16 An Index of Leading Indicators on Inflationary Trends and the Business Cycle*

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1 Introduction

For central banks and other institutions or private professional forecasters it is important to have indicators which can reliably predict price and business cycle trends. For many purposes forecasting their level is probably less important than analysing the basic direction in terms of the trends of inflation and GDP growth and the turning points in their development. Ideally, a leading economic indicator should be able to identify and forecast lasting and substantial changes in the rate of inflation and GDP growth quickly and at an early stage.

To do this, a decision must first be taken on the relevant forecasting horizon. Although inflation is a monetary phenomenon (see the quantity theory and the P*-concept) over the long term, this relationship is supplemented and masked over the short to medium-term by a large number of other factors. It is particularly in phases of higher financial market volatility and economic changes that this period is of interest in monetary policy terms, especially if the adjustments to the long-term equilibrium occur only slowly. The potential influencing factors can be derived from the various inflation theories. Receiving timely notice of the prospective real direction of the economy in terms of growth rates of GDP in the medium-term (one to two years) is also important to a wide variety of decisionmakers (households, firms, policymakers). Here business cycle theories give us hints of the factors that should be included in such a program.

For these reasons, it is usually not possible to concentrate on a single indicator variable.[1] However, in order to facilitate its handling, an *index of leading economic indicators* derived in this way should not contain too many explanatory factors. At the time of the forecast, the partial indicators should ideally be available in order to ensure that the exogenous variables do not have to be forecast, too. In an analysis over a long sample, however, there is the problem that the empirical structures and relationships can change, thus making a *time-dependent* inflation and business cycle explanation necessary. It would be advantageous, therefore, to have an indicator which adjusts adequately to the

* I thank K.-H. Toedter from the economics department of the Deutsche Bundesbank for valuable comments.

[1] For a comparison of individual indicators with an index of leading economic indicators for the United States, see Roth (1991). The advantages of such an index for inflation forecasting in the case of Germany and the United States have been emphasised by Juchems et al. (1996) and Garner (1995), respectively.

current circumstances. Accordingly, the index should not consist of a constant set of indicators, but, instead, change in composition over time.

Below, I shall attempt to integrate the points discussed into a single approach. Firstly, the variables considered overall will be explained. In a second step, an inflation and business cycle index, the composition of which can change over time, will be constructed for a given time horizon. This will be followed by a critical evaluation of the index, paying particular attention to the respective partial indicators considered.

2 The Variables Considered

In order to construct an index of leading indicators, it is first of all necessary to determine the *partial indicators* which in principle may influence the relevant development. These variables have to satisfy several criteria. Firstly, there should be a theoretical connection with inflation and GDP growth. Secondly, the data should be available on a monthly basis for inflation in order to obtain a high frequency of inflation forecasts. For GDP I use quarterly data, because GDP is only available on a quarterly basis.[1] And, thirdly, the data should be available as early as possible (see Artis et al. 1995, pp. 1148 f.).

The indicators used can be divided into five groups (see tables 1 and 4): monetary aggregates (M1, M2, M3, central bank money stock), interest rate variables (money market interest rate, capital market interest rate, interest rate spread), price variables (price expectations, producer prices, commodities prices, import prices, external value of the Deutsche Mark, index of share prices), labour market variables (unemployment rate, trends in productivity, unit labour costs, negotiated wage rates) and other real economic variables (inflow of orders in the manufacturing sector and in the consumer goods sector, export expectations, business climate, net output, retail turnover, output gap, disposable income).[2] In general, these variables are then subjected to certain transformations in order to ensure stationarity.[3] Overall, there are 23 and 21 potential leading indicators for price trends and for the growth rate of GDP, respectively. The variables to be explained are the annual change in the consumer price index (even following German unification, this is based on the west German price index) and the annual growth rate of real GDP (with all-German data from the third quarter of 1990 onwards). It is true that the consumer price index shows larger fluctuations than, for example, an index which excludes energy or food and mineral products (see figure 1).[4] This is the index to which the public pays most attention, however, and it probably also plays the most important role in economic decisions and the measurement of purchasing power. In addition, the time series show

[1] For an attempt to use monthly data to predict quarterly output in the U.S. see Ingenito and Trehan (1996).

[2] The appropriateness of some of these variables as isolated indicators of the development of inflation has been examined, for example, by Artis et al. (1995), Boughton/Branson (1991), Engsted (1995), Issing (1994), Jorion/Mishkin (1991), Juchems et al. (1995), Papell (1994). For forecasting GDP growth see e.g. Bernard and Gerlach (1996), Goldman Sachs (1993). Composite Leading Indicators are critically discussed, inter alia, in Garner (1995) and Moore et al. (1996).

[3] For the money stocks, for example, two-year growth rates are considered, since the accumulated effects are of importance for inflation. However, as a result of the transformations, the long-term information in the levels is eliminated.

[4] The corresponding standard deviations are 1.80, 1.54 and 1.57. This also shows that the differences are not too big (which is the case, for example, in the USA).

quite similar turning points or inflation cycles. Most of the variables used have been available since the early sixties. Owing to the statistical reorganisation problems in 1995 due to the inclusion of Eastern Germany in some time series and European statistical harmonisation (for that reason, some real variables on a monthly basis are available only up to end of 1994, e.g. retail turnover, unit labour costs) and the possibility of comparing forecast and real inflation trends from 1995 onwards (out-of-sample forecast), only data up to December 1994 are considered for predicting inflation. For GDP growth data until the fourth quarter of 1996 have been used. Here I tried to connect the variables only available until the end of 1994 with the newly constructed ones by the Federal Statistical Office of Germany since 1995.

3 The Construction of the Index

For the indexes to be constructed I propose a strategy for each month or quarter selecting *five* indicator series from a much larger set of candidates. This number is an arbitrary one to a certain extent, but, in my opinion, it represents a fair compromise between transparency and/or manageability, on the one hand, and the utilisation of available information, on the other. With these indexes, the development of inflation and the growth rate of GDP are to be forecast with a lead time of *1 1/2 years*. For periods of less than one year, autoregressive models of various kinds yield quite good results. By contrast, the quantity theory and growth theoretical aspects are based on longer time horizons (see e.g. McCandless and Weber 1995 and Fischer 1993). Thus, it is not the optimum lag length of the various indicators in each case which is being sought (see, for example, Artis et al. 1995), but, rather, the indicator quality over a constant time horizon which is being examined. In this context, the index should contain only variables which are available at the time of the forecast (at least in a provisional form). In order to ensure that its composition can change over time, the following approach is chosen.

For each observation time, a bilateral *correlation coefficient* between the rate of inflation or GDP growth and the indicator series is calculated. These correlation coefficients do not refer to the total observation period, however, but only to the current situation, measured on the basis of the trend over the past four/five years. In order to concentrate on the correlations with the future inflation or GDP growth, each leading indicator is lagged by 18 months or 6 quarters in accordance with the forecasting horizon. Overall, the construction of the index encompasses the following steps:[1]

1. The indicator series are subjected to certain transformations (see tables 1 and 4).[2]

2. The indicator series are lagged by 1½ years.

[1] A similar procedure is used by Feldstein and Stock (1996), pp. 7-12 in the case of the indicator properties of different monetary aggregates.

[2] The transformations are undertaken in order to ensure stationarity of the variables. Therefore, the long-run informations in the levels of the time series are neglected. This should be taken into account in the interpretation of the results.

3. Bilateral correlation coefficients between the rate of inflation (growth rate of real GDP) and the lagged indicators are formed over the past 4 (5) years in each case.[1]

4. Standardisation of the indicators (subtraction of the mean and division by the standard deviation, calculated in each case over the past 4 (5) years).

5. The five series with the highest correlation coefficients are included in the indicator.

6. The inflation indicator is brought forward by one month (one quarter) to emphasise the early availability of the data.

In January 1995, for example, the last available inflation figure is calculated from December 1994 to December 1993, and the last observation of the indicator series would be June 1993. A correlation coefficient for January 1995 would therefore relate to rates of inflation between December 1990 and December 1994 and the chosen leading indicator between June 1989 and June 1993. The index always includes the five series with the highest correlation coefficients. However, no simple arithmetic mean has been calculated. Instead, the correlation coefficient concerned determines (as a share in the sum total of the five correlation coefficients), in terms of the strength of the relation, the weight of the individual indicator. An analogous procedure is applied to the growth rate of real GDP.[2]

4 Results

4.1 Inflationary Developments

Figures 2 and 3 juxtapose the rate of inflation and the index of leading indicators.[3] The "smoother" time series shown in figure 3 indicate the relevant 12-month moving averages; these are perhaps better suited for interpreting the trend of inflation. The general price movements are, in principle, indicated quite clearly, although early identification of turning points of inflation is not always possible. This is not surprising, however, since a constant forecasting horizon was assumed for all indicators. From 1995 onwards, the actual price trend can be compared with the price trend predicted by the index, as only data up to the end of 1994 are used.[4] It can be seen from the charts that, initially, the index

[1] The longer time horizon taken into account for the real development is due to the a-priori belief that the current situation considered for GDP should be defined in a broader sense than for the inflationary development.

[2] An alternative weighting scheme would be to run a regression with the five indicator series on inflation and GDP, respectively, and to use the coefficients as (optimal) weights.

[3] The following statements remain valid if the inflation rate is calculated from t+12 to t, as it is done, for example, by Webb/Rowe (1995) in their analysis of the turning points of inflation, and if the construction of the index is adjusted accordingly.

[4] If the statistical problems due to European harmonization and the inclusion of the new Laender are eliminated, it is, in fact, possible to forecast a period of 18 months in advance from the end of the series. At the end of 1996 this would imply that the index shows the development of inflation up to mid-1998. With only two full years of the new time series available (1995, 1996) the statistical breaks created are not easy to handle.

of leading indicators and the rate of inflation point downward. From the end of 1995 onward, however, rising rates of inflation are predicted.

In a simple auto-regressive model, taking due account of the assumed time structure, there is a clear improvement in the explanatory value over the entire observation period when the composite indicator is included. The coefficient of determination rises from 0.37 to 0.59. The hypothesis that there is no relationship between the index and the inflation rate can be rejected by means of an F-test at the 1 % level of significance (F=208.7). The AR-model would admittedly, forecast decreasing rates of inflation for 1996. However, the connection between the index and the development of inflation has become looser in the nineties, which is hardly surprising. Whereas, previously, the correlation coefficient in the partial periods considered in table 3 was always higher than 0.5 and even reached 0.72 between 1985 and 1989, it fell in the period between 1990 and 1994 to 0.47. This result is doubtless mainly attributable to developments in the last part of the observation period.

It is also interesting to see which variables have been included in the index over time and thus have a close current connection with the development of inflation. This is shown in tables 2 and 3. It may be seen from these that *M3* has the highest explanatory value over the entire period, whereas retail turnover has the lowest one. M1 and M2, too, come off comparatively favourably. The strengths of M3 becomes apparent mainly from the mid-eighties onwards. In the nineties, capital and money market rates, commodities prices and the index of share prices are represented in the indicator along with M3. The monetary aggregates played a major role in inflation forecasting in all the periods under consideration, whereas it is mainly in the nineties that this has been true of the interest rate variables. The variables which, according to the time-related breakdown in table 3, *never* belong to the five variables with the largest share in the index, are the interest rate spread, sales price expectations, import prices, negotiated wage rates, industrial output and retail turnover. *M3* and the inflow of orders in the manufacturing sector come off best on this share-related analysis. It is also striking that in the seventies as well as between the mid-eighties and the late eighties, no variable has an extreme dominant position, as can be discerned in the other periods under consideration. Especially remarkable in this respect are the index of share prices and the trends in productivity in the sixties,[1] the unemployment rate in the first half of the eighties and the long-term interest rate in the nineties, which in these phases were included in the index in about 90 % of the possible cases. At the end of the sample, the index is composed of M3, the capital market rate and the change in it, the unit labour costs and the inflow of orders in the manufacturing sector. On the basis of the development of the correlation coefficients from month to month, it is in most cases possible to ascertain relatively early whether an indicator series will be included in the index in the near future or will be eliminated from it. It is by no means the case here that the index changes in composition from month to month. Rather, in general, the indicators are included in the index over a longer period of time.

The changes in economic structures since the sixties are clearly reflected in the index. What is chiefly apparent is a tendency towards an increasing importance of *financial*

[1] The sixties are not a representative period since, owing to the transformations made, only a few observations are available in many cases.

variables (monetary aggregates, interest rates) for forecasting price trends.[1] Furthermore, it is striking that price trends at the preliminary stages (producer and import prices) tend to play only a subordinate role.

4.2 Growth Rate of Real GDP

In a second step the same procedure is applied to the growth rate of real GDP with quarterly indicators. With quarterly observations the sample ended in the fourth quarter of 1996 and it is possible to forecast until mid 1998. Table 4 shows the potential candidate series considered. The index and GDP growth are compared in figure 4. All in all, the results are not very promising which demonstrates that this kind of analysis is perhaps not very well suited for GDP. But the poor overall performance may also be due to the considered time horizon, the variables taken into account or an incorrect specification of the current circumstances.

Until the mid 1980s the growth trend in GDP is not well captured by the composite indicator. In many cases even the wrong direction is indicated by the index. But in the last ten years the general development is better predicted. In this period there is no variable which extremely dominates the index: The highest share is 71 % for the change in money market interest rates in the nineties. Interest rates and the output gap are relevant indicator variables in nearly every subperiod (see table 6). But from 1985 onwards "external" variables like commodities prices, the external value of the DM and export expectations more and more dominate the index. This may be due to increased foreign competition and globalisation. In the nineties, short-term interest rates, commodities prices and wage rates played the major role in explaining GDP growth. In contrast, M3 in no case enters the index in that period. M1, M2, sales price expectations, the unemployment rate, productivity, unit labor costs, the business climate and disposable income are the variables which in no subperiod belong to the five time series with the largest share in the index.

For 1997/98 the index would forecast declining growth rates of GDP. In 1996, the relevant base period, the main determinants of the index are the inflow of orders in the manufacturing sector, producer prices, long-term interest rates and the change in short-term interest rates. These are responsible for the pessimistic forecast. Especially the declining producer prices in 1996 enter with a high weight.

5 Summary and Conclusions

The indexes proposed in this paper have the advantage that they respond to changed economic conditions by altering their composition. In terms of a regression analysis, this would satisfy the requirement of time-variable coefficients. One problem, however, is that only bilateral relationships are analysed. Consequently, interactions with other variables

[1] An investigation of the role of financial variables in forecasting GDP growth and inflation for various countries and the period 1980-1995 is presented in Andersen (1997). He concludes that forecasts could be improved by using information from changes in the yield curve and of movements in exchange rates and other asset prices.

cannot be taken into consideration. It is quite possible that a variable, if considered in isolation, does not show any lead time in relation to inflation, whereas this would be the case if other variables were taken into account. Thus, the significant role played by the interest rate variables in the nineties might decrease in certain circumstances, if the monetary trend, too, were considered in the forecasting equation. Moreover, with the method chosen, it is not possible to indicate any significance level of the influences. However, it is rather difficult to integrate all the variables used here into one regression analytical approach.[1]

The indexes have a theoretical foundation since nearly all the variables used have been derived from inflation and business cycle theories. They are not suitable for a point forecast of inflation or growth, but yield valuable information for analysing the turning points and general trends. As the presented analysis has shown, the used methodology is more appropriate for explaining inflationary trends than for the growth rates of real GDP. The specific role played by some variables (the index of share prices or sales price expectations, for example,) should be evaluated carefully and not be overinterpreted, however. The fixed time-related forecasting horizon of 18 months, on the other hand, could be easily changed to cover other periods.

One further extension of the paper could be to treat rising and falling inflation rates or recessions and booms in an asymmetrical way (see Kim and Yoo 1995). In the present context that could be done, for example, by considering different (optimal) lead times or different indicators for recessionary and expansionary periods.

[1] One possibility is dealt with by Stock/Watson (1989), p. 366. VAR models for inflation forecasting, by contrast, perform rather poorly, at least in the case of the United States (see, for example, Webb 1995). One method which might be useful in this context is the analysis of principal components (Quinn and Mawdsley 1996, Cabrero and Delrieu 1996). This approach considers a linear combination of variables which explain as large a part as possible of the variance of the variables. These variables could then be aggregated by means of weighted least squares.

Table 1 Leading indicators considered for inflation

Variable	Start	Transformation
1. Monetary aggregates[1]		
- M1	1960,1	2-year growth rate
- M2	1960,1	2-year growth rate
- M3	1960,1	2-year growth rate
- Central bank money stock (cbm)	1960,1	2-year growth rate
2. Interest rates		
- 3-months money market rate (is)	1960,1	
- ditto, change against previous year (dis)[2]	1961,1	
- Yield on bonds outstanding (il)	1960,1	
- ditto, change against previous year[2] (dil)	1961,1	
- Interest rate spread[3] (spd)	1960,1	
3. Price variables		
- Sales price expectations[4] (pe)	1970,1	12-months moving average
- Producer prices[5] (pp)	1960,1	Annual growth rate
- Import prices (pim)	1960,1	Annual growth rate
- Commodities prices (comp)	1968,1	Annual growth rate
- Weighted external value of the DM (e)[6]	1960,1	12-months moving average of annual growth rate
- Index of share prices[7] (shp)	1960,1	ditto
4. Labour market[8]		
- Unemployment rate[9] (u)	1960,1	Ratio of the current month to moving 5-year average
- Productivity[10] (pro)	1962,1	12-months moving average of annual growth rate
- Unit labour costs[11] (ulc)	1960,1	ditto
- Negotiated wage rates overall economy	1960,1	Annual growth rate
5. Other real economic variables[8]		
- Inflow of orders in the consumer goods industry (ord1)	1960,1	12-months moving average of absolute annual change
- Inflow of orders in the manufacturing sector (ord2)	1960,1	ditto
- Net production in manufacturing (y)	1960,1	Ratio of the current month to 5-year moving average
- Retail turnover (rtu)	1960,1	ditto

1) From June 1990, figures for the all-Germany; 2) Both the level and the change have been examined since it is not clear which variable is stationary. 3) Yield on bonds outstanding minus 3-month rate.
4) Ifo Institute economic test for the manufacturing sector. 5) Industrial products; from July 1990, west German figures have been used, as before. 6) Vis-à-vis 18 industrial nations.
7) Of the Federal Statistical Office. 8) From July 1990, the figures refer to western Germany, as before.
9) In terms of dependent labour force.
10) Production per employment hour ("Beschaeftigtenstunde") (mining and manufacturing sectors).
11) Gross wages and salaries per product unit (mining and manufacturing sectors).

Table 2 Indicators contained in the overall inflation index[1]

Variable	Number of available months	Number of months considered	Percent
M1	372	113	30
M2	372	124	33
M3	372	154	41
cbm	372	82	22
is	396	90	23
dis	384	50	13
il	396	141	36
dil	384	100	26
spd	396	57	14
pe	270	54	20
pp	390	53	14
pim	390	43	11
comp	294	64	22
e	378	87	23
shp	378	109	29
u	342	95	28
pro	354	98	28
ulc	378	119	31
w	390	93	24
ord1	378	75	20
ord2	378	133	35
y	342	4	1
rtu	342	0	0

1) The five indicators most frequently represented in the index, in terms of their share, have been printed in bold type.

Table 3 Indicators contained in the inflation index, in terms of sub periods, in percent[1]

Variable	Sixties	Seventies	1980-84	1985-89	1990-94
M1	37	**44**	0	**55**	0
M2	19	**35**	**42**	40	32
M3	**54**	27	0	**65**	**72**
cbm	0	27	17	**63**	3
is	14	27	18	18	**38**
dis	23	7	**37**	2	0
il	36	25	3	37	**88**
dil	1	19	32	25	**65**
spd	15	13	18	12	15
pe	(-)	30	12	0	18
pp	4	**33**	0	0	15
pim	4	7	32	5	13
comp	(-)	18	28	7	**35**
e	24	15	32	**43**	8
shp	**92**	10	0	10	**35**
u	0	20	**93**	25	0
pro	**89**	27	27	0	3
ulc	**78**	19	15	23	20
w	20	**41**	**33**	10	0
ord1	4	29	**47**	0	15
ord2	**63**	**42**	15	**60**	23
y	0	3	0	0	0
rtu	0	0	0	0	0

1) The five variables of the respective period most frequently contained in the index, in terms of their share, have been printed in bold type; "x" means that the variable is included in the index in x % of the possible cases.

Table 4 Leading indicators considered for GDP

Variable	Start	Transformation
1. Monetary aggregates[1]		
- M1	1960,1	2-year growth rate
- M2	1960,1	2-year growth rate
- M3	1960,1	2-year growth rate
2. Interest rates		
- 3-months money market rate (is)	1960,1	
- ditto, change against previous year (dis)[2]	1961,1	
- Yield on bonds outstanding (il)	1960,1	
- ditto, change against previous year[2] (dil)	1961,1	
- Interest rate spread[3] (spd)	1960,1	
3. Price variables		
- Sales price expectations[4] (pe)	1970,1	4-quarter moving average
- Producer prices[5] (pp)	1960,1	Annual growth rate
- Commodities prices (comp)	1968,1	Annual growth rate
- Weighted external value of the DM (e)[6]	1960,1	Annual growth rate
4. Labour market[8]		
- Unemployment rate[9] (u)	1960,1	Ratio of the current quarter to moving 5-year average
- Productivity[10] (pro)	1962,1	4-quarter moving average of annual growth rate
- Unit labour costs[11] (ulc)	1960,1	ditto
- Negotiated wage rates overall economy (w)	1960,1	Annual growth rate
5. Other real economic variables		
- Output gap (gap)	1962,1	ratio of real GDP to production potential
- Inflow of orders in the manufacturing sector (ord2)	1960,1	4-quarter moving average of absolute annual change
- Business climate (bc)[12]	1969,1	4-quarter moving average
- Export expectations (exe)[12]	1970,1	4-quarter moving average
- Disposable income (yd)	1960,1	4-quarter moving average annual growth rate

1) In real terms. From June 1990, figures for all- Germany
2) Both the level and the change have been examined since it is not clear which variable is stationary.
3) Yield on bonds outstanding minus 3-month rate.
4) Ifo Institute business survey for the manufacturing sector.
5) Industrial products; from July 1990, west German figures have been used, as before.
6) Vis-à-vis 18 industrial nations.
7) Of the Federal Statistical Office.
8) From July 1990, the figures refer to western Germany, as before.
9) In terms of dependent labour force.
10) Production per employment hour ("Beschaeftigtenstunde") (mining and manufacturing sectors).
11) Gross wages and salaries per product unit (mining and manufacturing sectors).
12) Reported by the Ifo Institute for Economic Research.

Table 5 Indicators contained in the overall GDP index[1]

Variable	Number of available quarters	Number of quarters considered	Percent
M1	130	14	11
M2	130	30	23
M3	130	21	16
is	138	38	28
dis	134	89	66
il	138	28	20
dil	134	75	56
spd	138	57	22
pe	106	8	8
pp	138	58	42
comp	110	35	32
e	134	20	15
u	128	9	7
pro	130	14	11
ulc	138	25	18
w	134	53	40
gap	134	74	55
ord2	134	23	17
bc	110	5	5
exe	106	12	11
yd	134	24	18

1)The five indicators most frequently represented in the index, in terms of their share, have been printed in bold type.

Table 6 Indicators contained in the GDP index, in terms of sub periods, in percent[1]

Variable	Sixties	Seventies	1980-84	1985-89	1990-96
M1	9	7	0	30	11
M2	23	35	0	30	18
M3	0	35	0	**35**	0
is	24	**42**	**50**	0	11
dis	**65**	**67**	**80**	**45**	**71**
il	33	17	30	0	18
dil	**81**	**50**	**100**	**55**	11
spd	13	**37**	5	30	14
pe	(-)	5	0	0	21
pp	**90**	32	35	10	32
comp	(-)	10	**50**	30	**54**
e	4	2	5	**35**	**36**
u	6	0	20	10	7
pro	0	22	0	15	7
ulc	23	17	0	20	25
w	**54**	20	20	**60**	**54**
gap	31	**77**	**55**	**60**	**43**
ord2	**46**	12	0	0	21
bc	(-)	0	15	5	4
exe	(-)	0	0	10	**36**
yd	35	17	15	20	4

1)The five variables of the respective period most frequently contained in the index, in terms of their share, have been printed in bold type; "x" means that the variable is included in the index in x % of the possible cases.

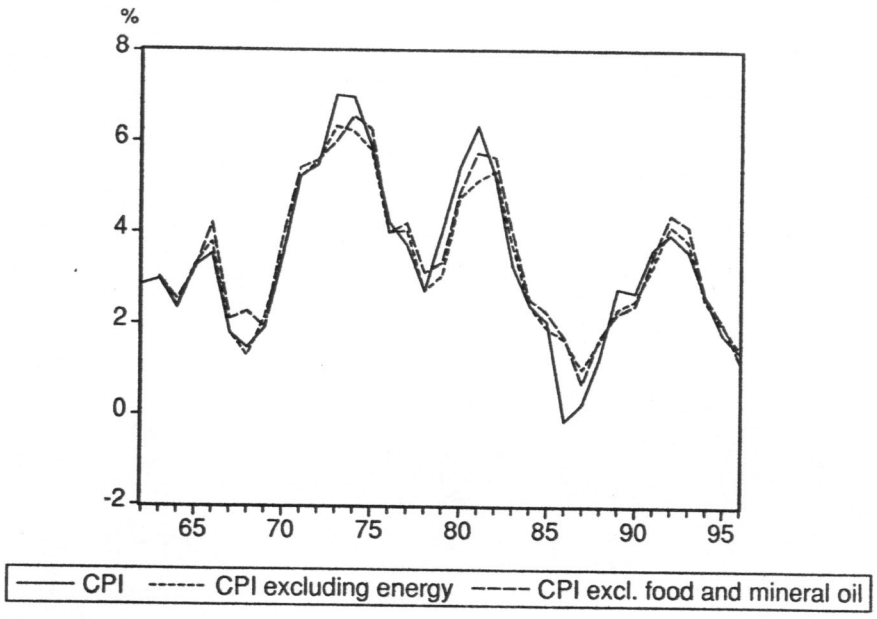

Figure 1 Consumer price index (CPI) in various definitions

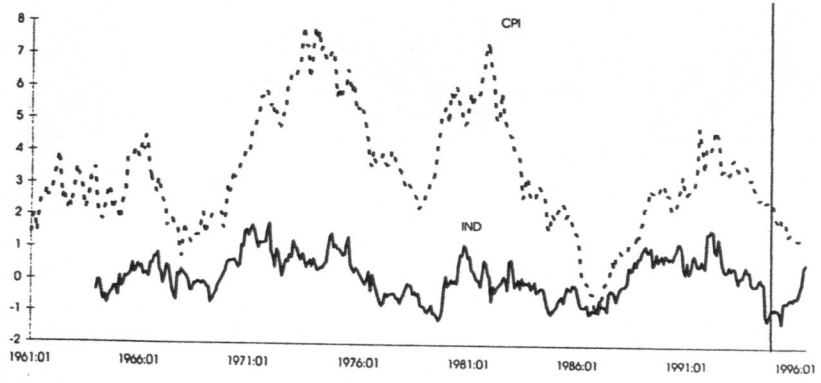

Figure 2 Consumer price index (CPI) and index of leading indicators (IND)[1)]
1) The inflation rate is calculated from t to t-12.

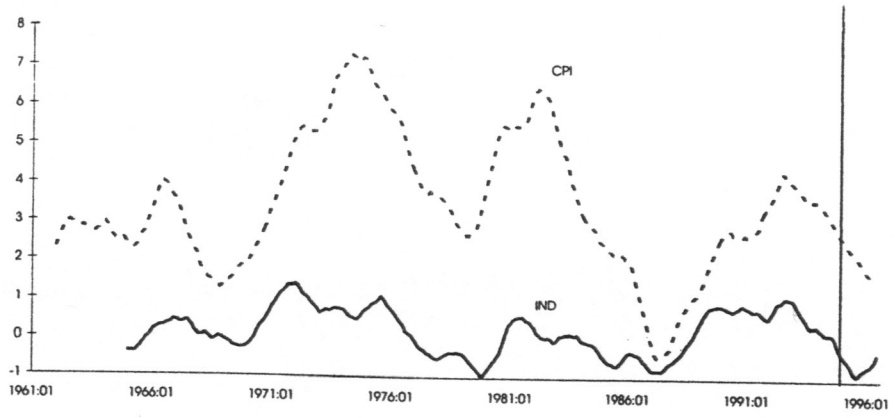

Figure 3 Consumer price index (CPI) and index of leading indicators (IND)[1)]
1) 12-month moving average in each case.

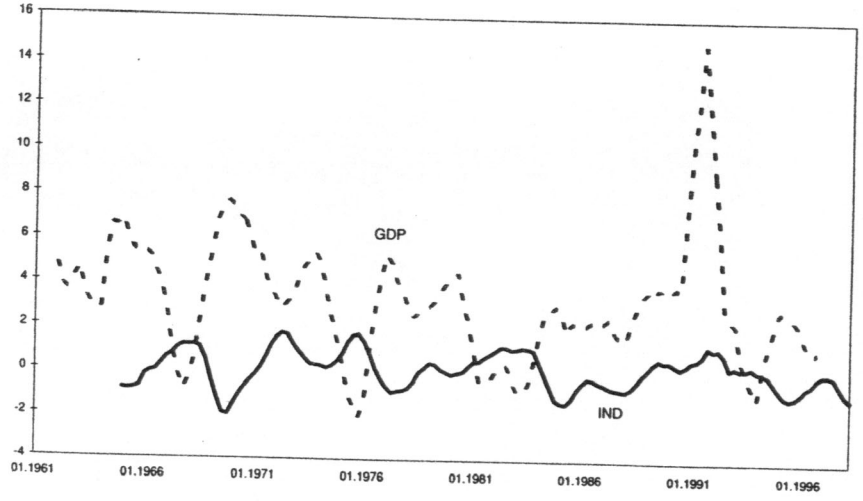

Figure 4 GDP growth (GDP) and index of leading indicators (IND)[1)]
1) 4-quarter moving average in each case.

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