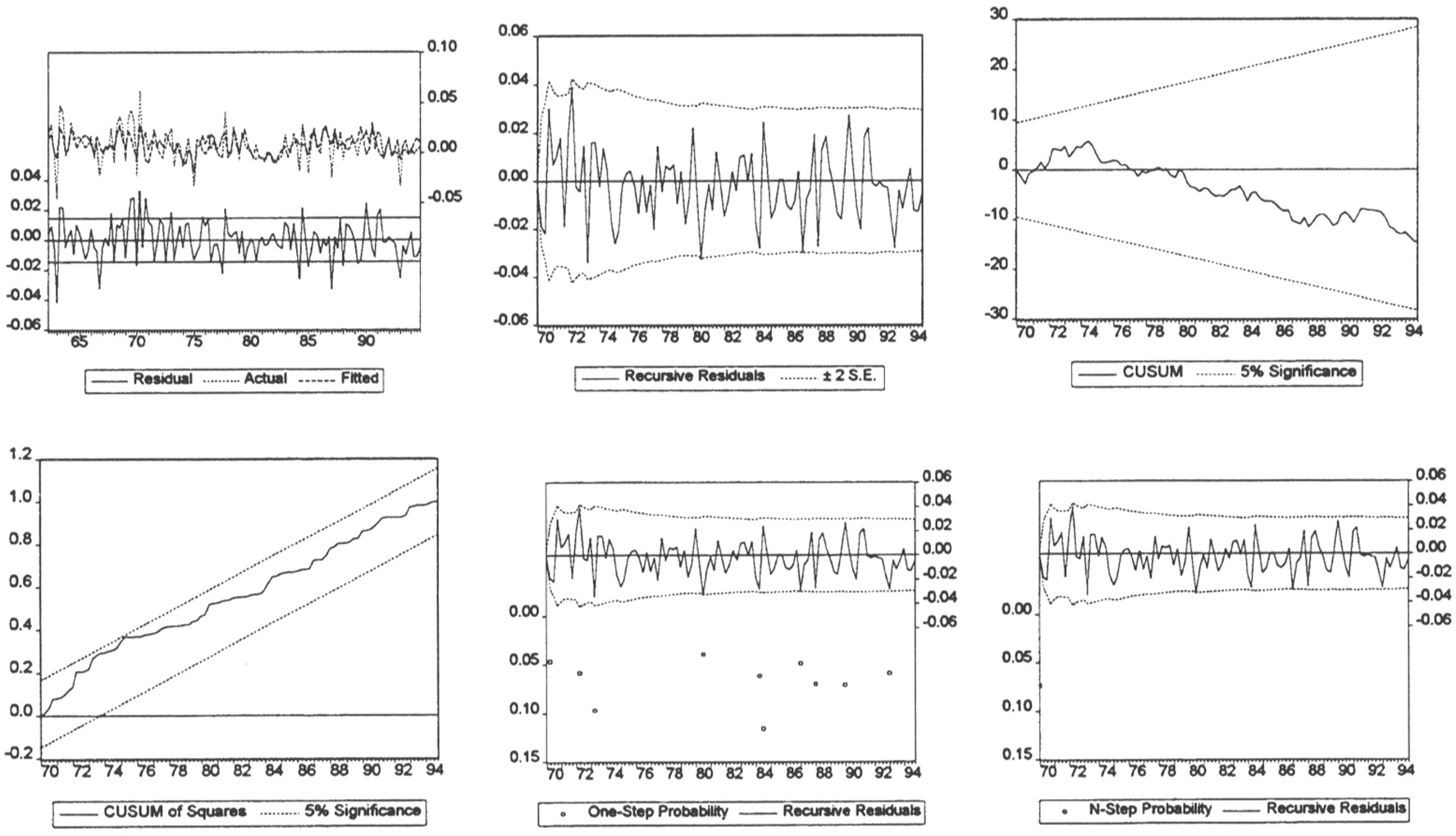
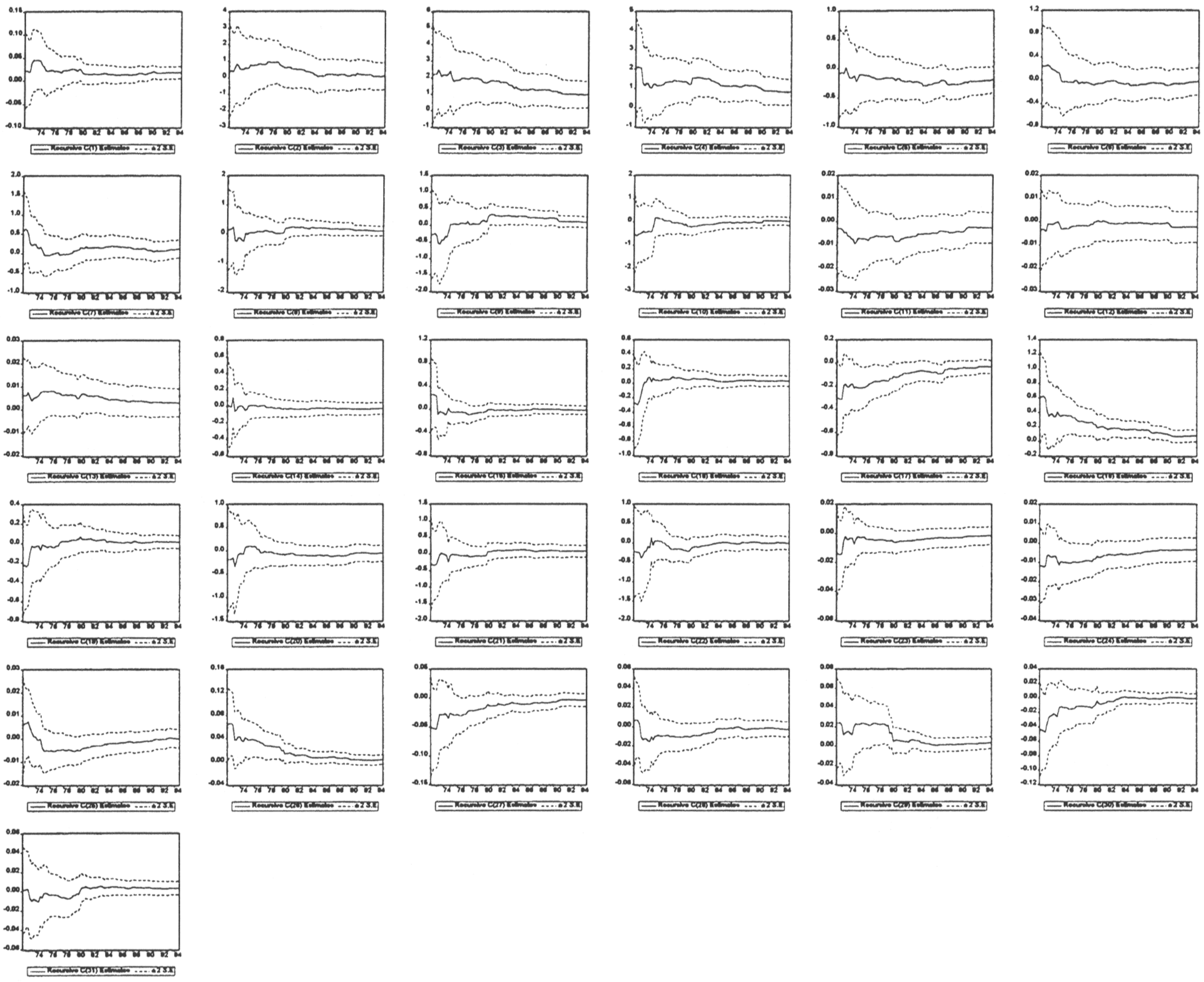


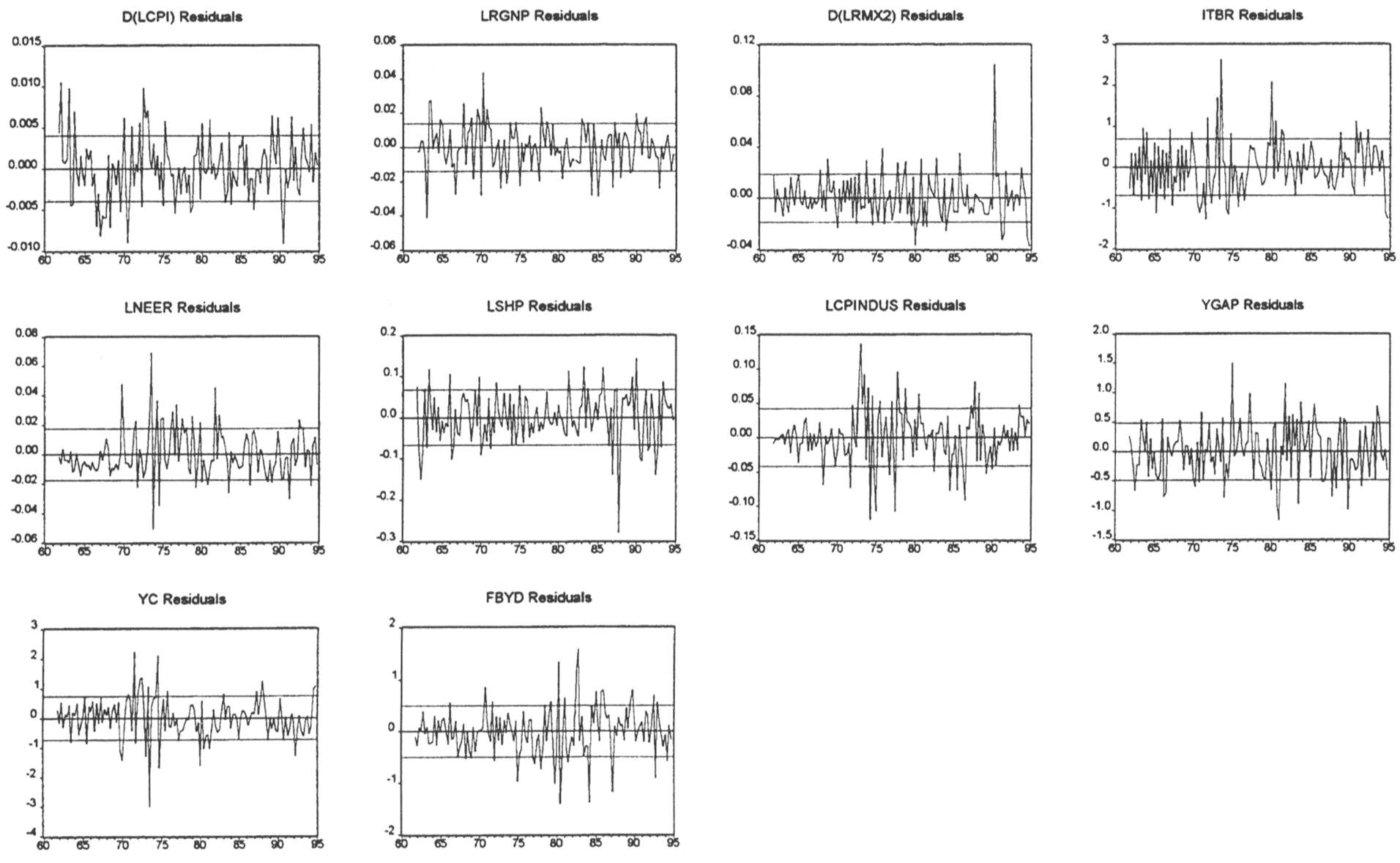
Figure A5 : Recursive residuals for the GNP growth equation (*) in the VAR(3)



(*) Note : Figures A3 and A5

c(1), c(2), c(3): refer to coefficients of Δ^2LCPI lagged 1, 2, 3 periods.
c(4) c(5), c(6):..... ...ΔLRGNP .....
c(7)c(8), c(9):..... ... ΔLRM2 .....
c(10)c(11), c(12):..... ... ITBR .....
c(13) c(14), c(15):..... ... ΔLSHP .....
c(16)c(17), c(18):..... ... ΔLNEER .....
c(19)c(20), c(21):..... ... ΔLCP .....
c(22)c(23), c(24):..... ... ΔYC .....
c(25)c(26), c(27):..... ... ΔYGAP .....
c(28)c(29), c(30):..... ... ΔFBYD .....
c(31) : refers to the constant.

Figure A6: VECM (order 1): residuals.



Explanation of some summary statistics.

- Serial correlation LM test (Breusch-Godfrey test)
  Test for order-p serial correlation. It is computed as $T*R^2$ from a regression including p lagged residuals.The statistic is χ^2_p distributed.
- ARCH LM test
  Test for heteroskedasticity of the error term. It is based on a regression of squared residuals on lagged squared residuals and computed as $TR^2 \sim \chi^2_{\#\text{ lagged squared residuals}}$.
- RAMSEY Reset test
  The test is based on an augmented regression : $Y=X\beta+Z\alpha+\varepsilon$. Z includes powers of the predicted values of the dependent variable. The output gives an F and a LR statistic that coefficients of the forecast vector Z are all zero.
- Jarque-Bera test
  This statistic tests whether a series is normally distributed and is given by $\frac{T-k}{6}\left[S^2+\frac{1}{4}(K-3)^2\right.$ where T is the number of observations, k is the number of regressors, S is skewness and K kurtosis. Under the null hypothesis of normality, the JB statistic is distributed χ^2 with 2 dergrees of freedom. Skewness is $S=\frac{\frac{1}{T}\sum(y_t-\bar{y})^3}{\sigma^3}$. It is zero for a smmetrical distribution and positive for if the upper tail of the distribution is thicker than the lower tail. Kurtosis is $K=\frac{\frac{1}{T}\sum_{t=1}^{T}(y_t-\bar{y})^4}{\sigma^4}$. The kurtosis of a normal distribution is 3. If the distribution has thicker tails than the normal distribution, its kurtosis will exceed 3.
- Recursive least squares
  The equation is estimated repeatedly using ever larger subsets of the sample data. If there are k coefficients to be estimated in the b-vector, then the first k observations are used to form the first estimate of b. The next observation is then added to the dataset and all k+1 observations are used to compute the second estimate of b. This proces is repeated until all the T sample points have been used, yielding T-k estimates of the b-vector.
  The forecast is $x_t'b_{t-1}$, the forecast error is $y_t - x_t'b_{t-1}$, the variance is $\sigma^2\left[1+x_t'\left(X'_{t-1}X'_{t-1}\right)^{-1}x_t\right]$.
- Recursive residual
  The recursive residual is defined as the one-step forecast error of a regression with the last estimate of b used to predict the next value of the independent variable. The recursive residual is defined as $w_t=\frac{y_t-x_t'b_{t-1}}{\sqrt{1+x_t'\left(X_{t-1}'X_{t-1}^t\right)^{-1}x_t}}$, t=k+1,..., T.
- Cusum test
  This test is based on the following statistic :
  $W_t=\frac{1}{s}\sum_{\tau=k+1}^{t}w_\tau$, with t=k+1, ..., T and s : SER fitted to all T observations.
  If b is constant from period to period, then $E[W_t]=0$. If b changes, W_t will tend to diverge from the zero mean value. Movement of W_t outside the 5% critical lines is suggestive of parameter instability.
- Cusum of squares test
  This test is based on the following statistic : $s_t=\frac{\sum_{k+1}^{t}w_\tau^2}{\sum_{k+1}^{T}w_\tau^2}$ with t=k+1, ...,T
  The mean value of this statistic under the hypothesis of parameter constancy is $E[s_t]=\frac{t-k}{T-k}$, which goes from zero for t=k to unity for t=T. Movements of s_t outside the critical lines is suggestive of parameter instability.
- One-step forecast test
  The one-step ahead forecast error can be compared with its standard deviation to test whether the value of the dependent variable at time t comes from the model fitted to all the data up to that point. The lower portion of the plot shows the probability values for those sample points where the parameter constancy hypothesis would be rejected.
- N-step forecast test
  This test carries out a sequence of Chow tests at all feasible dates starting with the smallest sample size.
- Recursive coefficients estimates
  Recursive coefficient estimates enables you to trace the evolution of any coefficent as more and more of the sample data are used in the estimation. If the coefficient displays significant variation as more data are added to the estimating equation, it is a strong indication of instability.

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