Arbetsrapport

Nr 16

April 1994

A Time Series Approach to Selecting Inflation Indicators

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ISSN 1101-6604
ISRN SVRB-AR--16--SE

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1 Introduction

The purpose of this study is to develop a procedure to identify the best available indicators, or information variables, for the future rate of inflation. We use time series techniques to find those variables that have been highly correlated with the inflation rate.

In doing this we avoid making any assumptions concerning the economic structure behind the observed process, i.e. we do not impose any restrictions derived from economic theory on the data. The assumption we make is that the relationship between the inflation rate and the indicator variables can be adequately captured by linear regressions of the inflation rate on lagged inflation and the various indicator candidates (and deterministic terms). An important judgemental element is the transformations needed to render the variables stationary and thus amenable to traditional time series analysis. On the way we have to take a stand on rather difficult issues concerning how to deal with time-varying means and variances, sometimes due to time-varying seasonal patterns.

We apply the proposed procedure to Swedish quarterly data from 1970 to the first quarter 1993. We limit the number of indicators to select to five. A fairly robust set of indicators is chosen for the period 1988q1 to 1993q1. Money stock (M3) and OECD:s leading index for industrial production are selected as the main indicators of future inflation. The price index for imports of agricultural products are also often selected as an indicator of inflation. The short term interest rate contain information on future inflation during the first half of the period we study. Variables related to the orders to manufacturing firms also appear informative.

The paper is structured as follows. In section 2 we describe the method used for selecting a set of indicator variables from a large number of candidates. In section 3 we apply the selection procedure to our data. In this section we also describe that part of the procedure that involves most of our ad hoc decision, namely selecting and transforming the variables so that they will be suitable for statistical testing. Section 4 concludes.

2 A Time Series Approach to Selecting Indicator Variables

The purpose is to extract from a large number of candidates those variables that, taken together, most efficiently can indicate the future rate of inflation. This means that we want to select a combination of variables that each contribute as much information as possible to the whole, given the other variables included. The way we do this is by a simple form of stepwise regression, by following a bottom-up strategy in four steps:[1]

Step 1: We regress inflation on lagged inflation (and deterministic terms),

[1] $$\pi_t = \mu_t + A(L)\pi_t + \varepsilon_t$$

where π_t is the inflation rate in time t, μ_t represents deterministic terms (for instance the constant term and seasonal dummies) and A(L) is a lag polynomial of order p.[2] We perform this regression for successively higher values of p, from p equal to unity up to a maximum order chosen *ad hoc.*[3] An information criterion is used to indicate which polynomial order p gives the most "bang for the buck", i.e. the most information of future inflation taking into account the number of lags included.[4] The "best" number of lagged inflation rates so decided is retained in the regression equation in the next step.

Step 2: We perform bivariate regressions of inflation on lagged inflation rates and on lags of each of the indicator candidates in our dataset,

[2] $$\pi_t = \mu_t + A(L^{p^*})\pi_t + B(L)x_{it} + \varepsilon_t \qquad \text{for } i = 1, 2, \ldots, n$$

where $A(L^{p^*})$ is a lag polynomial with the optimal number of lags decided in step 1, B(L) is a lag polynomial of order p and x_i is indicator candidate with index i = 1,2,...n. As in step 1 the equation is estimated for values of p varying from unity up to a predetermined maximum. The indicator candidate with achieves the best information criterion is retained in the equation as we move on to step 3. However, we only choose an indicator candidate if the

1 This strategy is described by Lütkepohl (1991) in a VAR setting.

2 The lag operator , L, is defined as $Lx_t = x_{t-1}$ and $A(L)x_t = \sum_{i=1}^{p} a_i L^i x_t = \sum_{i=1}^{p} a_i x_{t-i}$.

3 Determined mainly by *a priori* views on the relevant horizon for monetary policy and data availability.

4 Information criteria measures the ability of the variables on the right hand side of the equation to account for the historical variation in the variable on the left hand side of the equation, while penalizing an excessive use of explanatory variables.

information criterion shows that this variable improves on the information already contained in lagged inflation itself.

Step 3: Given lags of inflation and the indicator variable chosen in the previous steps, denoted x_{it} in equation [3] below, the equation is augmented with lags of, in turn, the remaining variables in the data set. The following equation is estimated,

[3] $$\pi_t = \mu_t + A(L^{p^*})\pi_t + B(L^{p_i^*})x_{it} + C(L)x_{jt} + \varepsilon_t$$
for $j = 1, 2, \ldots, n$ but $j \neq i$

where p* and p_i* are the lag orders chosen for inflation and the "best" indicator variable, C(L) is a lag polynomial of order p and x_{jt} is indicator variable with index $j \neq i$. As before, the information criterion is used to select the variable with the most additional information on future inflation.[5] The chosen indicator variables and lag lengths are retained in the equation in step 4.

Step 4: Step 3 is repeated until a predetermined number of indicator variables have been chosen, or until there is no improvement in the information criterion compared to the previous step.

5 This also means that the information criterion improves compared to step 2.

3 An Application of the Procedure

We have applied the procedure described above to Swedish quarterly data from 1970 to the first quarter 1993.[6] As the measure of inflation we used the growth rate of the consumer price index (CPI).[7] As candidates for indicator variables we used those time series at quarterly frequency that we had at our disposal and that could be traced back to the beginning of the seventies. This set included measures of the level of utilization of productive capacity; possible indicators of monetary policy; such as the money stock (M3), bank loans and short interest rates; price indices of oil, imports and exports; forward looking variables like the long term interest rate and business orders, in all around thirty variables.

These variables are plotted in Appendix, Figure A1. Many series are clearly non-stationary, showing signs of trends and seasonal patterns. Furthermore, there are signs that conditional variances, trends and seasonal patterns could be time-varying. We now turn to the issue of how to render time series like these suitable for further analysis.

3.1 Transforming the Time Series

First we transformed series with a trending mean to natural logarithms in order to mitigate time-varying variances. Next, the series were scrutinized for seasonal patterns. Inclusion of seasonal dummies in estimation should take care of any deterministic seasonal effects in the variables, but variables with a time-varying seasonal pattern must be adequately transformed. Using simple graphical approaches, see Hylleberg (1992), it is possible to detect signs of time-varying seasonal patterns as well as deterministic seasonal patterns. In Appendix Figure A2, the variables are displayed as separate time series for each quarter.[8] For variables with a constant seasonal pattern the series for the different quarters will be parallel. If the relative position of the time series for the different quarters change over time, this reflects a time-varying seasonal pattern. Judging from Figure 2, the retail sales variable (RST) stands out as an example of a deterministic and rather constant seasonal pattern, while the money stock (M3), real gross domestic product (GDP) and new orders manufacturing (NOM) could be examples of variables with time-varying seasonal patterns.

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6 The variables included in the dataset are listed in section 6.

7 More precisely, the first difference of natural log of the CPI.

8 The notation in the paper is as follows; the national logarithm of a variable is denoted by an *l* preceding the abbreviation, the first difference of a variable is denoted by *d*, and the seasonal difference of a variable by *s*.

We also performed statistical tests of seasonal integration as suggested by Hylleberg et.al. (1992). Evidence of unit roots on the long run or seasonal frequences may call for taking differences or seasonal differences of the variables.[9] According to the formal test of seasonal integration, see Table A1 in the Appendix, we cannot reject the hypotheses of a seasonal unit root in GDP, labour cost (LCH), jobs vacancy (JBV) and unemployment (UPC). These variables should therefore be seasonally differenced. For M3, NOM and RST the HEGY-test indicates presence of unit roots but the hypotheses of seasonal unit roots seems to be rejected. According to the formal test, these variables should therefore be consecutively differenced. However, when differenced, M3 and RST show signs of seasonal unit roots. We therefore apply seasonal differences, instead of consecutive differences, to these two series as well.[10]

Other trending variables with no sign of time-varying seasonals were (consecutively) differenced. The results in Table A1 indicate that differencing is appropriate in all cases except for the OECD composite leading indicator for industrial production (CLI). In this case the test suggests that the series varies around a deterministic trend but we choose to retain the transformation. In Table 1 corresponding results for the interest rate variables are also given. We cannot reject the hypotheses of unit roots in the 3-month interest rate (I3M) and the 5-year interest rate (I5Y). The yield curve variable (YLD), as measured as the simple difference between I5Y and I3M, seems to be stationary.

Furthermore, there is a group of variables with a special feature. The variables in this group show signs of business cycle deterministic seasonal patterns. For these variables the seasonal pattern seems to get inverted depending on whether the economy is booming or recessing. If this actually is a problem, then there is, to our knowledge, no appropriate way to deal with it. This group includes variables like full capacity utilization (FCU), order stock (ORS), business order book (BOB), and machine capacity (MCI), all of the business cycle variables with no obvious trend. According to the HEGY test results in Table A1 most of these variables are stationary in levels.

The transformed variables are shown in Appendix, Figure A3. The formal test of presence of remaining unit roots, see Appendix Table A2, indicate that GDP, RST, LCH, UPC and credit to the public (CRP) ought to be differenced (at least) twice to become stationary, which is not unbelieveable

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[9] The (consecutive) difference is defined as $\Delta x_t = (1-L)x_t = x_t - x_{t-1}$ while the seasonal difference with quarterly data is defined as $\Delta^4 x_t = (1-L^4)x_t = x_t - x_{t-4}$.

[10] According to Berg and Jonsson (1993) M3 shows a time-varying seasonal pattern.

looking at their respective graphs. We also applied the procedure to a dataset including this further differencing. This transformation of the dataset did have some effect on the choice of inflation indicators. We comment on that below.

3.2 Selecting Indicator Variables[11]

We decided, on a more or less ad hoc basis, that the size of the group of indicators should not exceed five, not counting lagged inflation. The main reason for this was to limit the number of possible combinations and maximise degrees of freedom given a maximum of twelve lags of each variable. In running the procedure the total number of lags included in the regression was limited by the restriction that the total number of degrees of freedom should not be less than twenty.[12]

We first applied the procedure to the entire sample, that is we used all observations including the first quarter 1993.

The regression equations were estimated by OLS. In estimating the equations we included a constant, seasonal dummies and three dummies for the first quarter each year 1990-92, in order to account for the effects of the tax reform. The Hannan-Quinn information criteria was used to choose the best indicators as well as the appropriate lag structure.

In the first stage, the optimal number of lags was decided for the inflation variable. Subsequently, the indicator variables were added to the equation on the basis of improvement in the information criteria. This process went on until five indicator variables had been selected.[13] The result is presented in Table 1.[14]

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[11] As a preliminary step, and when the dataset is large, one might want to consider bivariate Granger causality tests between the inflation rate and each of the variables in the dataset in order to reduce the number of variables included in the actual procedure. This could save computer time. With 30 variables in the dataset the procedure takes only 15 minutes to run.

[12] This rule of thumb, suggested to us by Sune Karlsson, was used to prevent the information criteria from "breaking down" due to overparameterization.

[13] We did not try to reduce the number of lags for variables chosen in previous steps. In particular, this means that we kept the initial choice of inflation lags, even though in many cases this lag length could have been reduced in the final equation.

[14] The choice of indicators was the same for the dataset including GDP, RST, LHC, UPC both consecutively and seasonally differenced and CRP twice (consecutively) differenced.

Table 1. Selected Indicator Variables 1993q1

Number of lags in parenthesis

1st Indicator	2nd Indicator	3rd Indicator	4th Indicator	5th Indicator
M3(4)	CLI(2)	XP(8)	MP(1)	JBV(1)

Basic regression statistics

Last observation	1993Q1
Observations:	72
Degrees of freedom:	44
$\overline{R}^2$:	0.80

Regression evaluation

	Value	*Marginal Significance Level*	*H0*
Norm	0.82	0.66	normal errors
BoxLjung	16.7	0.02	no residual autocorrelation up to lag 12
LM	23.5	0.02	no residual autocorrelation up to lag 12
ARCH	11.4	0.50	no autoregressive conditional heteroscedasticity

Residual autocorrelation

	Coefficient	*t-value*	*Marginal Significance Level*
Lag1	-0.08	-0.67	0.50
Lag2	-0.08	-0.67	0.50
Lag3	-0.07	-0.60	0.55
Lag4	0.15	1.26	0.21
Lag5	0.04	0.33	0.74
Lag6	-0.18	-1.49	0.14
Lag7	-0.35	-2.93	0.00
Lag8	-0.13	-1.09	0.28
Lag9	0.03	0.23	0.82
Lag10	0.13	1.12	0.26
Lag11	0.01	0.07	0.94
Lag12	-0.16	-1.34	0.18

H0: Autocorrelation at lag i = 0, for i=1, 2, .., 12

The procedure chooses five lags of inflation in the first step. It may be of some interest for a central banker to notice that the 12-month change in the money stock, M3, comes in first among the chosen indicator variables, after lags of the inflation rate have been included. Four lags of the 12-month growth rate in the money stock are included in the equation. The next indicator variable to be chosen is the quarterly growth rate in the OECD composite leading indicator for industrial production (CLI), with two lags included in the equation. The quarterly growth rate in the export price index (XP) is next on the list, with eight lags included. The last two indicator variables to be chosen are the quarterly change in the import price index (MP) and the 12-month change in jobs vacancy (JBV).

In Table 1 we also report statistics to evaluate the information content of this set of indicator variables, as measured by the residuals. Judging from the two tests of residual serial correlation the residuals in the estimated equation are correlated. This is due to a strong residual autocorrelation at lag 7. These evalutation statistics indicate that the selected set of indicator variables do not explain all of the variance in inflation. Furthermore, since the procedure could have included other variables from the dataset or longer lags, one possible interpretation is that our dataset lacks some variables that could be informative of future inflation.

An interesting question is whether the selected set of indicator variables changes over time. Considering the major structural changes of the Swedish economy this is highly likely. We test the stability of the indicator choice by running the regression for periods with different end dates.[15] We start twenty quarters back, the first quarter 1988, and search for indicator variables as described above, given the information available up to that date.[16] We then take one step forward and repeat the process. The result is shown in Table 2.

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15 We use the same transformation of the variables as described above.

16 This is not exactly true since we use data series that might have been subject to certain revisions.

Table 2: Selected indicator variables 1988q1-1993q1

Number of lags in parenthesis

Quarter	1st Indicator	2nd Indicator	3rd Indicator	4th Indicator	5th Indicator
1988:1	M3(4)	CLI(2)	MP1(3)	I3(12)	PIC(1)
1988:2	M3(4)	CLI(2)	MP1(3)	I3(12)	PIC(1)
1988:3	M3(4)	CLI(2)	MP1(3)	I3(12)	CRP(2)
1988:4	M3(4)	CLI(2)	MP1(3)	I3(12)	CRP(2)
1989:1	M3(4)	CLI(2)	MP1(3)	I3(12)	CRP(2)
1989:2	M3(4)	CLI(2)	MP1(3)	I3(12)	BOI(6)
1989:3	M3(4)	CLI(2)	MP1(3)	I3(12)	BOB(8)
1989:4	M3(4)	CLI(2)	MP1(3)	I3(12)	BOB(9)
1990:1	M3(4)	CLI(2)	MP1(3)	I3(12)	BOB(9)
1990:2	M3(4)	CLI(2)	MP1(3)	I3(12)	CRP(9)
1990:3	M3(4)	CLI(2)	MP1(3)	XP(8)	PIM(12)
1990:4	M3(4)	CLI(2)	MP1(3)	XP(8)	PIM(12)
1991:1	M3(4)	CLI(2)	MP1(3)	XP(8)	PIM(12)
1991:2	M3(4)	CLI(2)	MP1(3)	I3(12)	CRP(9)
1991:3	M3(4)	CLI(2)	MP1(1)	ORS(8)	CRP(2)
1991:4	M3(4)	CLI(2)	MP1(3)	ORS(8)	BOB(5)
1992:1	M3(4)	CLI(2)	MP1(3)	ORS(8)	BOB(5)
1992:2	M3(4)	CLI(2)	XP(8)	PIC(1)	MP1(6)
1992:3	M3(4)	CLI(2)	XP(8)	MP(1)	RST(1)
1992:4	M3(4)	CLI(2)	XP(8)	MP(1)	RST(1)
1993:1	M3(4)	CLI(2)	XP(8)	MP(1)	JBV(1)

CPI	:quarterly change in consumer price index, per cent
M3	:12-month change in money stock(M3), per cent
CLI	:quarterly change in OECD Composite Leading Indicator for industrial production, per cent
MP1	:quarterly change in price index for imports of agricultural products, per cent
I3	:quarterly change in short term (3 month) interest rate, percentage points
PIC	:quarterly change in producer price index for chemical products, per cent
CRP	:quarterly change in bank credit to the public, per cent
BOI	:business order inflow, indicator (OECD)
BOB	:business order book level, indicator (OECD)
PIM	:quarterly change in producer price index for basic metals, per cent
ORS	:order stock, indicator (Konjunkturinstitutet)
XP	:quarterly change in price index of exports, per cent
MP	:quarterly change in price index of imports, per cent
RST	:quarterly change in value of retail sales, per cent

In all periods the procedure chooses five lags of inflation in the first step. A first observation is that the choice of indicator variables is quite stable.[17] In all periods the procedure picks out four lags of annual money stock growth and the change in the OECD composite leading indicator for industrial production, lagged two quarters. As one might expect, the change in import prices are important indicators for the inflation rate. During the period 1988q1-1992q1 the growth in import prices of agricultural products was

[17] If we do not include tax dummies the selected indicator set changes considerably during the years 1990-92.

chosen as the third best indicator. In the last three quarters of the sample, the growth in total import prices lagged one quarter seem more informative. The importance of this change can only be assessed using more data. The second observation is that there are variables that are informative for a number of periods, but then disappear. The prime example is the quarterly change in short term interest rate that contains information on future inflation only during the first half of the period we study. Even if it is tempting to explain the disappearance of the short term interest rate as an indicator for inflation by the recurrent runs on the Swedish currency from the autumn of 1990 and thereafter, it is not obvious why it appeared in the first place. Our third observation is that there are a number of variables associated with the orders placed in the manufacturing sector that appear informative on inflation, such as the indicators of the business order level (ORS and BOB).[18]

When the procedure was applied to the dataset including GDP, RST, LHC, UPC both consecutively and seasonally differenced, and CRP twice consecutively differenced, the choices of inflations indicators were somewhat different. The procedure still picked out M3 and CLI as the prime indicators. However, now the *change in the growth* of credit to the public (CRP) was chosen in 13 out of the 20 quarters, on nine occasions one lag of this variable was chosen as the third best indicator. This can be compared to the results in Table 2, where we see that the *growth* of credit to the public was picked out in only six quarters and then as the 5th indicator.[19]

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[18] In almost all periods there is significant residual autocorrelation.

[19] Multicollinearity makes interpretation of the individual coefficients hazardous. Taking that into account, one should be careful not to draw any causal conclusions from these regressions. For instance, short lags (two quarters) of the growth of credit enter the equation with a negative sign, while longer lags (8-9 quarters) are positive. On the other hand, short lags of the change in the growth of credit enter the equation with a positive sign.

4 Conclusions

The main purpose of this study was to develop a procedure to identify indicators of the future rate of inflation. In the process of developing this method we used a dataset consisting of around thirty variables. Some of the variables that the procedure picked out are in line with what theory tells us, like the money stock and import prices. In the particular case of import prices, the value added of the procedure is the information that among the possible import price indices it was the price index for imports of agricultural products, rather than the price index for all imported goods, that should be used as an indicator for future inflation during most of the periods we studied. Since our main interest at this stage was to develop the procedure, and not to build a comprehensive dataset from which better indicators could be chosen, we do not want to draw any practical conclusions from this exercise. In almost all periods there are significant residual autocorrelation in the final regression equation, which could be interpreted as an indication of missing explanatory variables.

One possible development of this approach is to try to utilize information in the *levels* of the data, not just the growth rates. Another development would be to try to find variables that could be used to actually forecast inflation. This could mean building a full-fledged vector autoregressive (VAR) model. Multiple step forecasts of the inflation rate would require forecasts of the other variables in the system. The question then arises how these variables should be forecast. One problem with such a development of the present approach, however, is that there is no guarantee that the variables selected as good indicators of inflation are optimal from a VAR forecasting point of view, since there may be little feedback between the different variables.

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6 Dataset

1	CPI		Consumer Price Index (quarterly average of monthly data)
2	I3M	#1	Short Term (3 months) Interest Rate (quarterly average)
3	I5Y	#2	Long Term (5 years) Interest Rate (quarterly average)
4	YLD		Yield, Difference Between I5Y and I3M
5	M3		Money stock
6	SMI	#3	Stock Market Index
7	EXH		Effective Exchange Rate (based on OECD overall weights)
8	GDP		Gross Domestic Product, volume
9	XP		Price Index of Exports
10	MP		Price Index of Imports
11	MP1		Price Index of Imports of Agricultural Products
12	MP2		Price Index of Imports of Mineral Products
13	MP3		Price Index of Imports of Manufacturing
14	OPI		Oil Price Index
15	FCU		Index of Full Capacity Utilization
16	ISL		Index of Slack
17	ORS		Order Stock
18	MCI		Index of Machine Capacity
19	LBA		Labour Availability
20	BOI		Bussiness Order Inflow, tendency
21	BOB		Business Order Book, level
22	NOM		New Orders Manufacturing
23	RST		Retail Sales, value index
24	JBV		Jobs Vacant
25	LCH		Labour Cost/Working Hour
26	PIC		PPI Chemicals
27	PIM		PPI Basic Metals
28	CRP	#4	Credit to the Public (commercial banks, larger saving banks and agricultural credit institutions)
29	CLI		OECD Composite Leading Indicator
30	PFT		Production Future Tendency
31	UPC		Unemployment, insured

#1 1972-82 Interest Rate on Special Deposits (source: Handelsbanken), 1983-92 Treasury Discount Notes (sources: National Debt Office, Sveriges Riksbank)

#2 Annual Rate for Asked Prices on 5 year Central Government Bonds (source: Sveriges Riksbank Quarterly Review)

#3 General Stock Market Index (source: Affärsvärlden)

#4 Sum of Domestic Credit by Commercial Banks, large Savings Banks and Rural Credit Institutions

Variables 15-19 are business cycle indicators (Konjunkturbarometern), published by Konjunkturinstitutet (National Institute of Economic Research). Variables 20-31 are collected from OECD, Main Economic Indicators.

7 Appendix

Table A1. HEGY Test for Seasonal Unit Roots

Estimation period:1971Q1-1993Q1

	Deter-ministic terms	Degrees of free-dom	π_1	π_2	F-test $\pi_3 \cap \pi_4$	Auto	Lags
ICPI	c,sd,tr	80	-1.2	-6.8	58.2	0.11	0
IM3	c,sd,tr	80	-0.9	-3.9	57.9	0.66	0
ISMI	c,sd,tr	80	-1.9	-6.2	36.9	0.10	0
IMP	c,sd,tr	80	-1.5	-7.0	25.6	0.21	0
IMP1	c,sd,tr	76	-1.3	-3.0	16.7	0.68	2
IMP2	c,sd,tr	80	-1.6	-8.0	20.0	0.09	0
IMP3	c,sd,tr	80	-1.5	-6.2	31.0	0.54	0
IOPI	c,sd,tr	80	-1.7	-7.9	19.8	0.14	0
INOM	c,sd,tr	80	-0.8	-5.0	42.0	0.08	0
IRST	c,sd,tr	78	1.8	-3.9	6.8	0.37	1
ILCH	c,sd,tr	78	-0.9	-2.8	16.8	0.05	1
IPIC	c,sd,tr	80	-1.3	-6.2	35.6	0.35	0
IPIM	c,sd,tr	80	-2.4	-5.7	43.6	0.07	0
ICRP	c,sd,tr	80	-2.5	-5.1	57.9	0.62	0
ICLI	c,sd,tr	80	-3.9	-7.5	19.3	0.20	0
IGDP	c,sd,tr	78	-1.2	-1.1	3.4	0.42	0
IEXH	c,sd,tr	80	-2.5	-5.4	26.8	0.65	0
UPC	c,sd,tr	78	-2.8	-0.8	2.5	0.64	1
IXP	c,sd,tr	66	-0.9	-7.1	28.8	0.70	1
I3M	c,sd	73	-2.6	-5.9	22.5	0.21	0
I5Y	c,sd	73	-2.2	-5.5	31.0	0.18	0
YLD	c,sd	73	-3.3	-5.6	22.9	0.22	0
FCU	c,sd	81	-3.5	-4.7	69.0	0.72	0
ISL	c,sd	81	-4.4	-5.6	58.0	0.61	0
ORS	c,sd	81	-3.9	-5.4	50.2	0.91	0
MCI	c,sd	81	-3.9	-6.5	80.7	0.69	0
LBA	c,sd	81	-3.5	-6.4	71.8	0.06	0
BOI	c,sd	79	-4.4	-4.3	14.0	0.07	1
BOB	c,sd	81	-4.5	-5.1	102.8	0.57	0
JBV	c,sd	79	-3.7	-1.5	3.9	0.33	1
PFT	c,sd	81	-3.6	-6.8	41.0	0.75	0

Deterministic terms are constant (c), seasonal dummies (sd) and trend (tr).

Critical values at the 5 per cent level are approximately for π_1 -3.6, for π_2 -3 and for the F-test 6.6 (Hylleberg et.al. (1992)).

The equation for XP is estimated for the period 1974q1-1993q1 and the equations for I3M, I5Y and YLD are estimated for the period 1973q1-1993q1, if no additional lags are used.

Auto is the significance level of the Lagrange Multiplier test of H0: no residual autocorrelation up to lag 12.

The HEGY Test consists of the regression

$$y_{4,t} = \pi_1 y_{1,t-1} + \pi_2 y_{2,t-1} + \pi_3 y_{3,t-2} + \pi_4 y_{3,t-1} + \mu_t + \varepsilon_t$$

where $y_{4,t} = (1-L^4)x_t$,$y_{1,t} = (1+L+L^2+L^3)x_t$, $y_{2,t} = -(1-L)(1+L^2)x_t$ and $y_{3,t} = -(1-L)(1+L)x_t$. The test statistic for π_i, i=1,2, is similar to the t-statistic but it has a non-standard distribution. The null hypothesis of a unit root implies that π_i is zero. The alternative hypothesis of stationarity is that $\pi_i < 0$. The F-test is a joint test for $\pi_3 = \pi_4 = 0$. Critical values for the tests are given in Hylleberg et.al. (1992). Lags of $y_{4,t}$ are addded to the equation until there is no evidence of residual autocorrelation.

Table A2. HEGY Test for Seasonal Unit Roots

Estimation period:1971Q1-1993Q1

	Deterministic terms	Degrees of freedom	π_1	π_2	F-test $\pi_3 \cap \pi_4$	Auto	Lags
dlCPI	c,sd	80	-3.0	-6.3	32.8	0.43	0
dlSMI	c,sd	80	-4.1	-5.6	22.3	0.16	0
dlMP	c,sd	80	-4.0	-6.9	27.4	0.82	0
dlMP1	c,sd	80	-4.1	-5.1	24.9	0.07	0
dlMP2	c,sd	80	-4.7	-7.5	21.7	0.33	0
dlMP3	c,sd	80	-3.7	-5.8	29.4	0.92	0
dlOPI	c,sd	80	-4.9	-7.6	22.0	0.47	0
dlNOM	c,sd	80	-4.0	-4.5	20.9	0.22	0
dlPIC	c,sd	80	-4.1	-6.0	28.5	0.63	0
dlPIM	c,sd	80	-4.7	-5.7	45.1	0.07	0
dlCRP	c.sd	80	-2.9	-3.8	24.8	0.80	0
dlCLI	c,sd	80	-4.7	-7.6	28.9	0.47	0
dlEXH	c,sd	80	-4.0	-5.0	17.5	0.71	0
dlXP	c,sd	68	-5.2	-7.1	29.3	0.79	0
dl3M	c,sd	72	-5.0	-5.5	16.3	0.23	0
dl5Y	c,sd	72	-5.5	-6.2	31.0	0.51	0
YLD	c,sd	72	-3.4	-5.6	22.6	0.27	0
slM3	c,sd	77	-3.4	-4.7	47.5	0.08	0
slRST	c,sd	73	-0.1	-6.0	27.0	0.05	2
slLCH	c,sd	77	-1.9	-7.8	51.0	0.06	0
slGDP	c,sd	77	-2.0	-4.4	27.7	0.88	0
sJBV	c,sd	77	-4.0	-7.6	28.1	0.91	0
UPC	c,sd	77	-0.4	-3.5	45.3	0.05	0
sJBV	c,sd	77	-4.0	-7.6	28.1	0.91	0
FCU	c,sd	77	-2.9	-4.4	67.2	0.53	0
ISL	c,sd	77	-4.5	-5.4	53.8	0.83	0
ORS	c,sd	77	-3.9	-5.3	50.2	0.96	0
MCI	c,sd	77	-3.6	-5.9	79.4	0.85	0
LBA	c,sd	77	-3.5	-5.8	66.6	0.12	0
BOI	c,sd	69	-3.8	-5.6	12.0	0.05	4
BOB	c,sd	77	-4.3	-4.9	96.6	0.23	0
PFT	c,sd	77	-3.4	-6.6	39.7	0.82	0

Critical values at the 5 per cent level are approximately for π_1 -3, for π_2 -3 and for the F-test 6.6 (Hylleberg et.al. (1992)).

The equations for XP, I3M and YLD are estimated for the period 1974q2-1993q1 if no additional lags are used.

Auto is the significance level of H0: no residual autocorrelation up to lag 12.

Figure A1. Variable: CPI

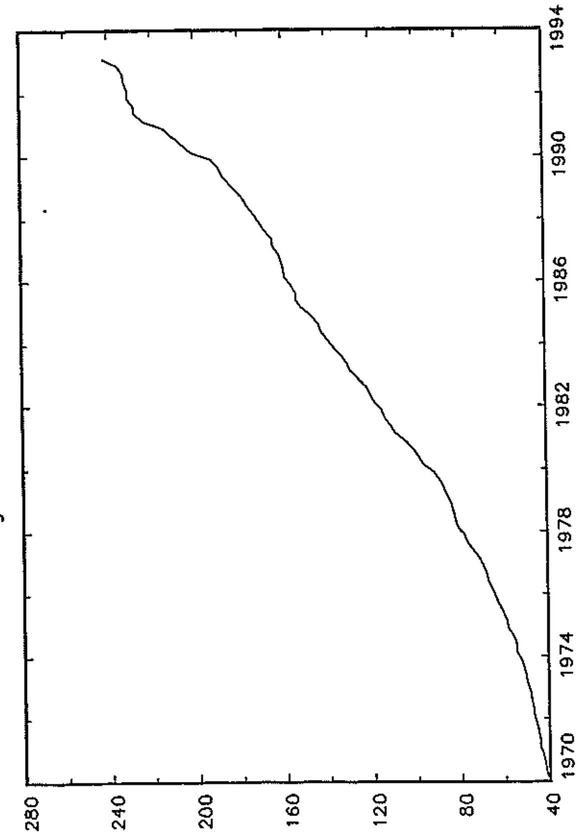


Figure A1. Variable: I3M

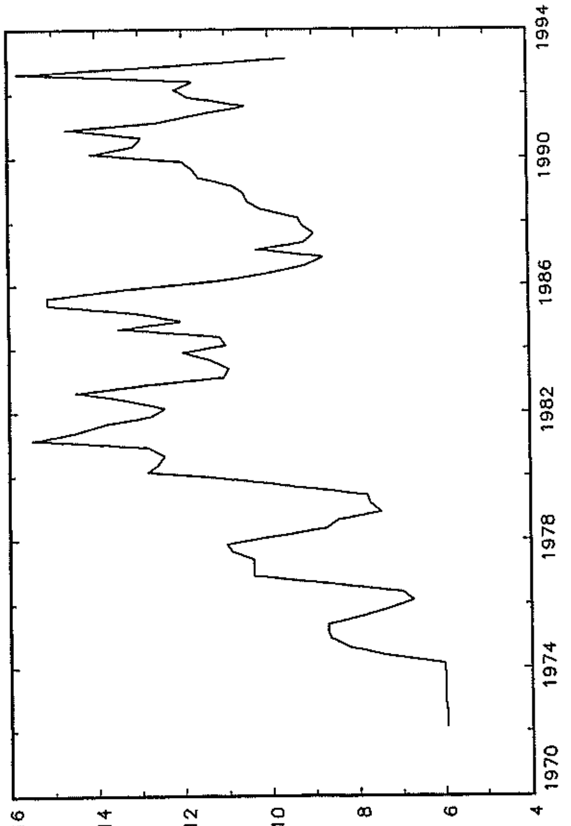


Figure A1. Variable: I5Y

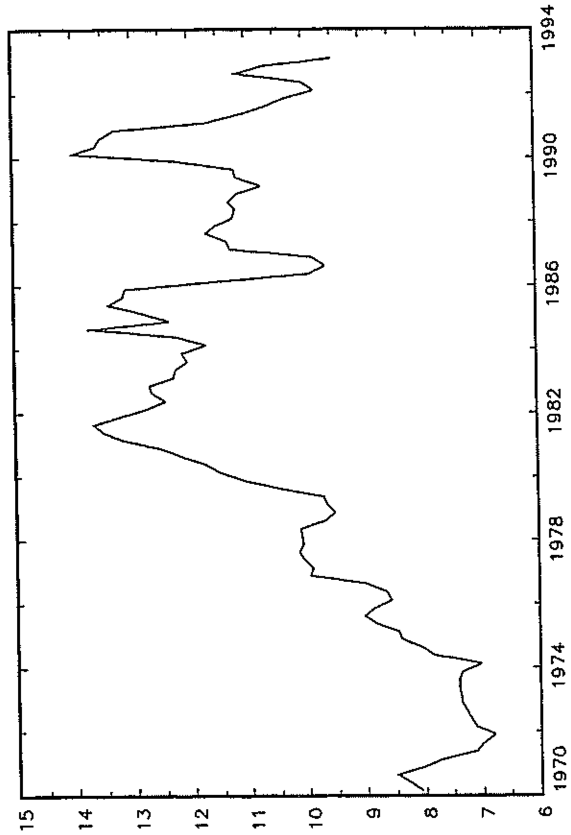


Figure A1. Variable: YLD

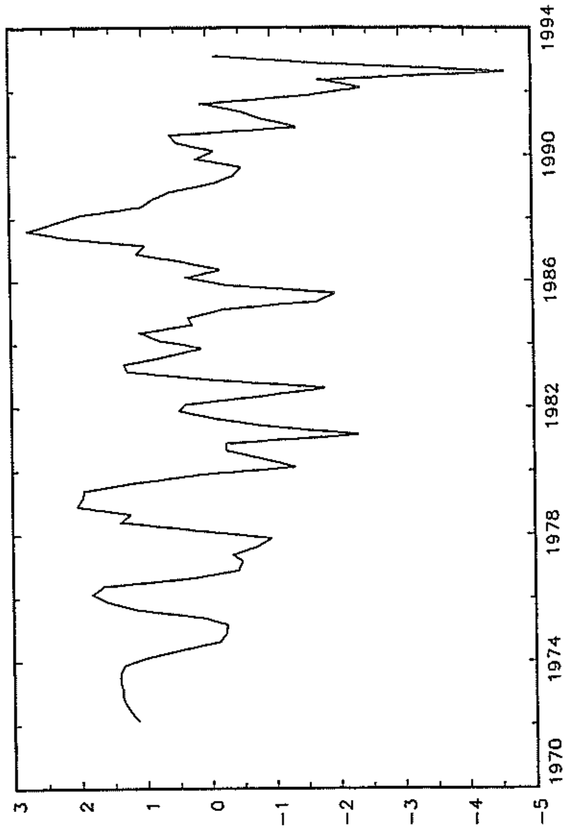


Figure A1. Variable: MP1

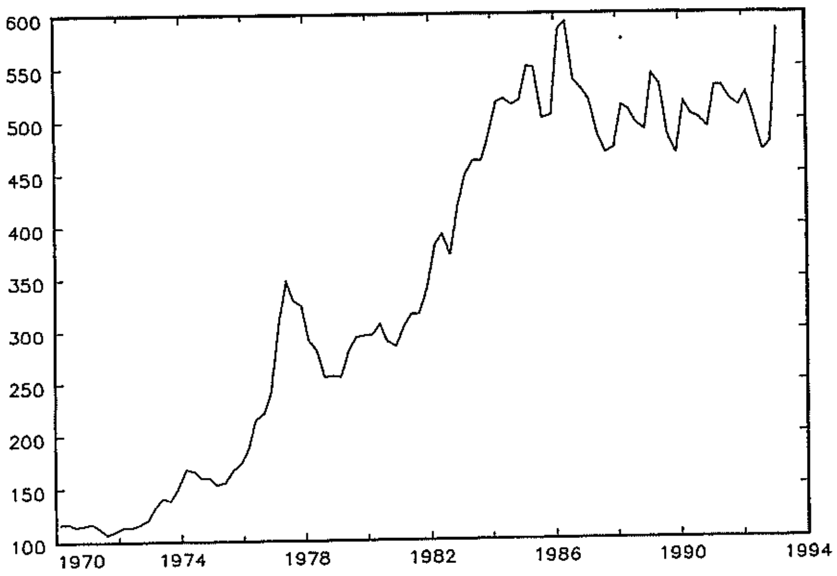
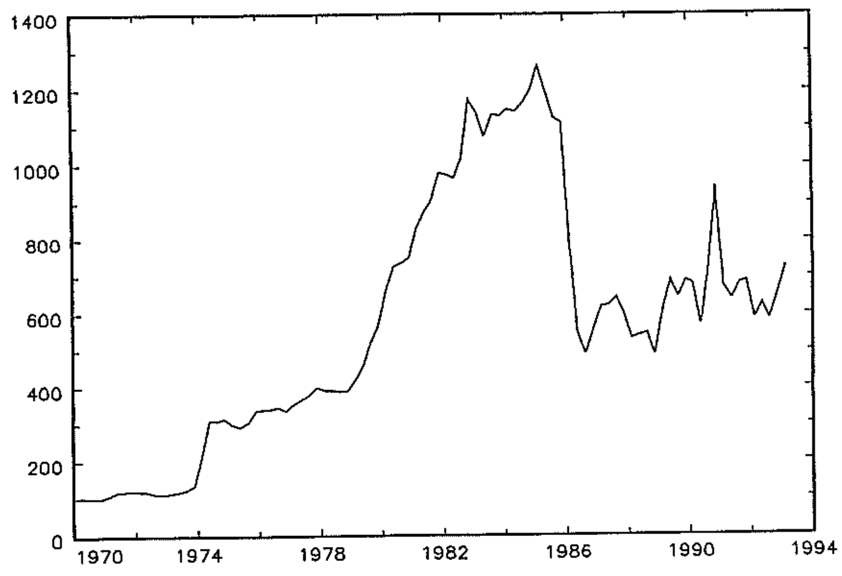


Figure A1. Variable: MP2



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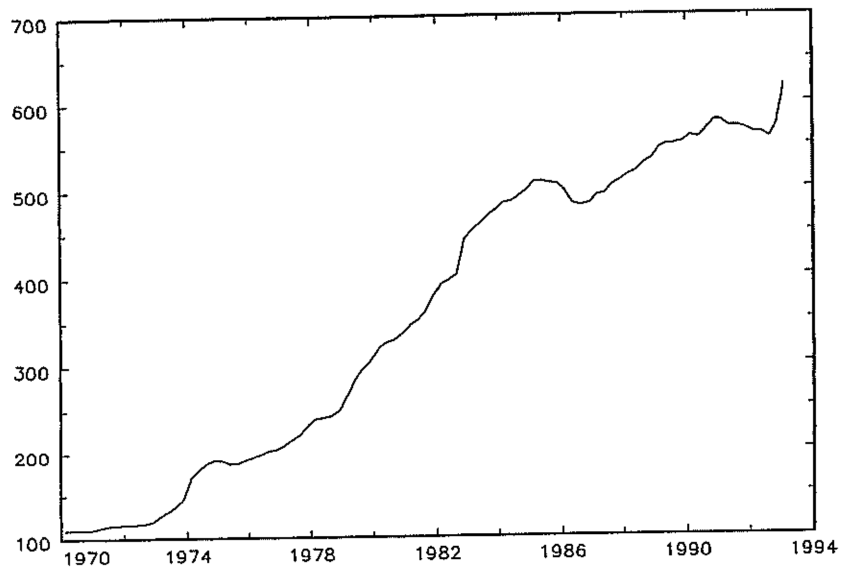


Figure A1. Variable: OPI

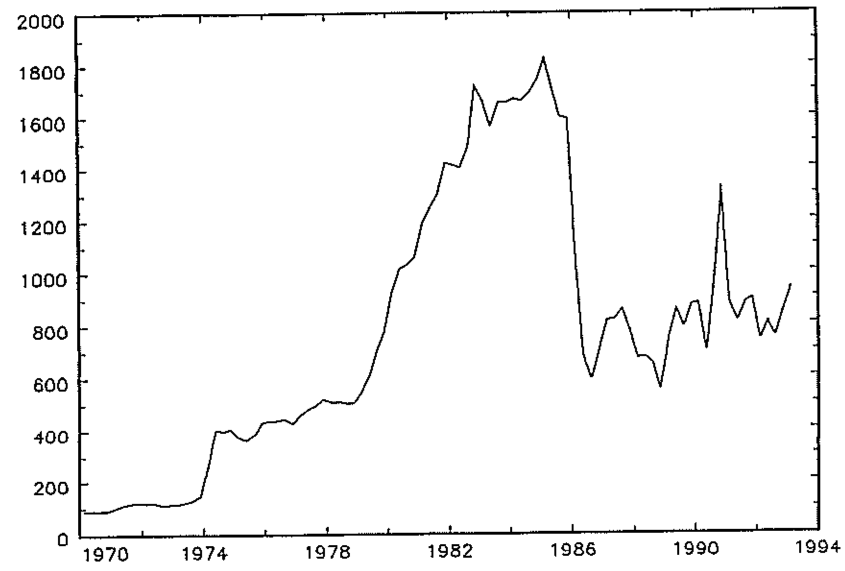
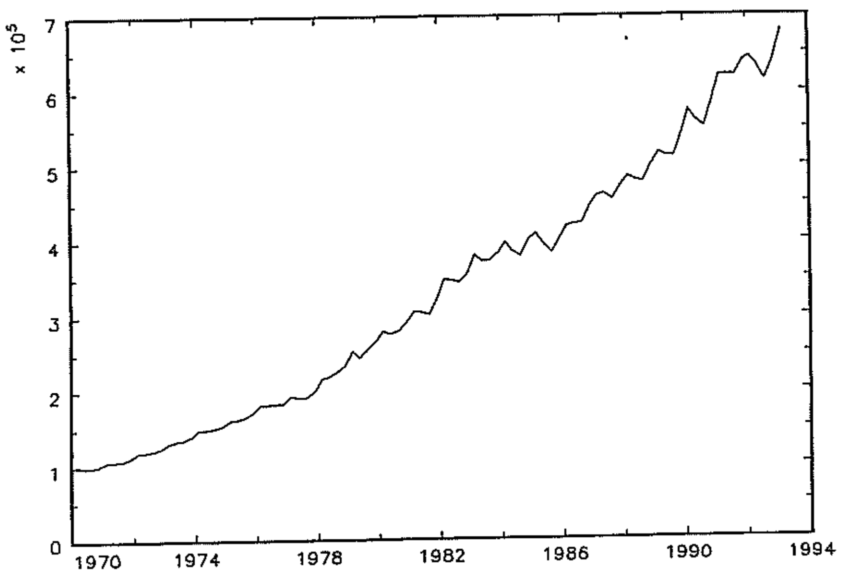


Figure A1. Variable: M3



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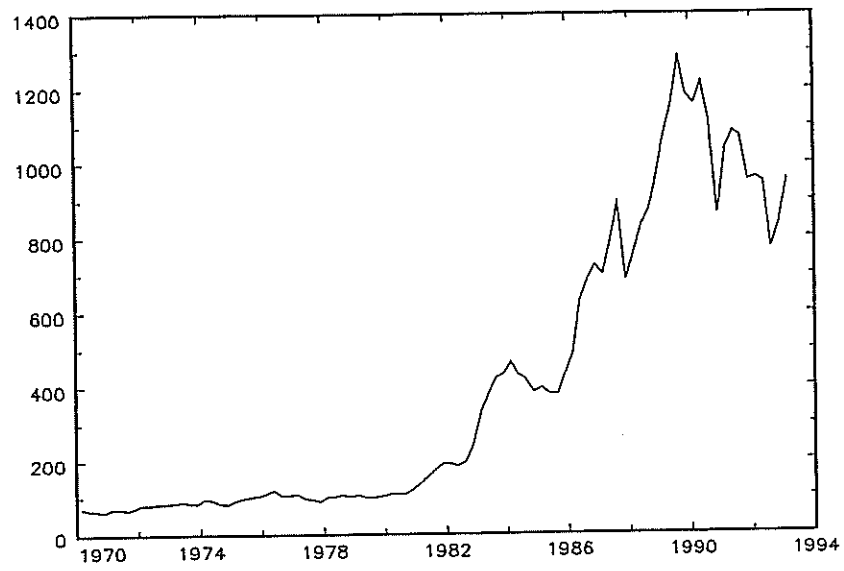


Figure A1. Variable: XP

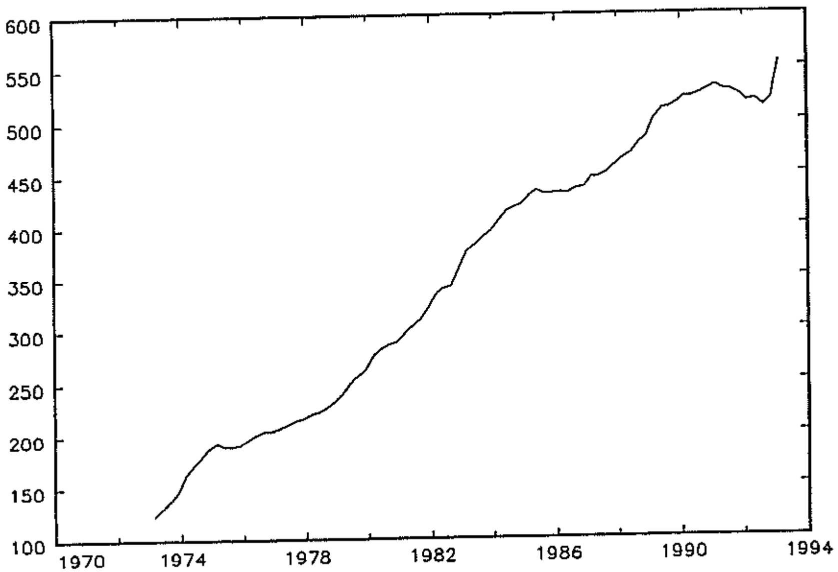
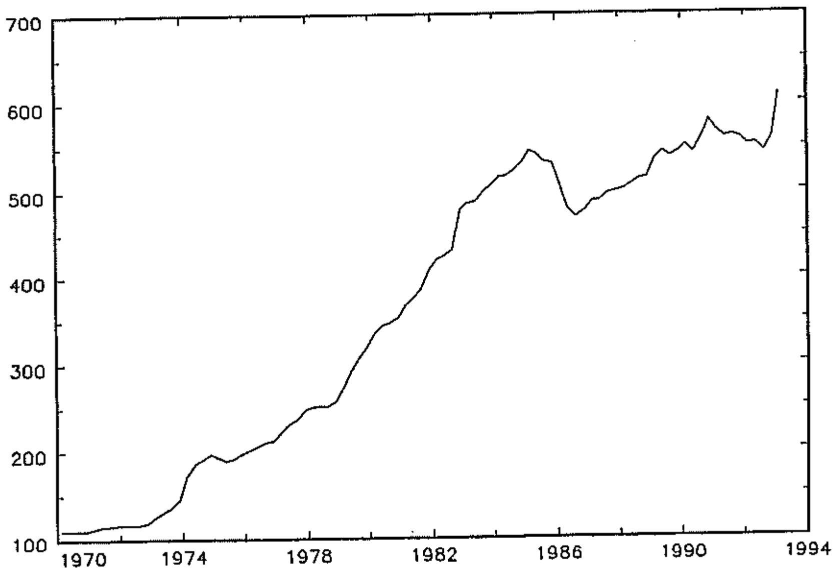


Figure A1. Variable: MP



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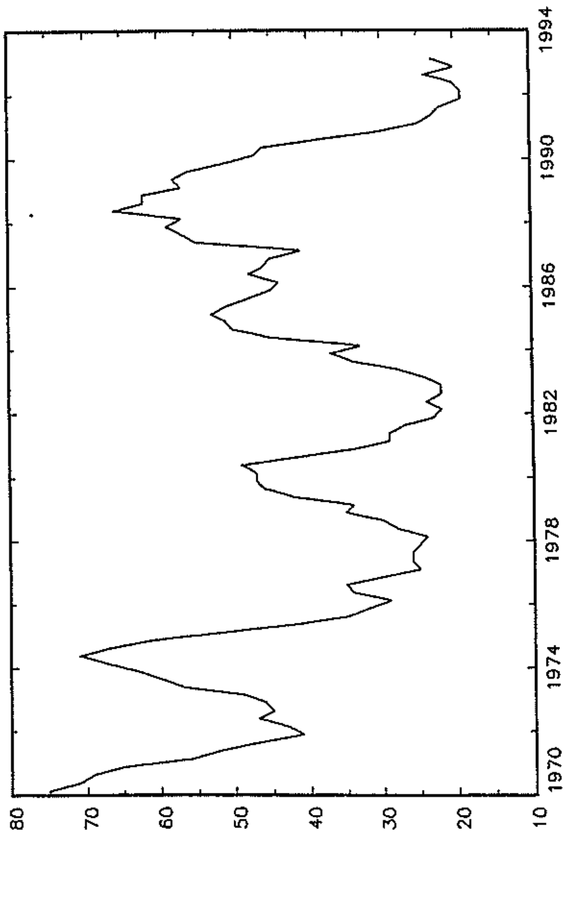


Figure A1. Variable: ISL

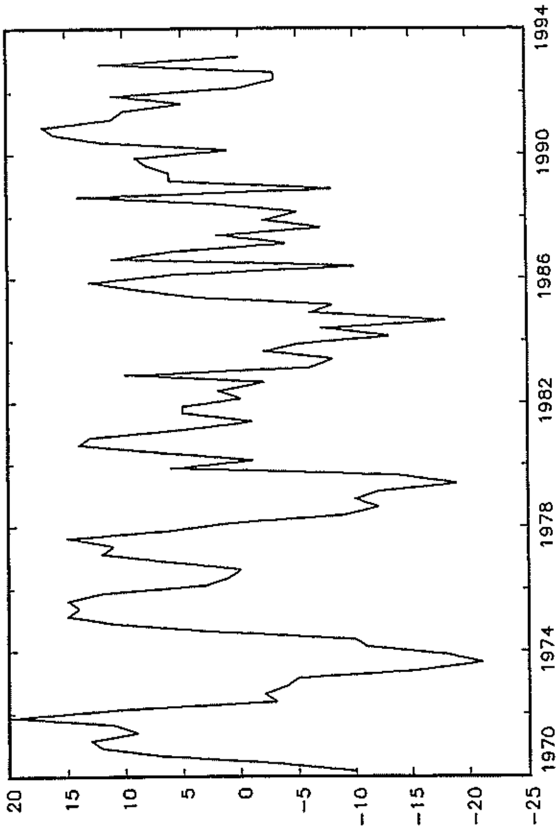
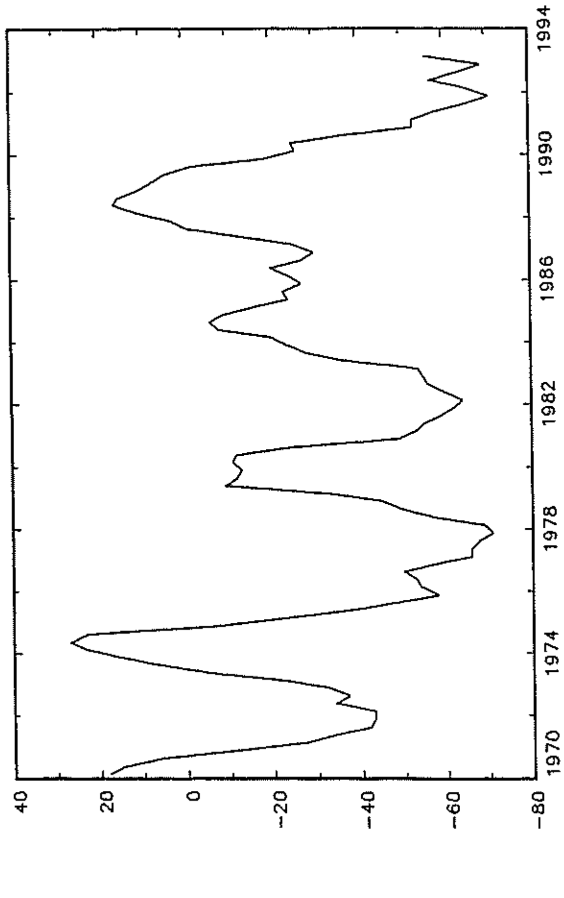


Figure A1. Variable: ORS



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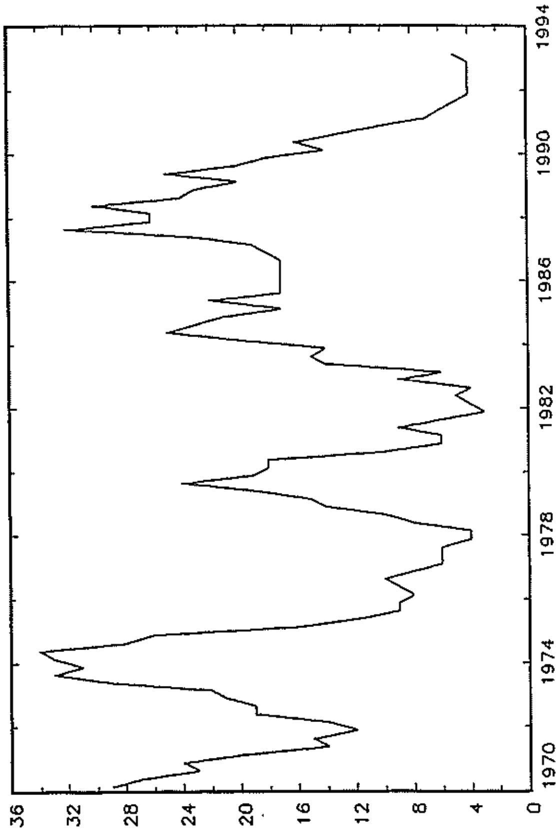

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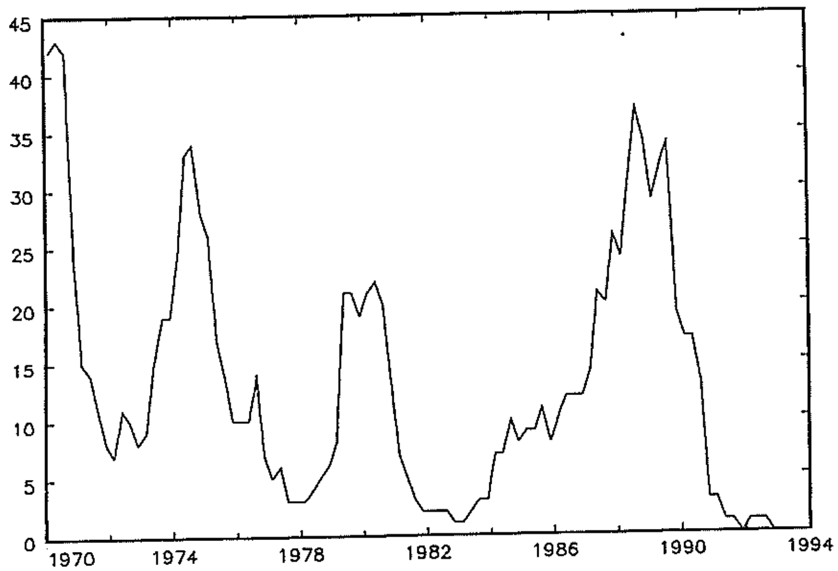


Figure A1. Variable: BOI

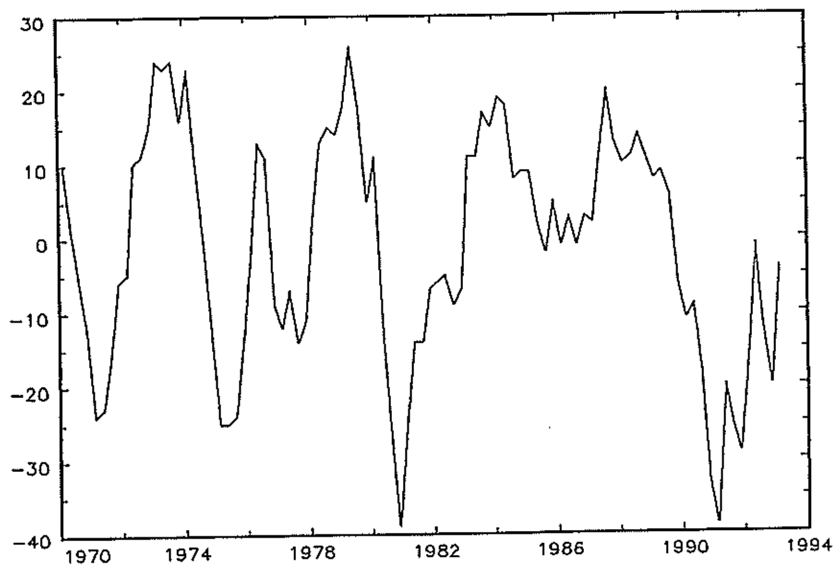


Figure A1. Variable: BOB

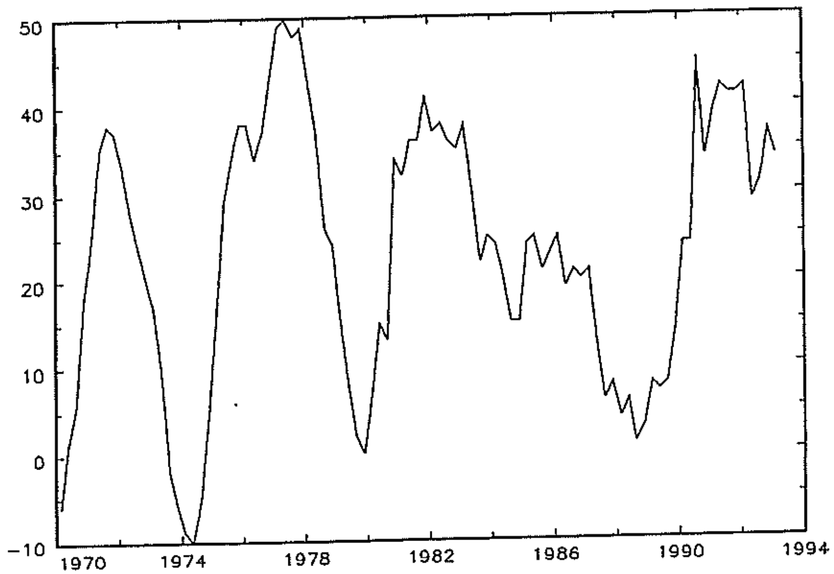


Figure A1. Variable: NOM

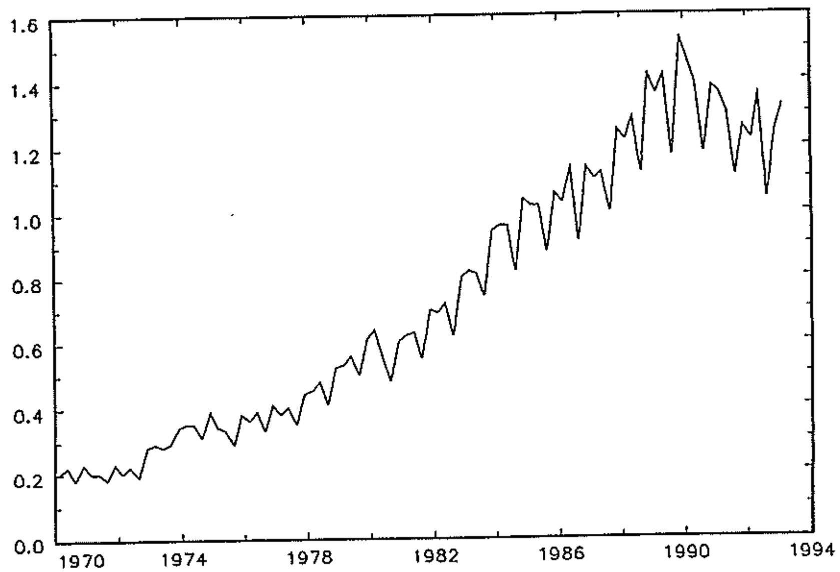


Figure A1. Variable: RST

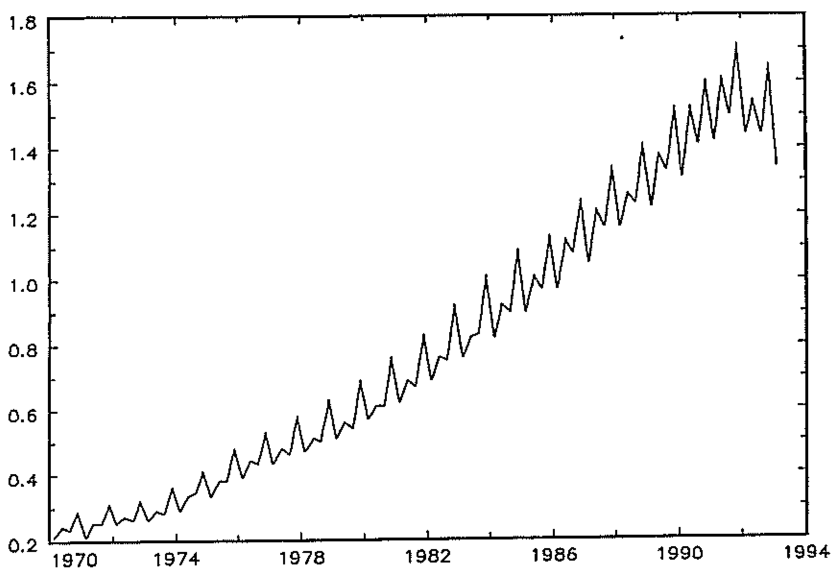
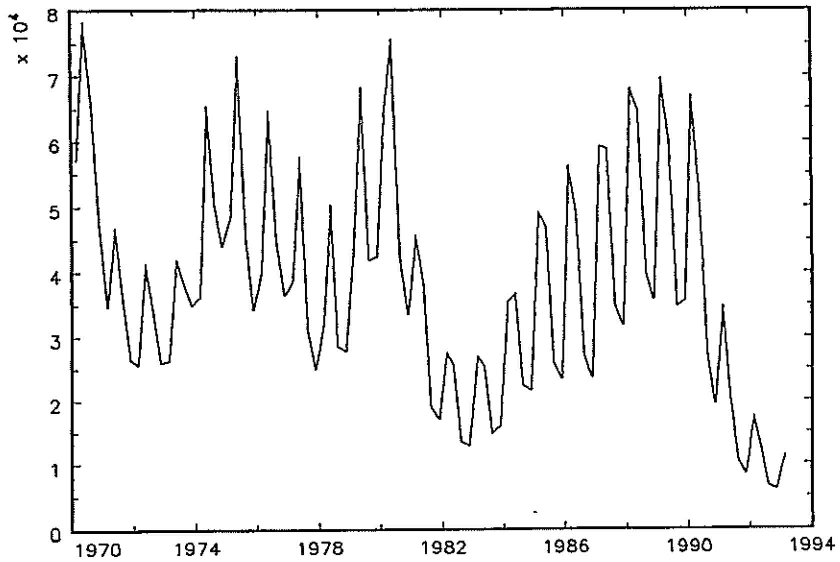


Figure A1. Variable: JBV



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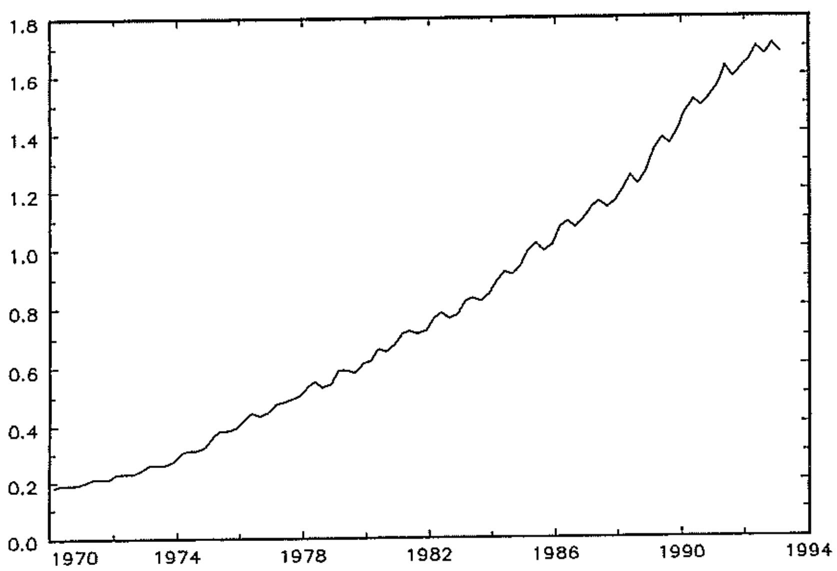

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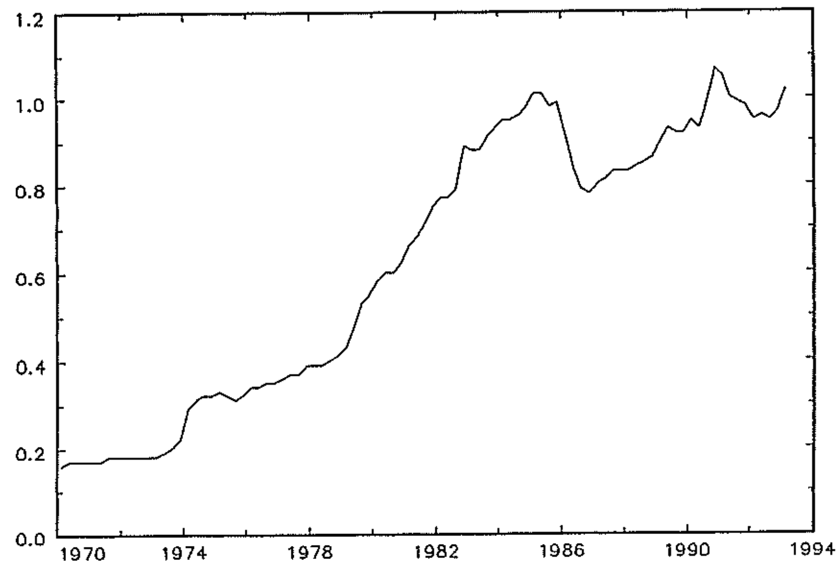

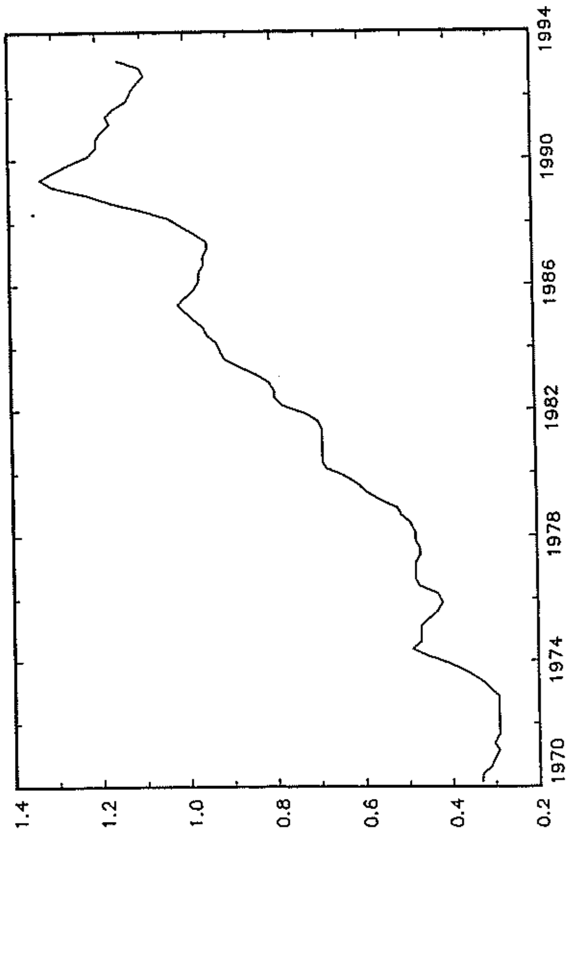

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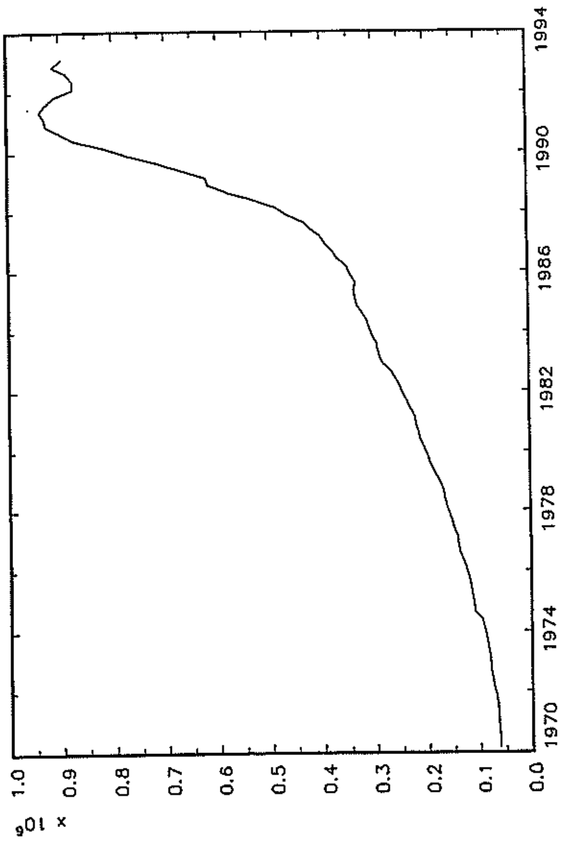

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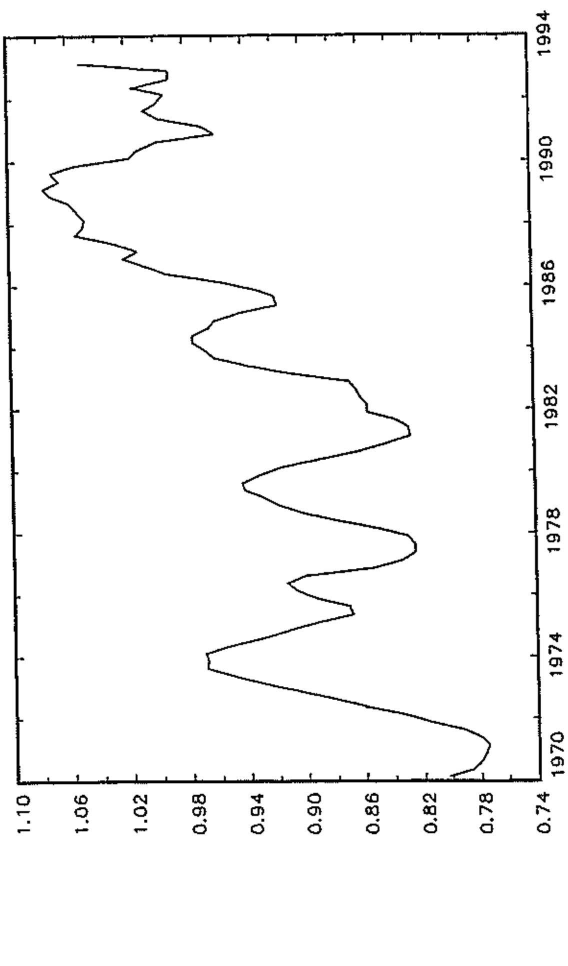

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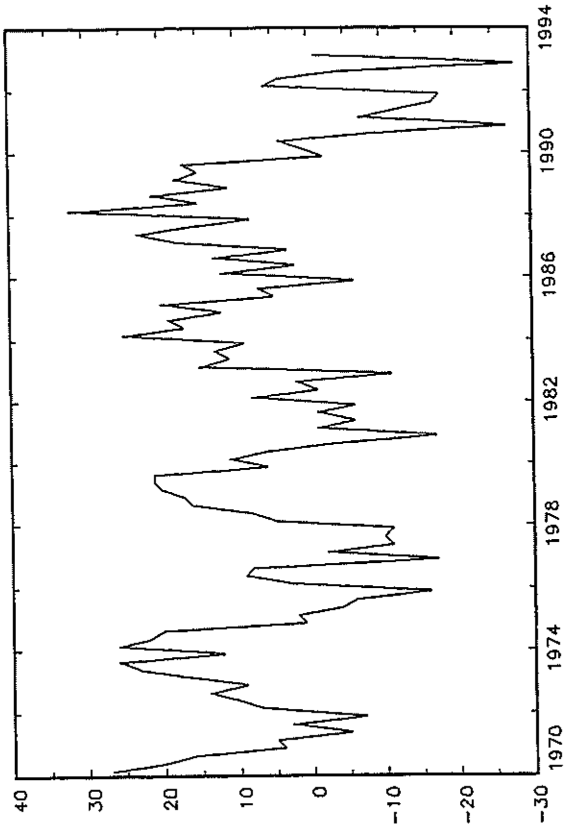


Figure A1. Variable: PFT

Figure A1. Variable: UPC

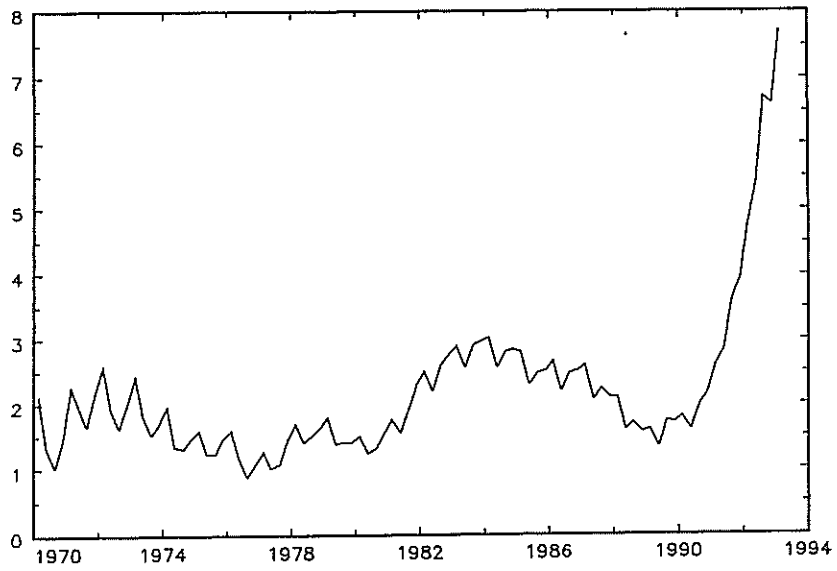


Figure A1. Variable: GDP

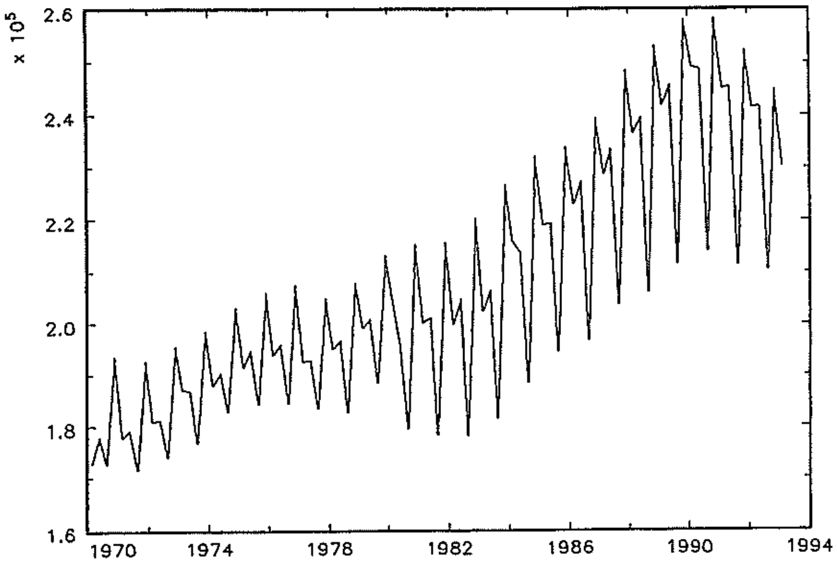


Figure A1. Variable: EXH

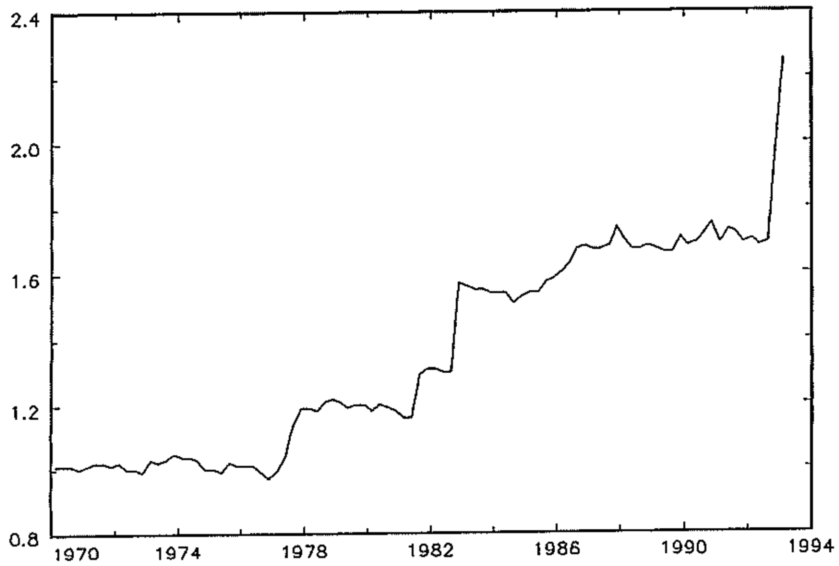


Figure A2. Variable: ICPI

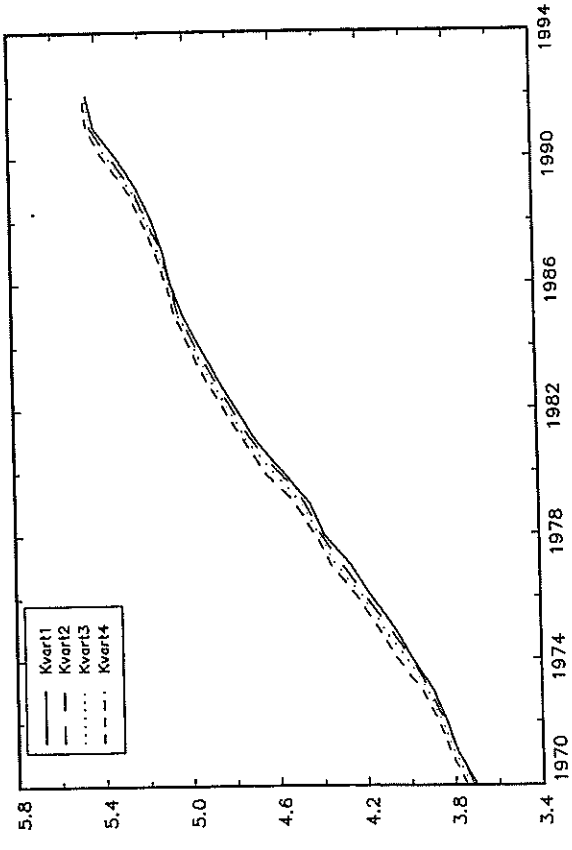


Figure A2. Variable: IM3

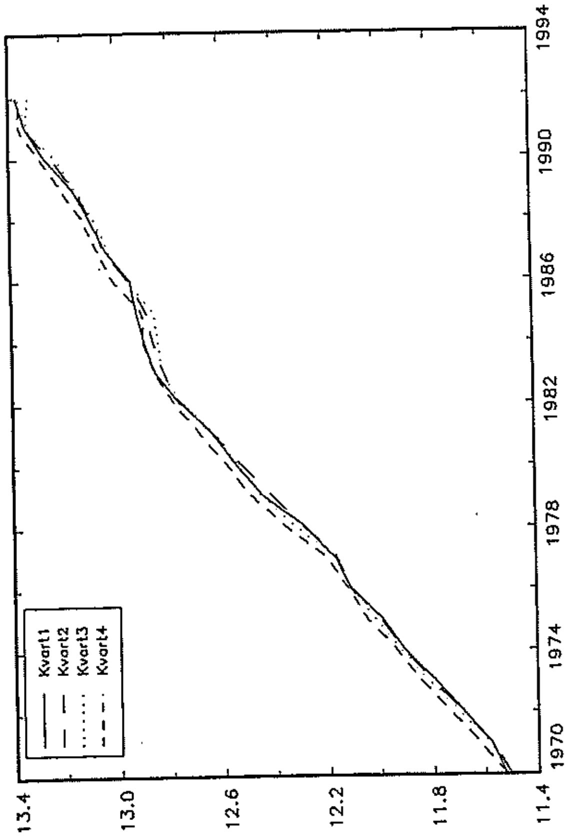
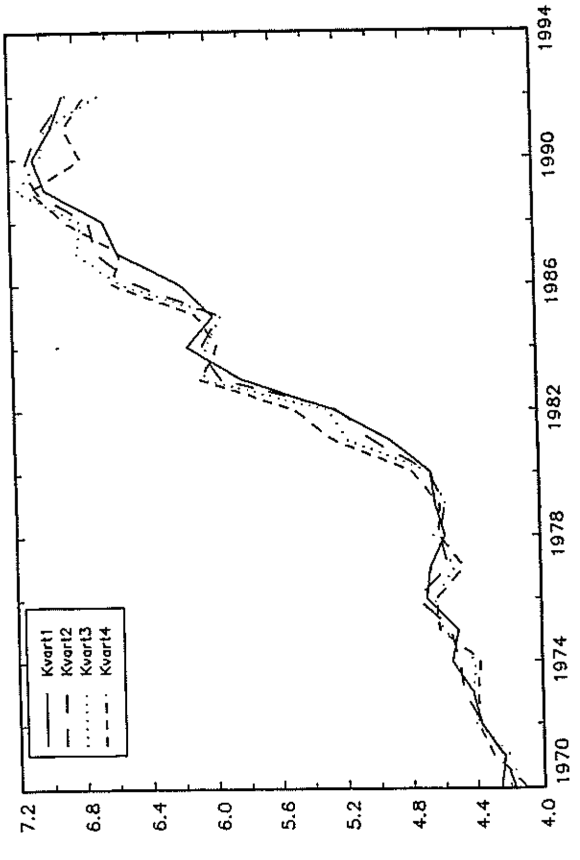


Figure A2. Variable: ISMI



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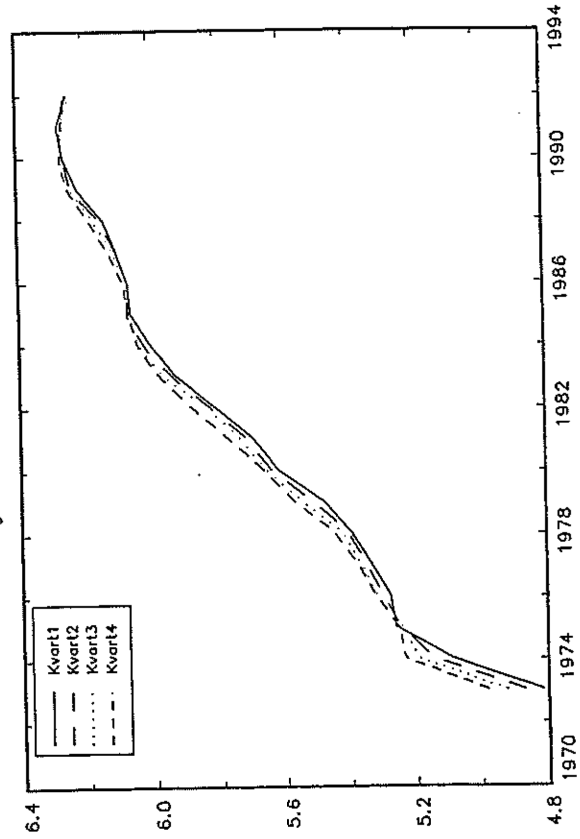


Figure A2. Variable: IMP

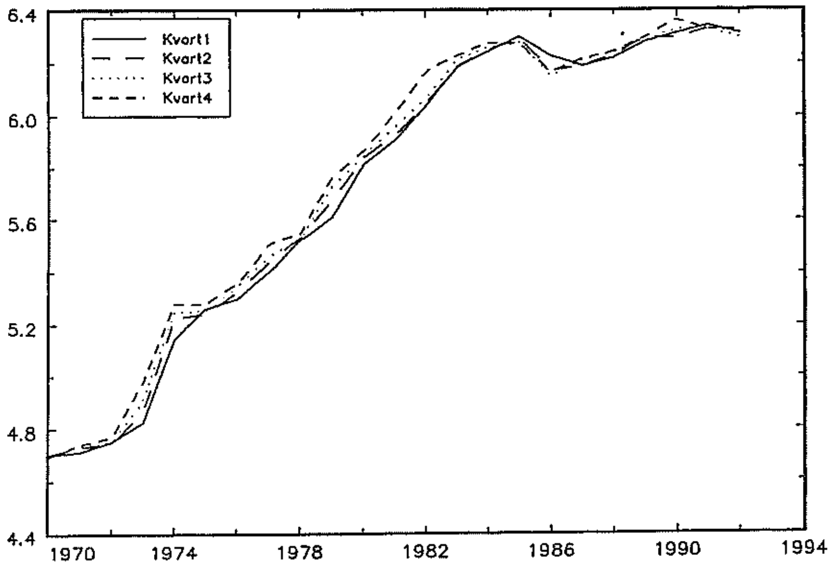


Figure A2. Variable: IMP1

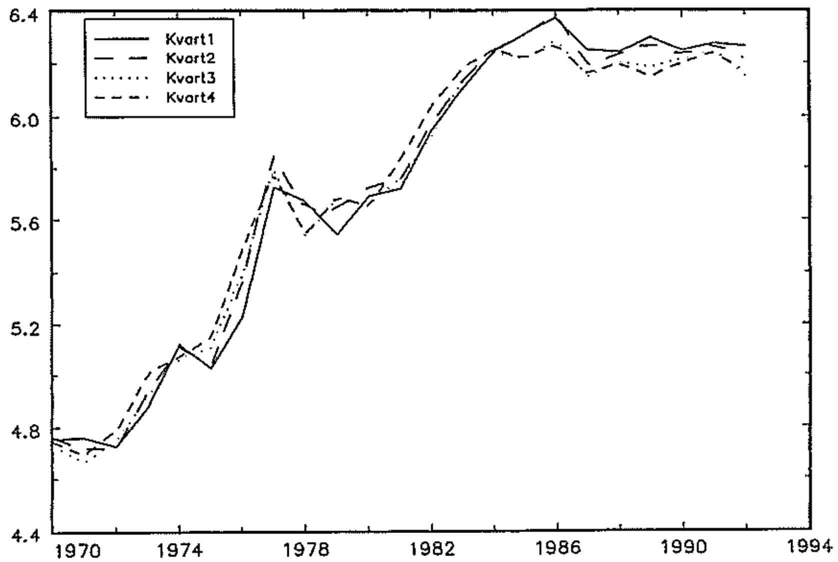


Figure A2. Variable: IMP2

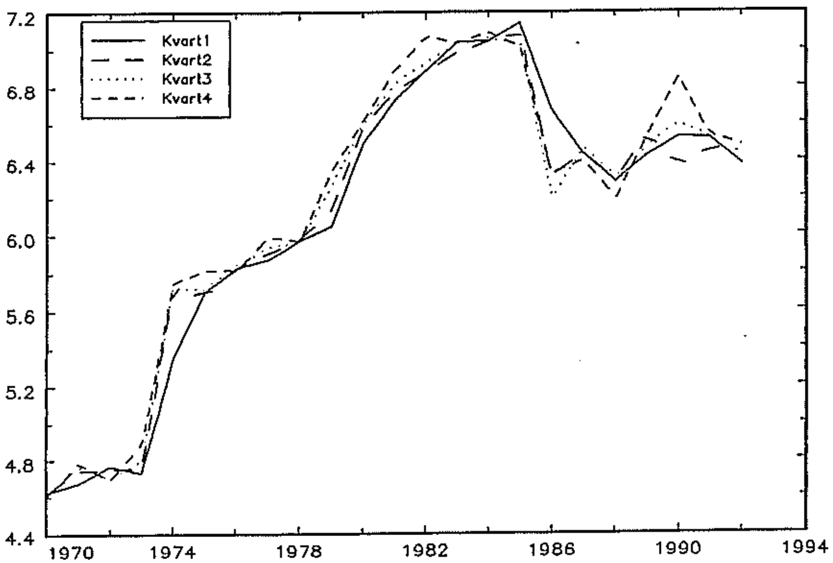


Figure A2. Variable: IMP3

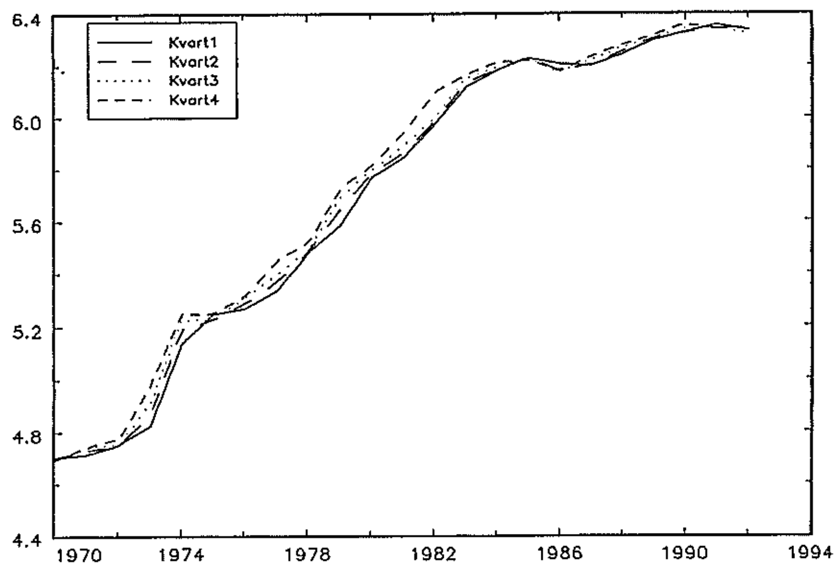


Figure A2. Variable: IOPI

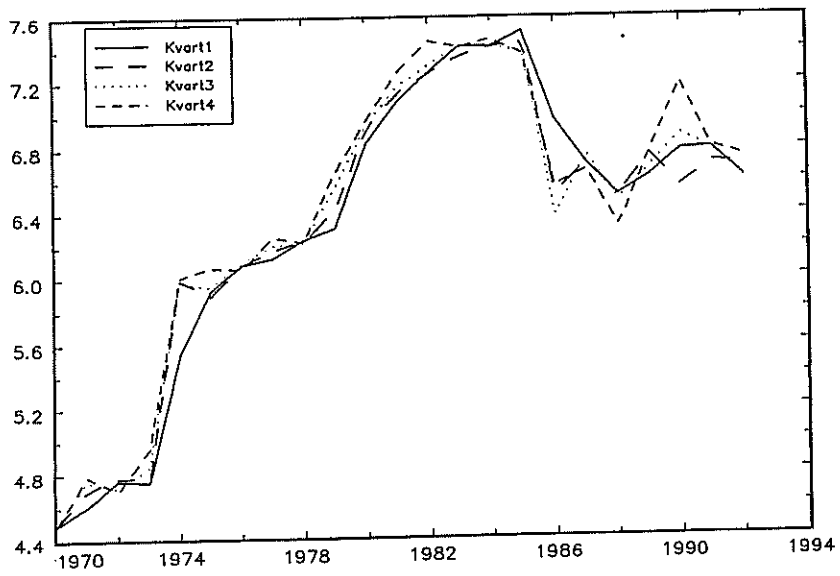


Figure A2. Variable: INOM

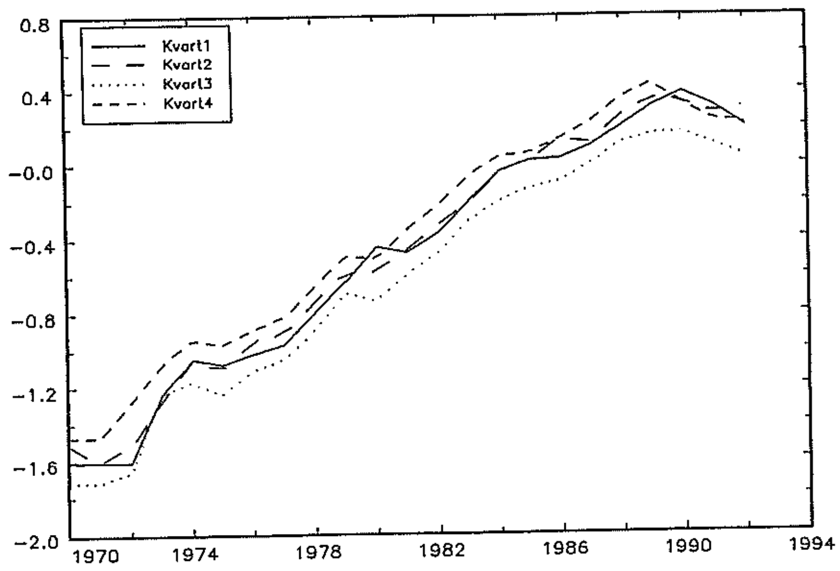


Figure A2. Variable: IRST

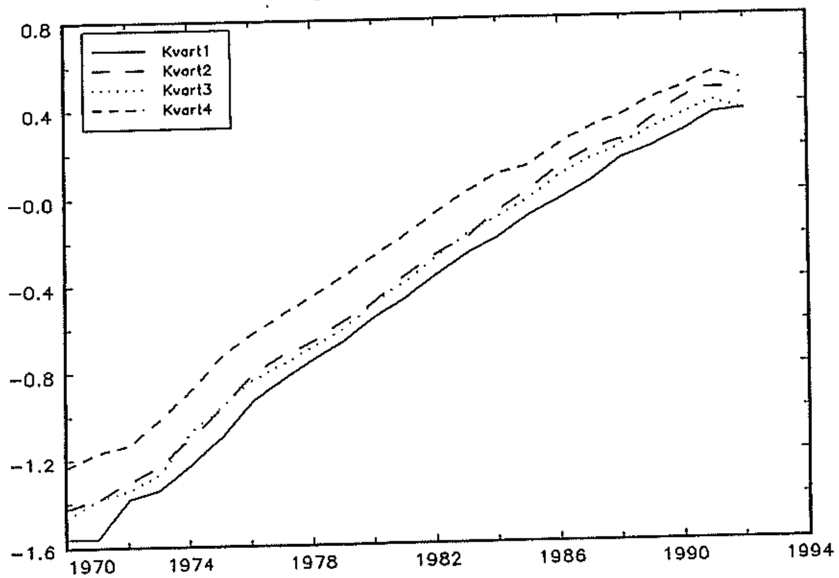
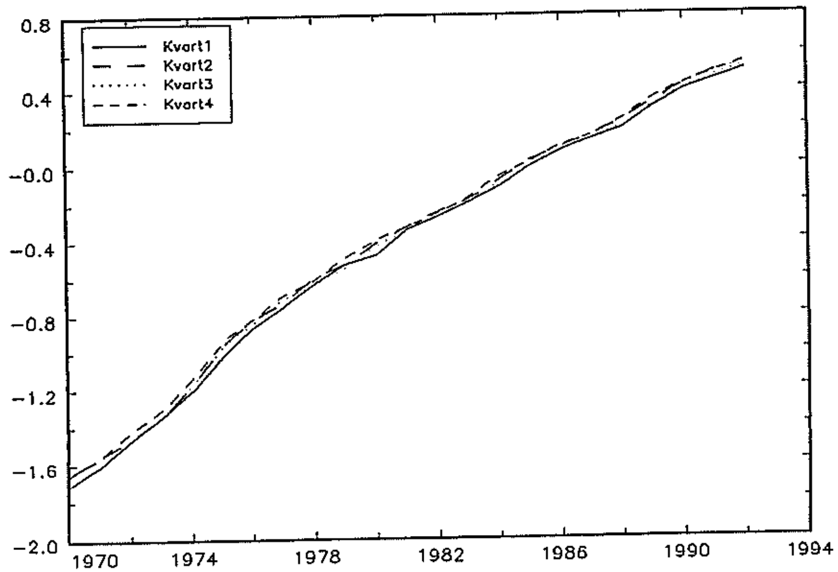
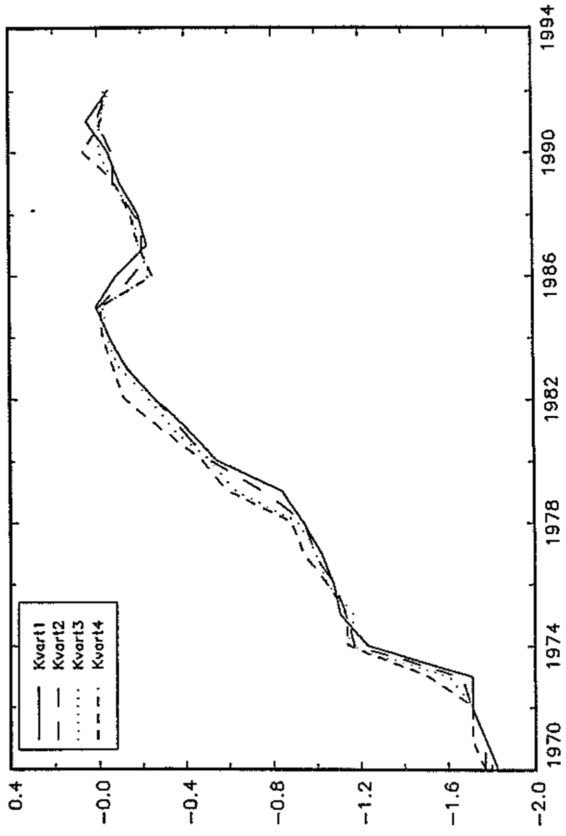


Figure A2. Variable: ILCH





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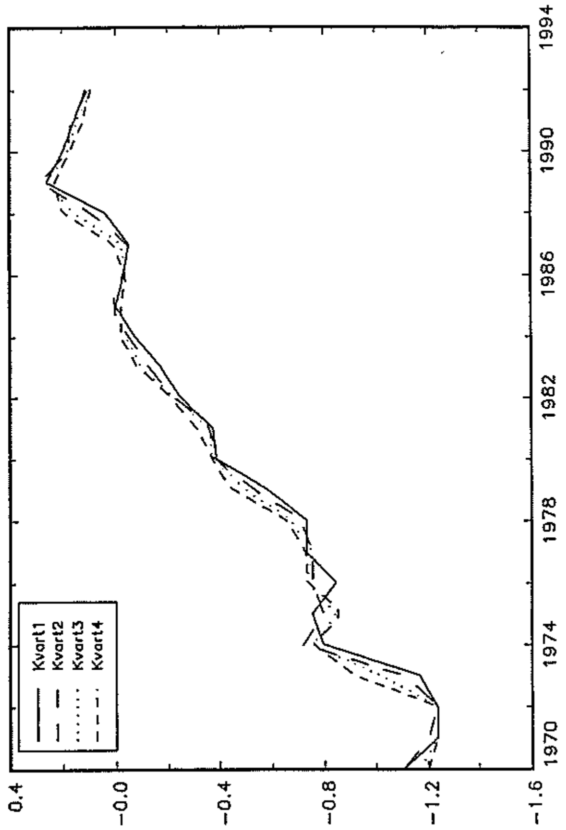


Figure A2. Variable: IPIM

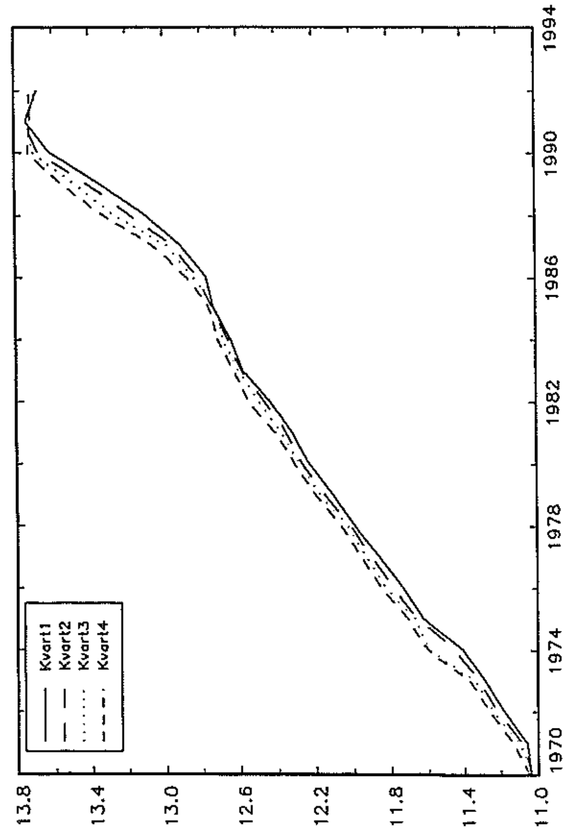


Figure A2. Variable: ICRP

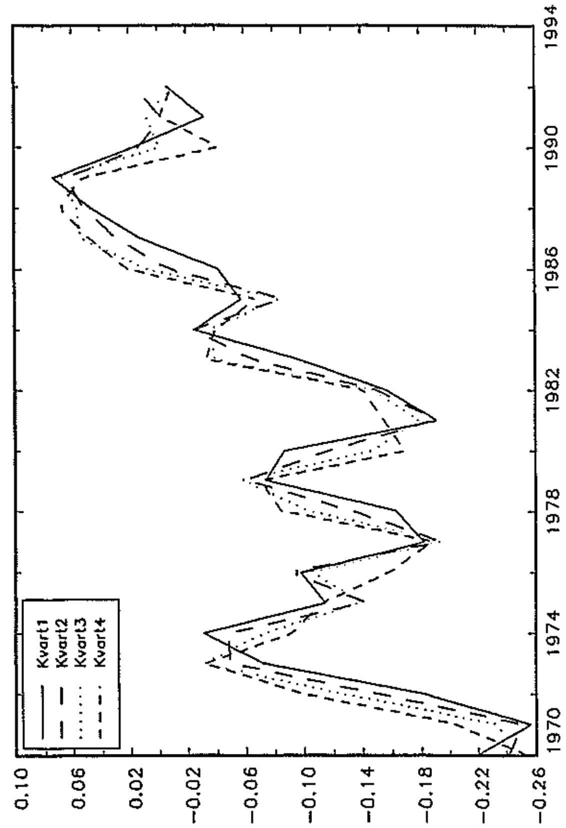


Figure A2. Variable: ICLI

Figure A2. Variable: lGDP

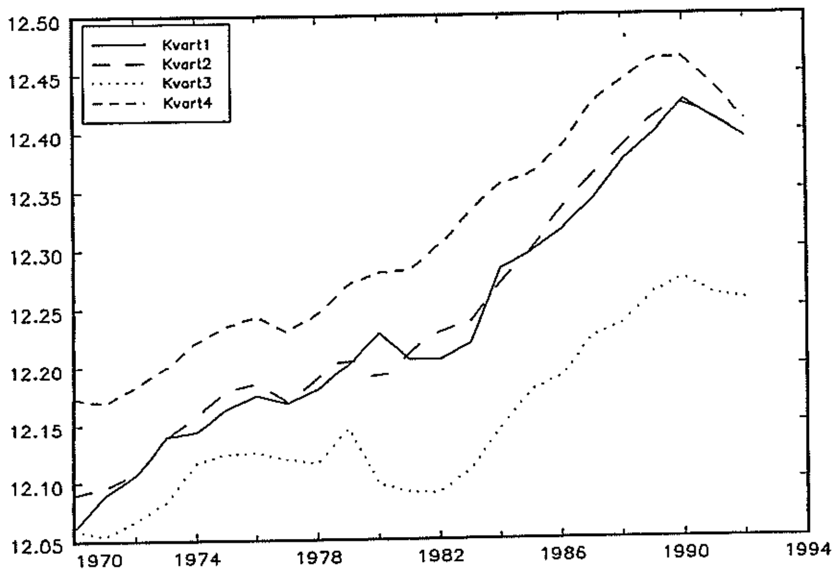


Figure A2. Variable: lEXH

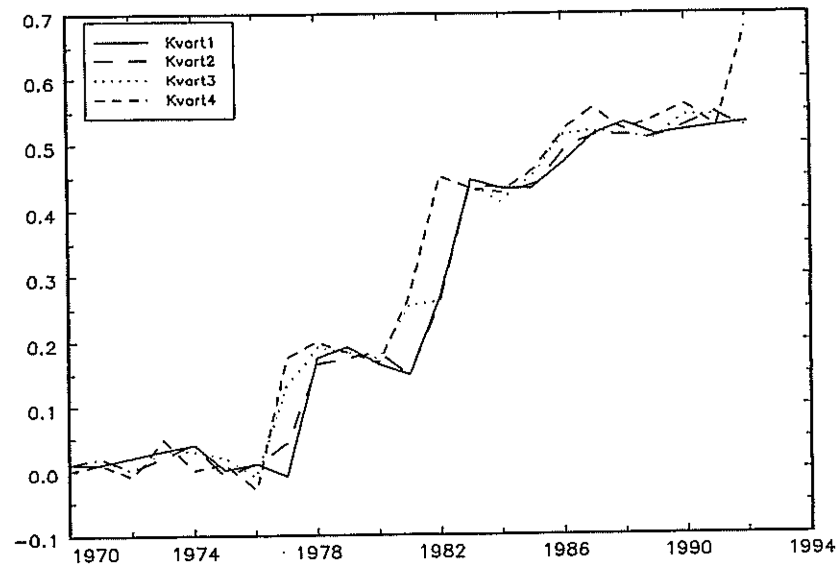


Figure A2. Variable: I3M

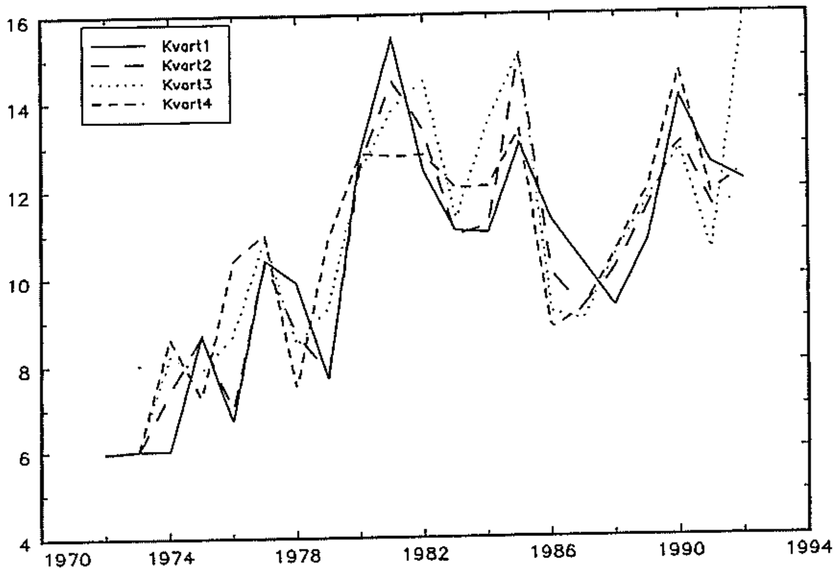


Figure A2. Variable: I5Y

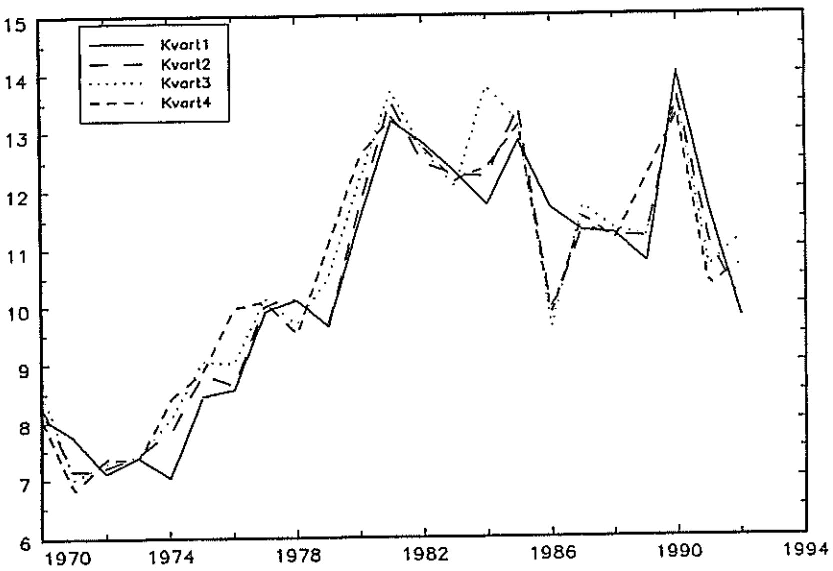


Figure A2. Variable: YLD

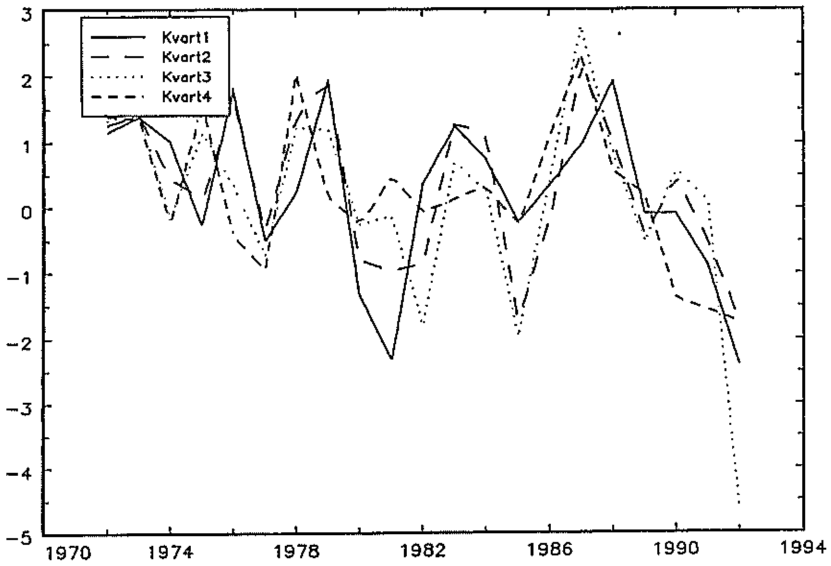


Figure A2. Variable: FCU

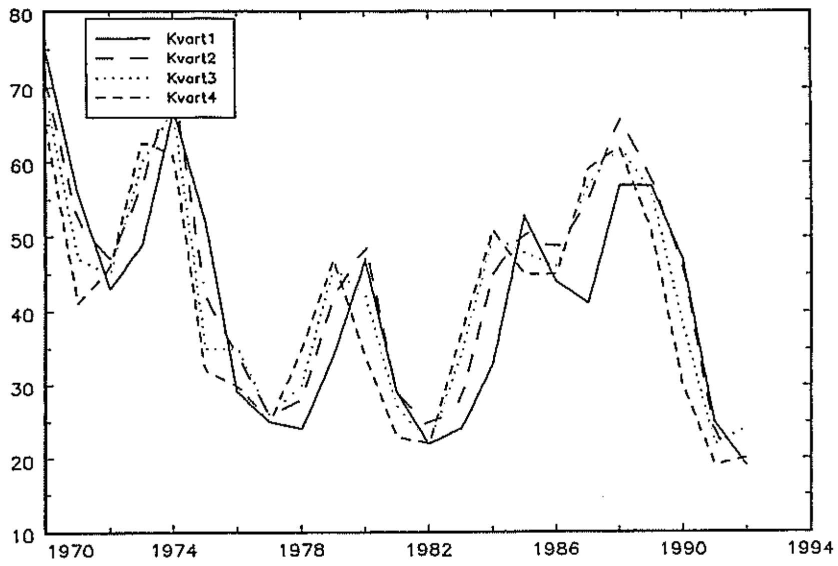


Figure A2. Variable: ISL

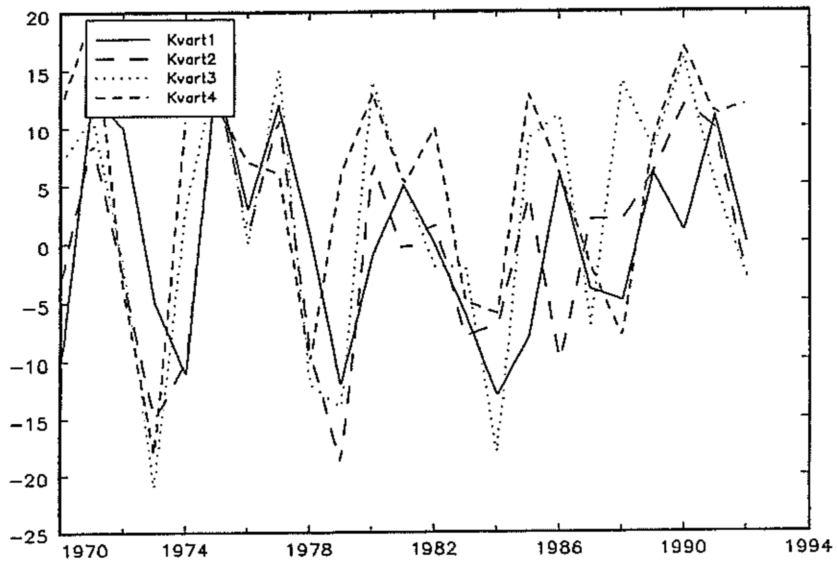


Figure A2. Variable: ORS

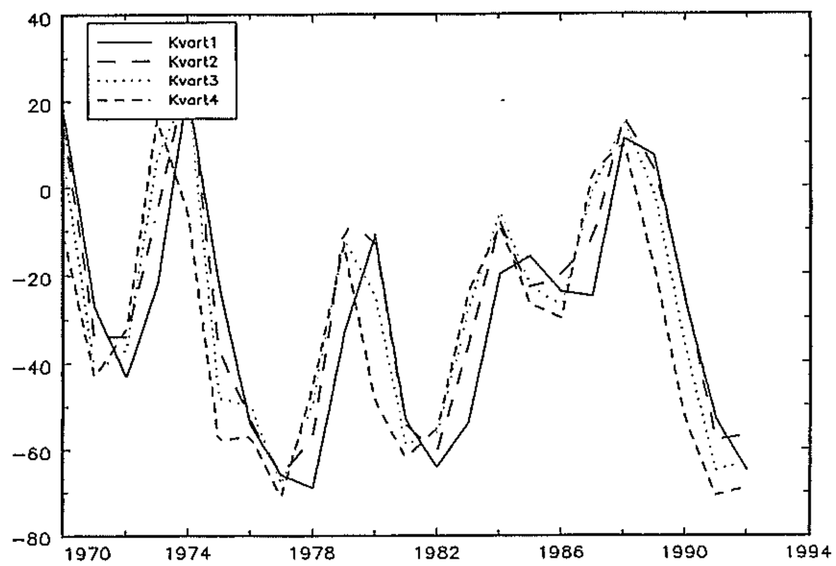


Figure A2. Variable: MCI

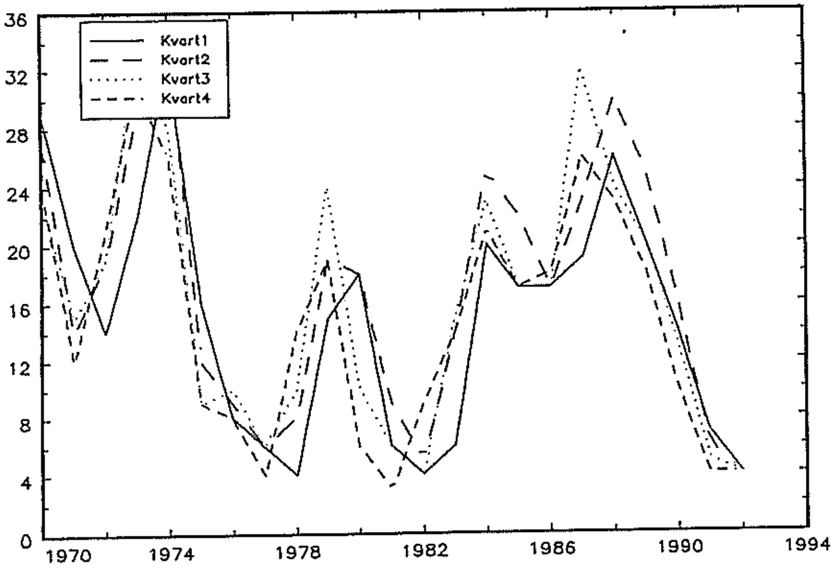


Figure A2. Variable: LBA

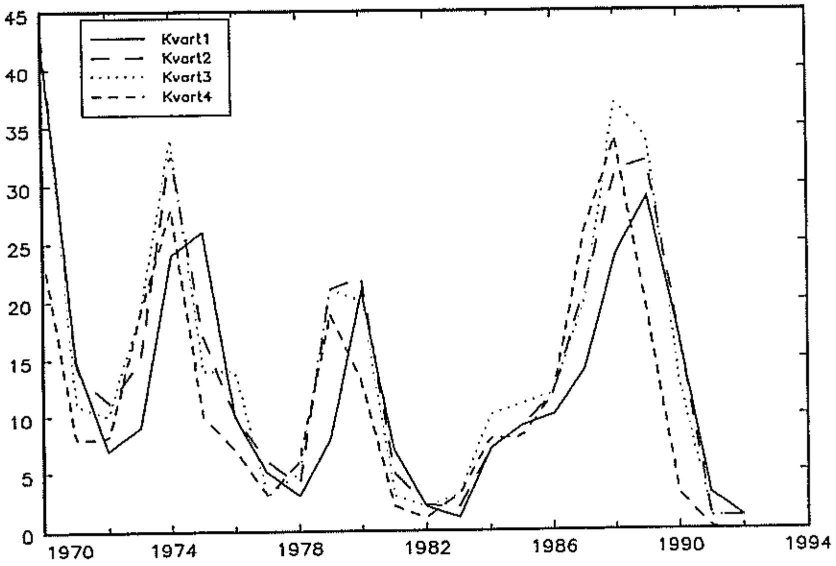


Figure A2. Variable: BOI

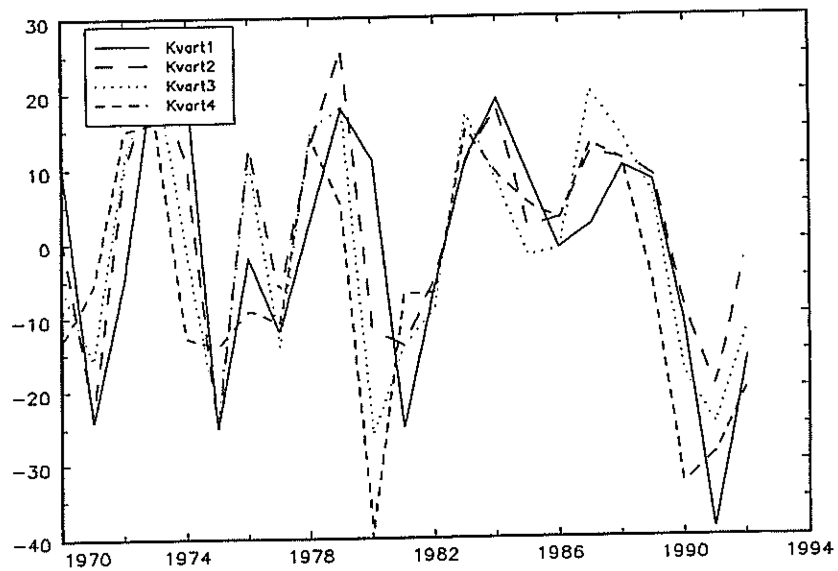


Figure A2. Variable: BOB

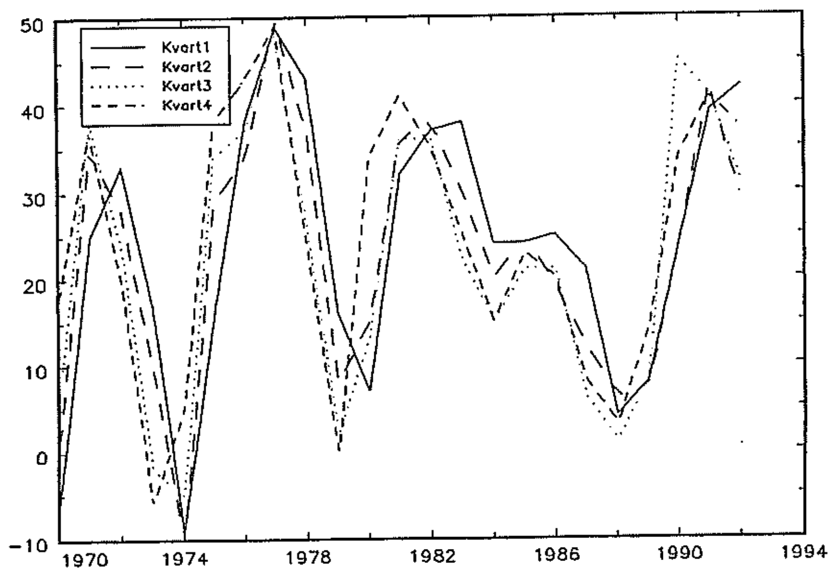


Figure A2. Variable: JBV

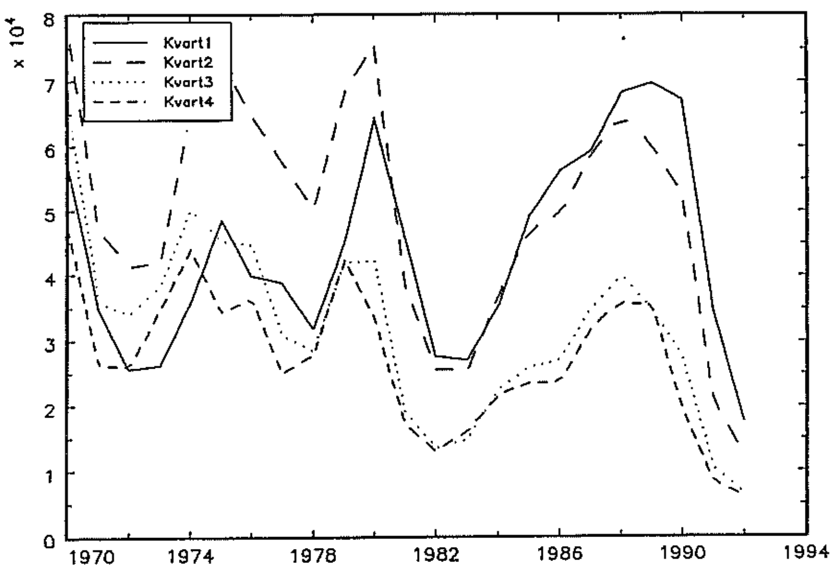


Figure A2. Variable: PFT

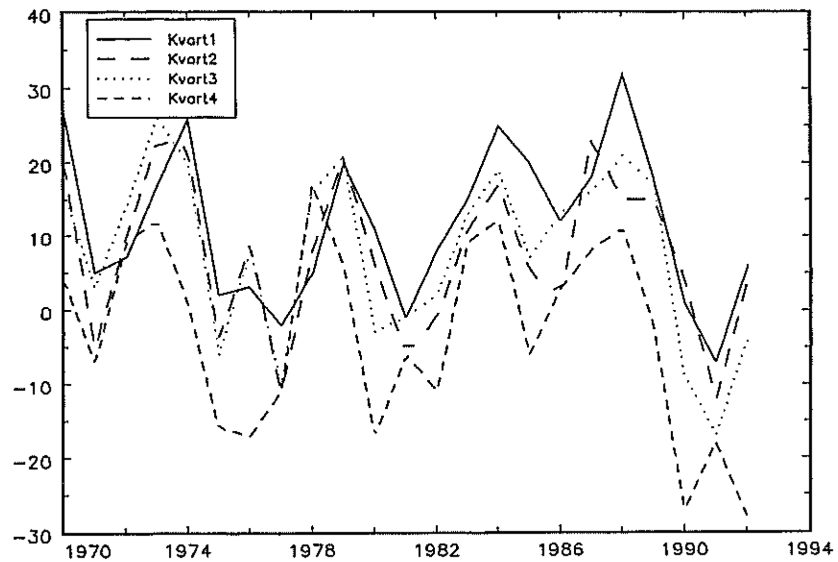
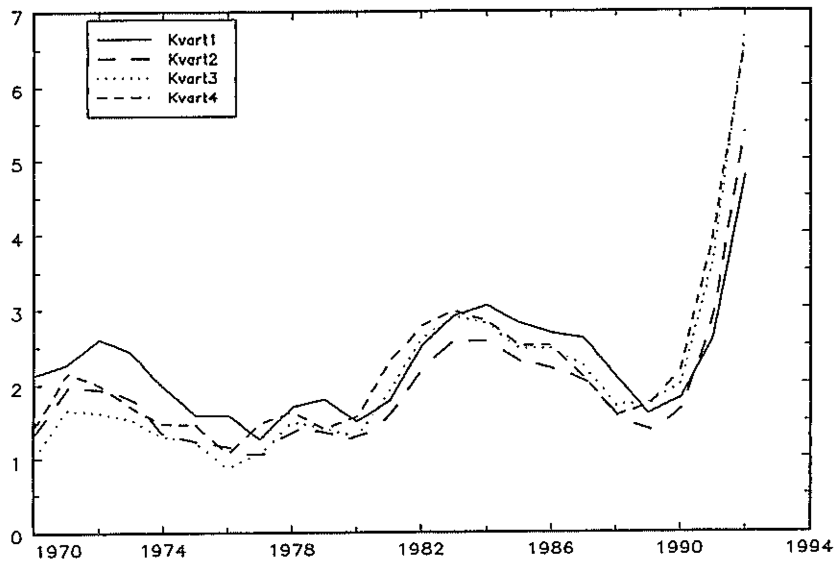


Figure A2. Variable: UPC



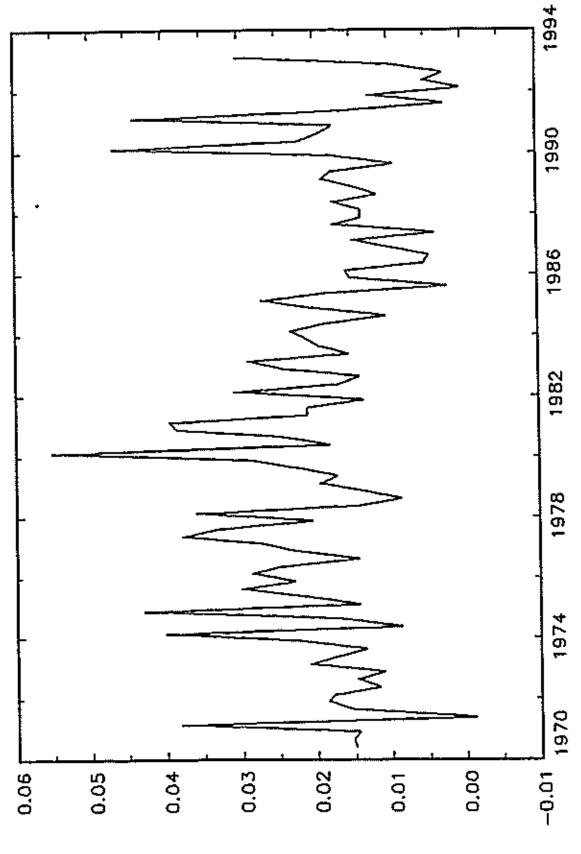


Figure A3. Variable: dlCPI

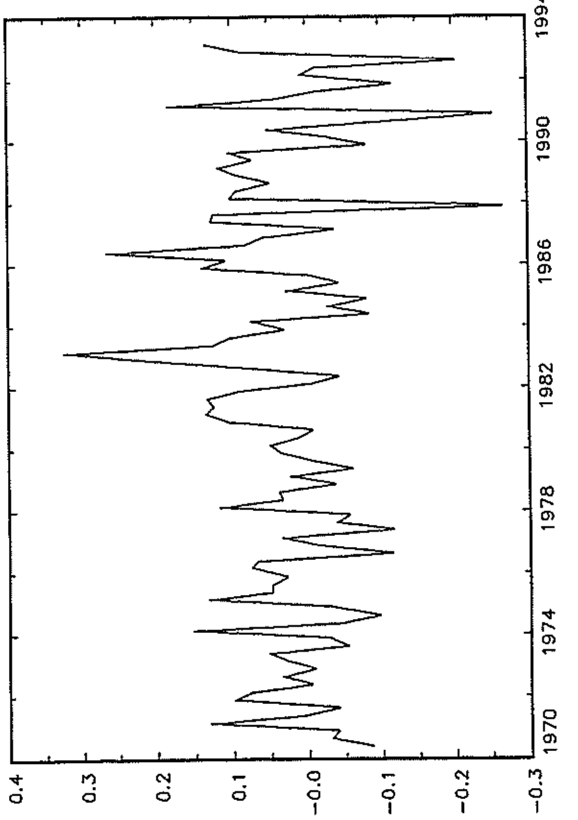


Figure A3. Variable: dlSMI

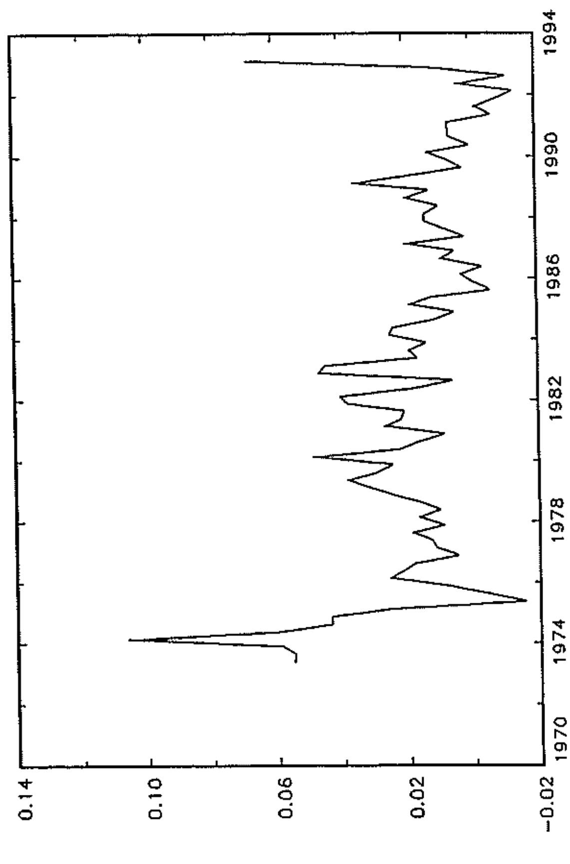


Figure A3. Variable: dlXP

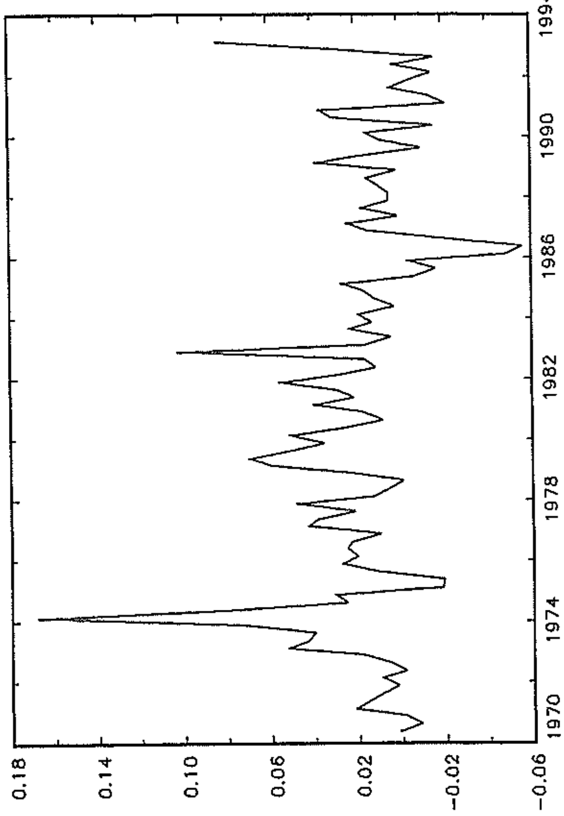


Figure A3. Variable: dlMP

Figure A3. Variable: dIMP1

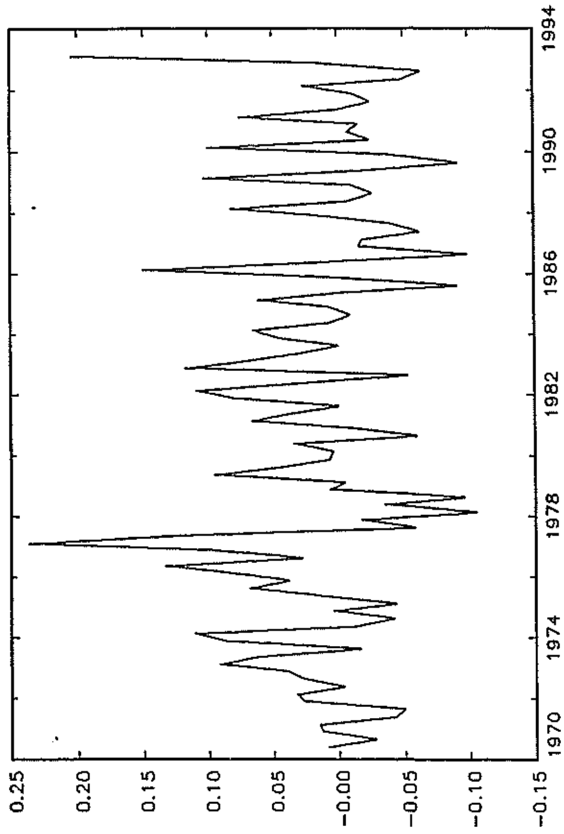


Figure A3. Variable: dIMP2

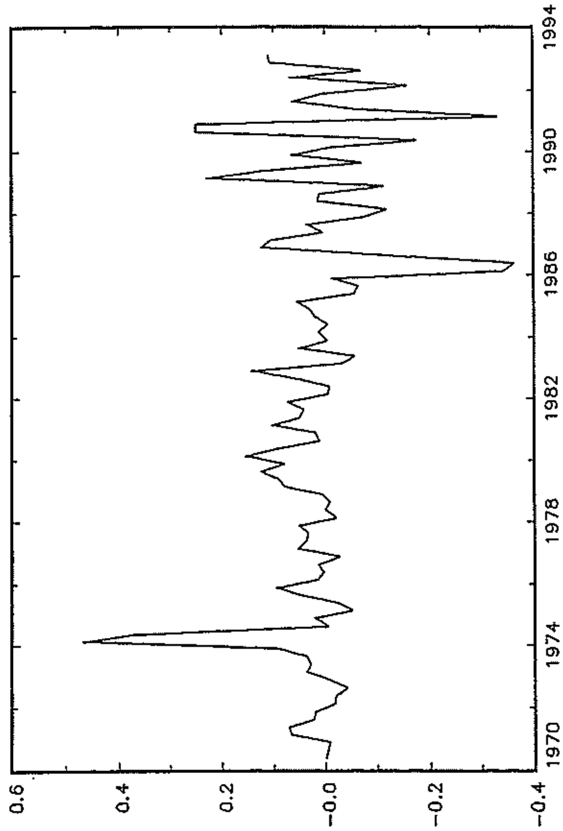


Figure A3. Variable: dIMP3

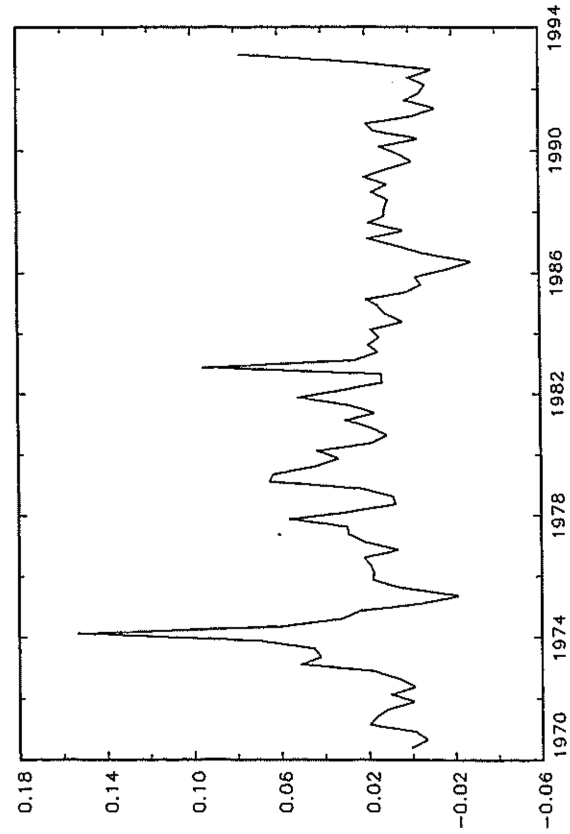
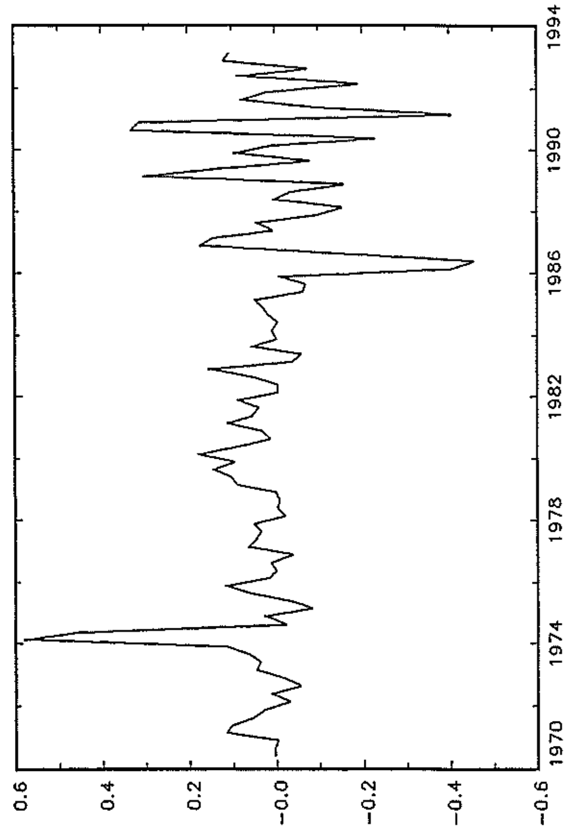


Figure A3. Variable: dIOPI



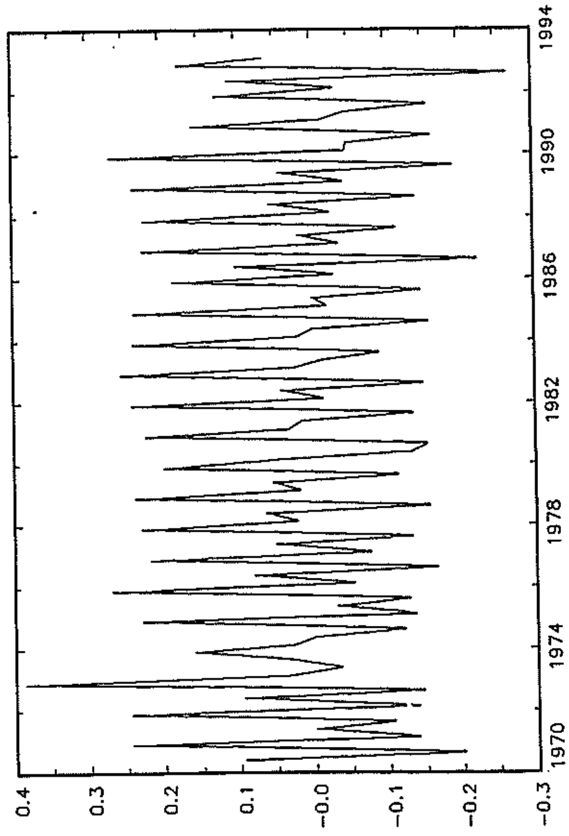


Figure A3. Variable: dINOM

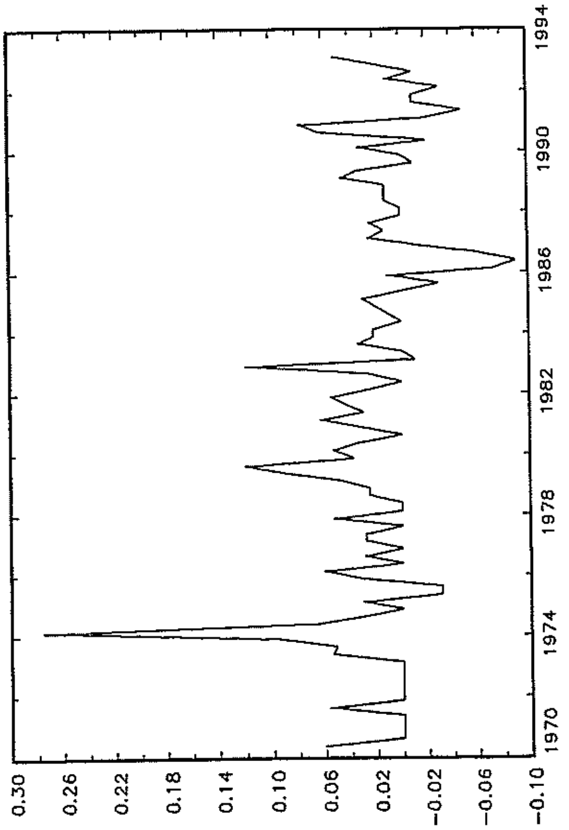
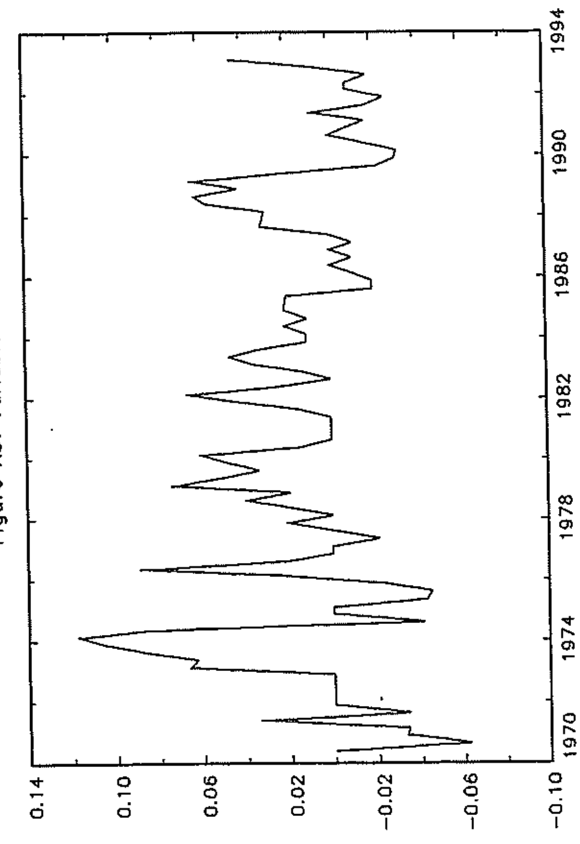


Figure A3. Variable: dIPIC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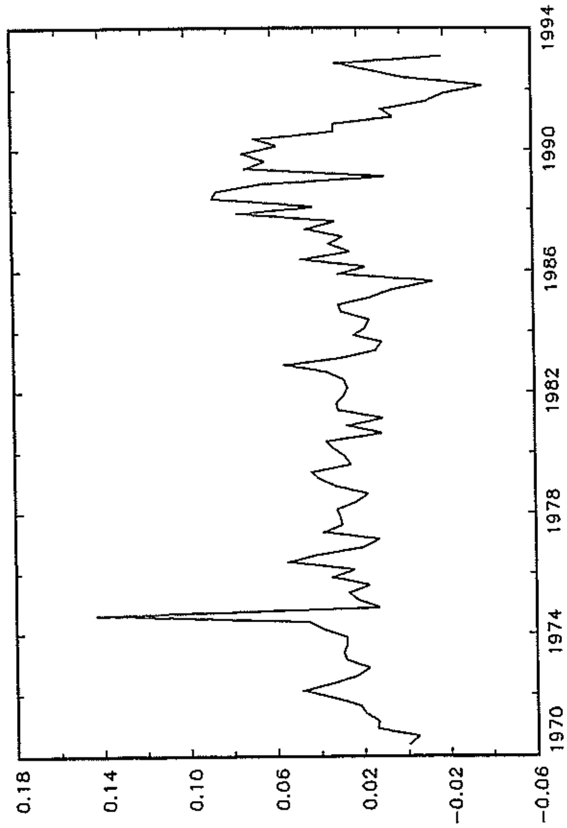


Figure A3. Variable: dICRP

Figure A3. Variable: dlCLI

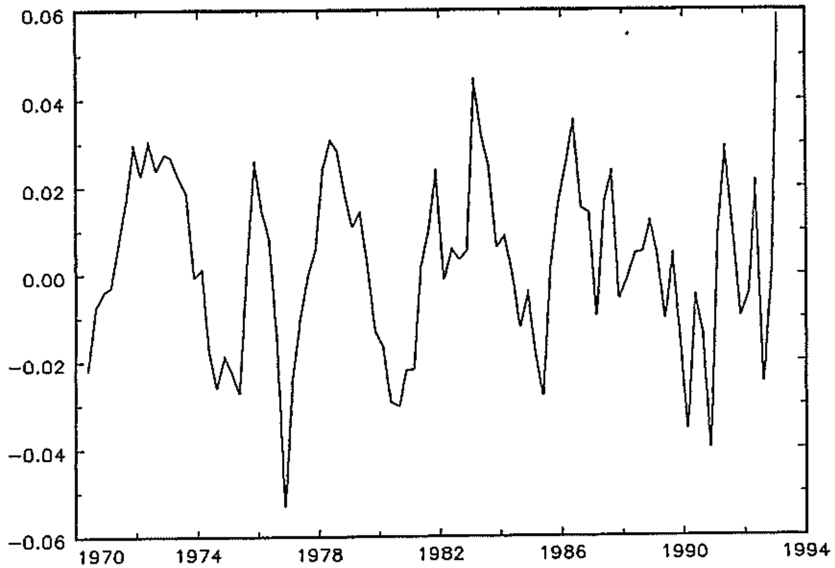


Figure A3. Variable: dlEXH

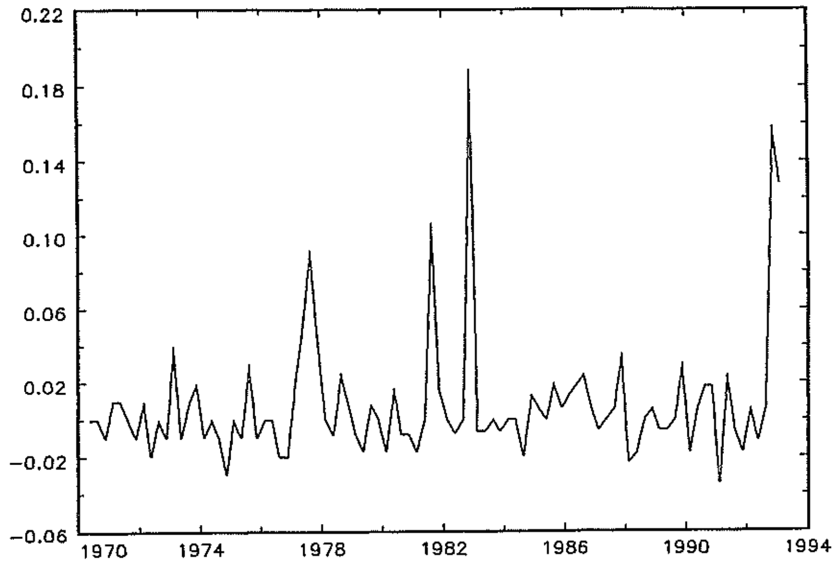


Figure A3. Variable: dl3M

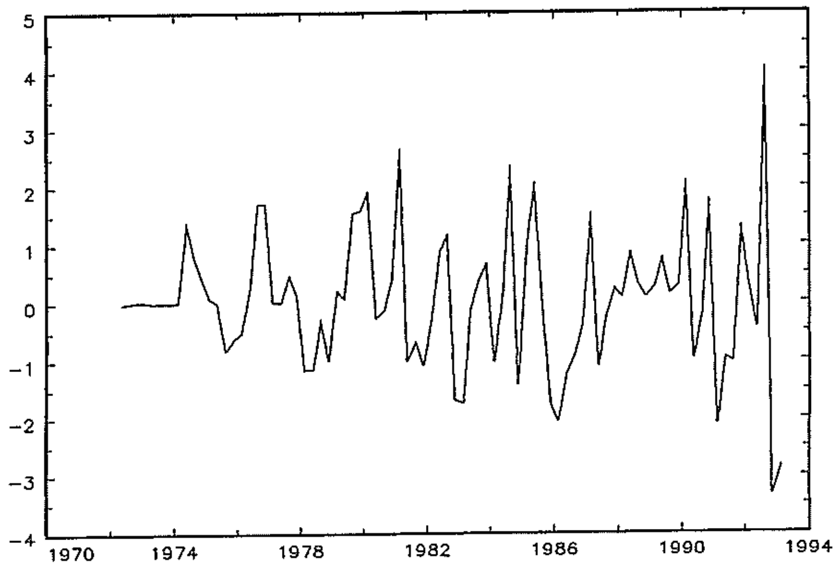
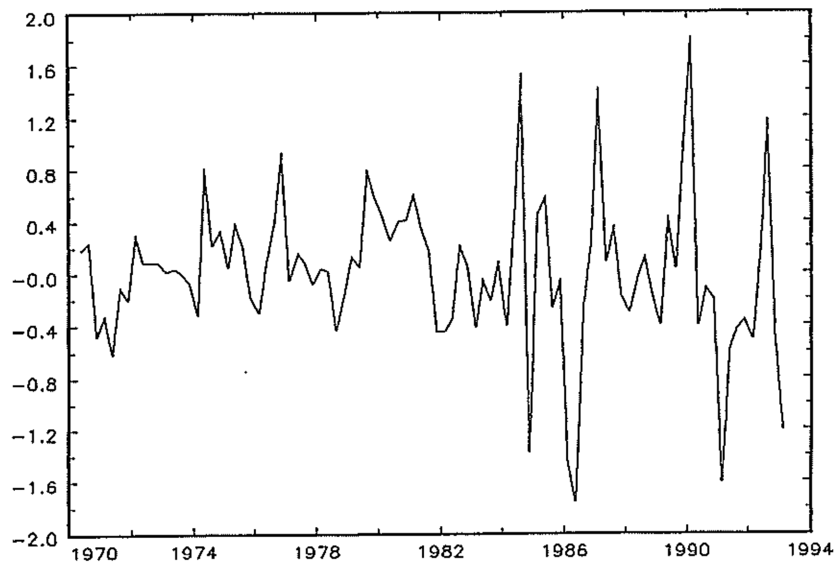


Figure A3. Variable: dl5Y



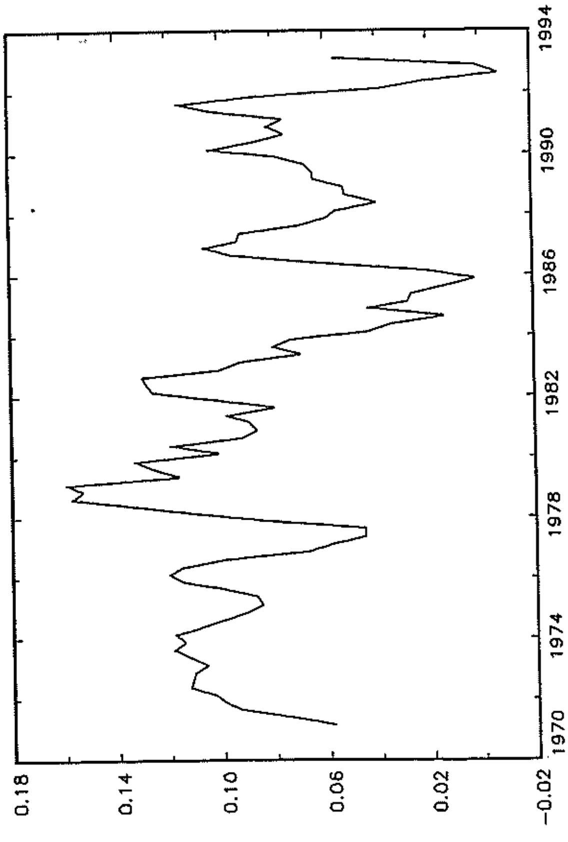


Figure A3. Variable: slM3

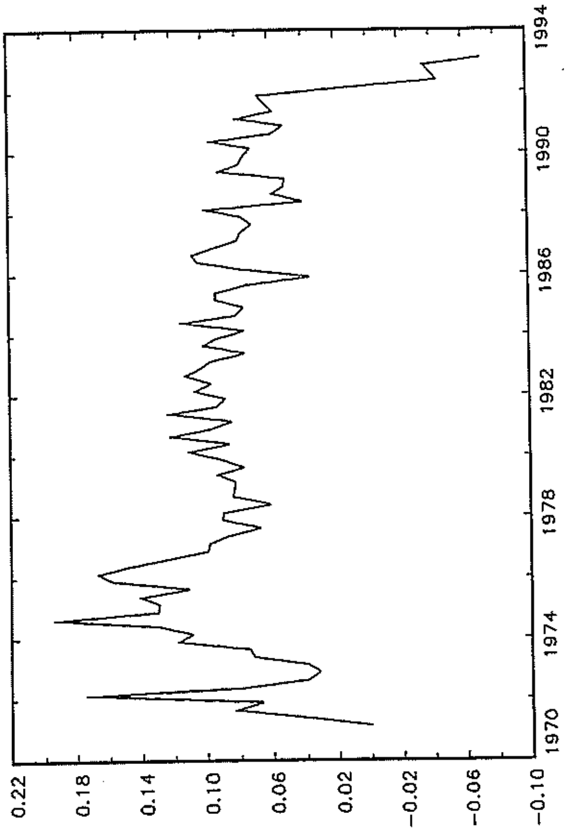


Figure A3. Variable: slRST

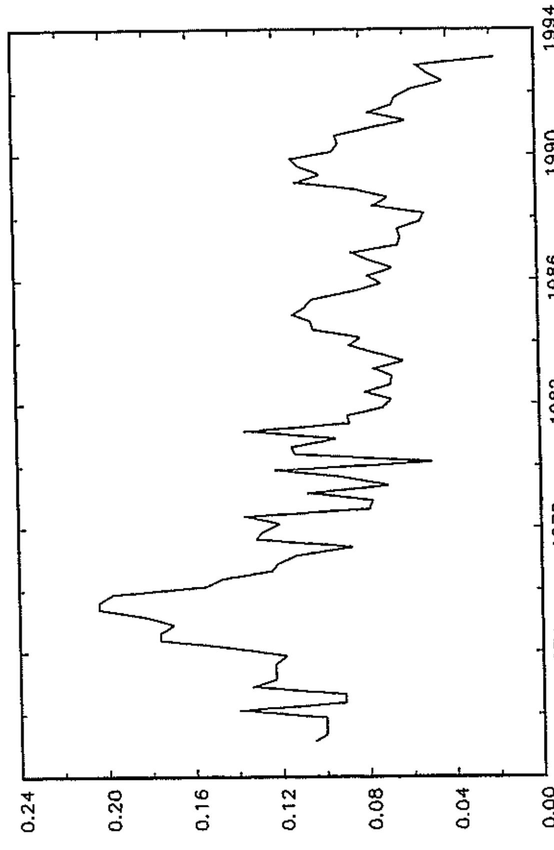


Figure A3. Variable: slLCH

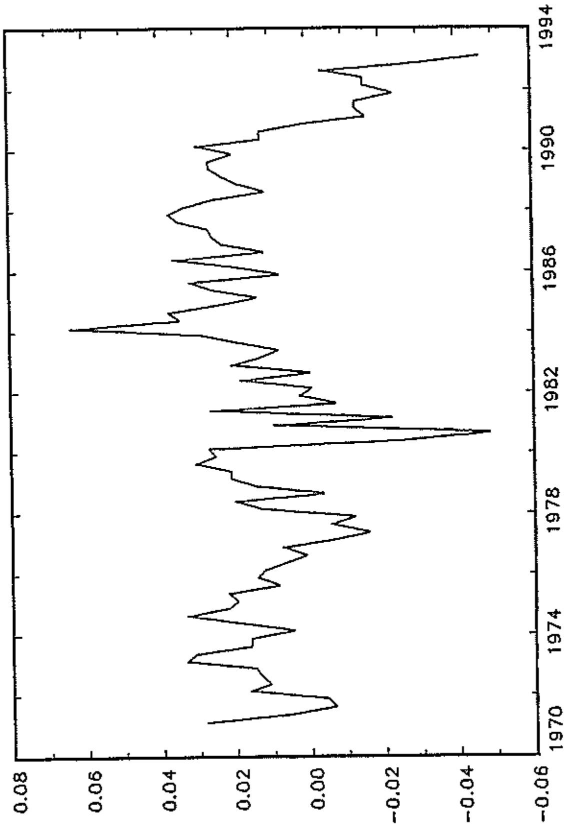


Figure A3. Variable: slGDP

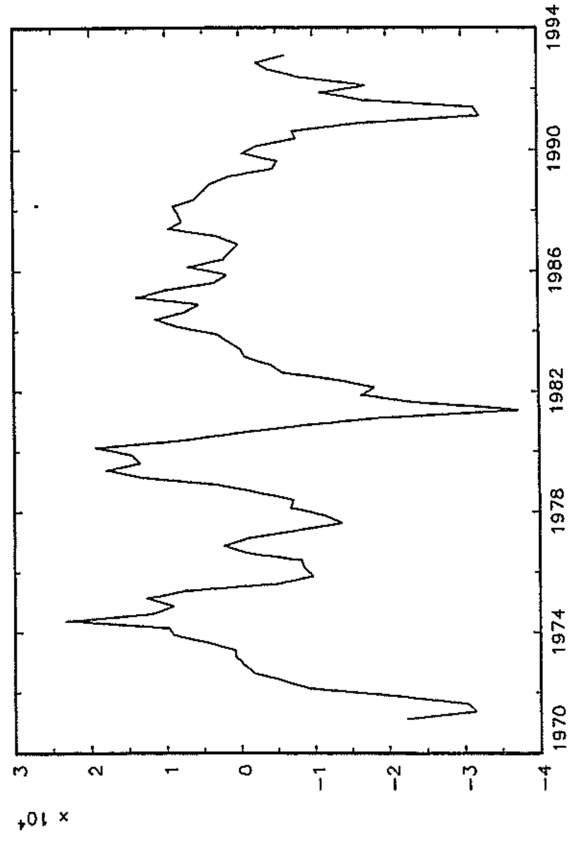


Figure A3. Variable: sJBV

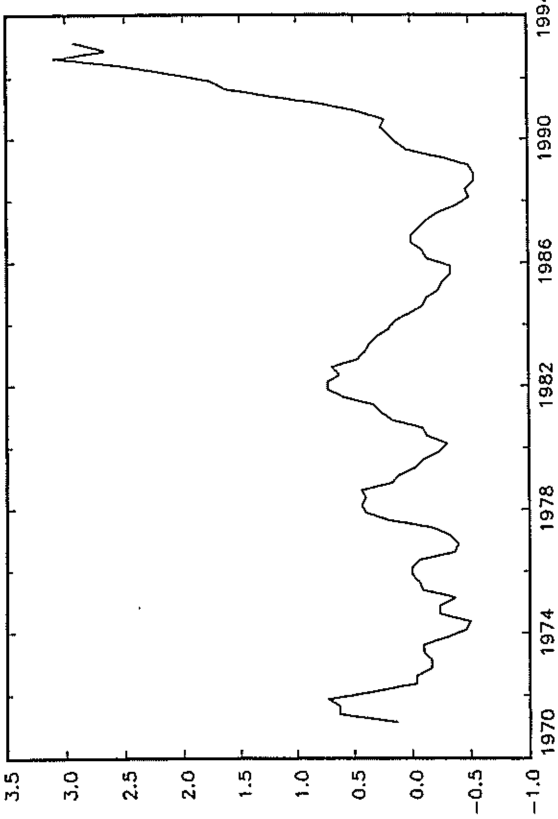


Figure A3. Variable: sUPC

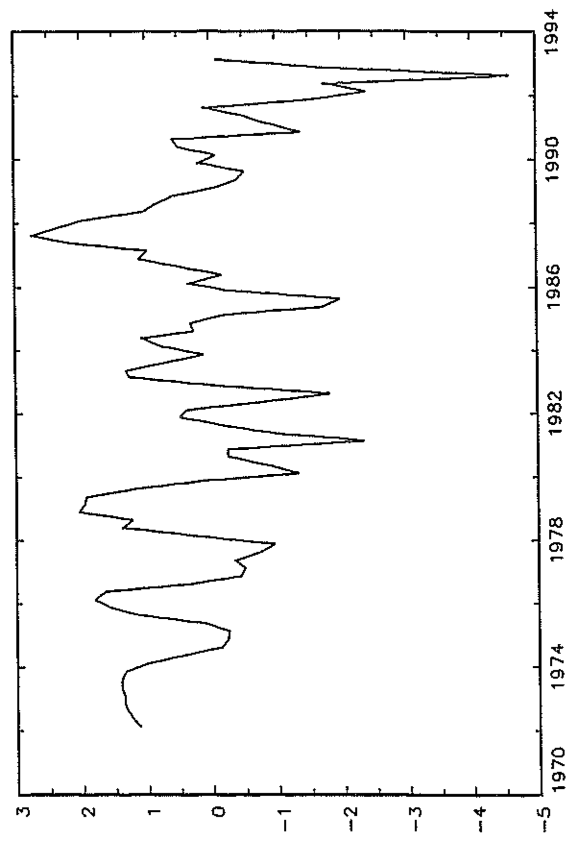


Figure A3. Variable: YLD

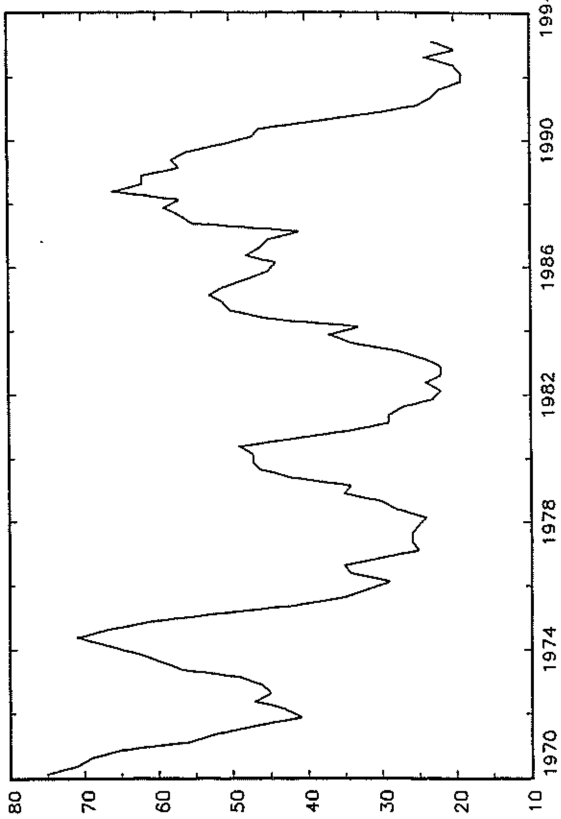


Figure A3. Variable: FCU

Figure A3. Variable: ISL

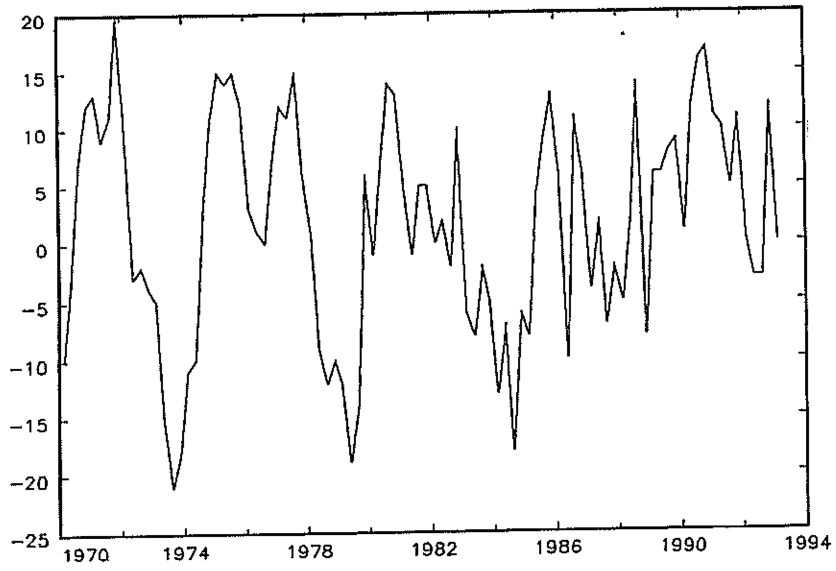


Figure A3. Variable: ORS

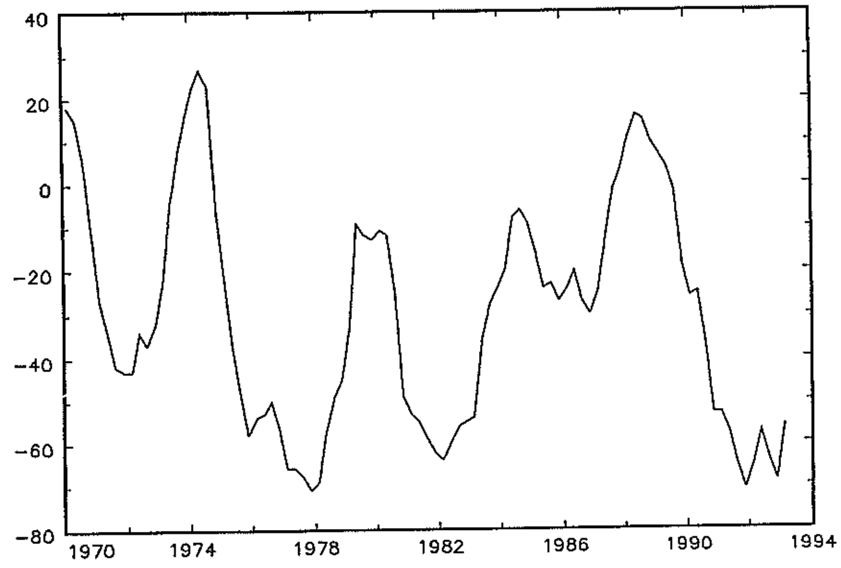
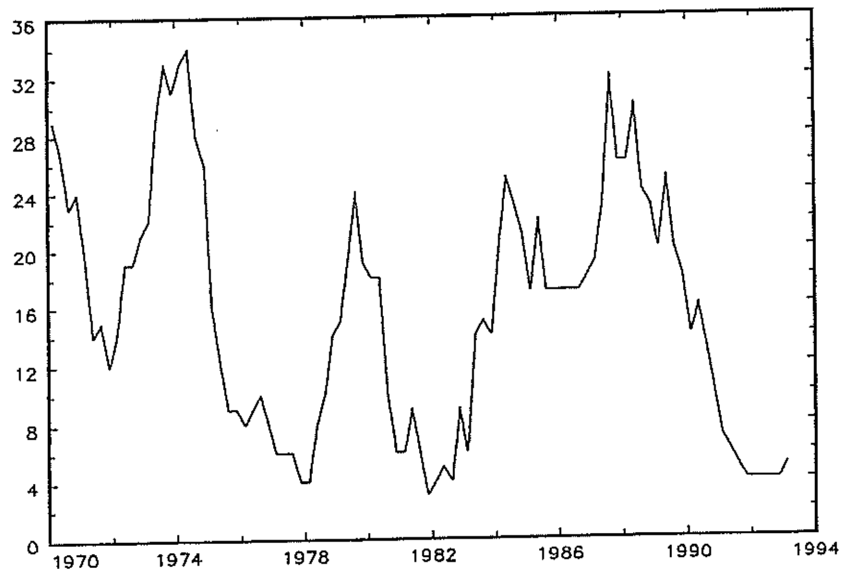


Figure A3. Variable: MCI



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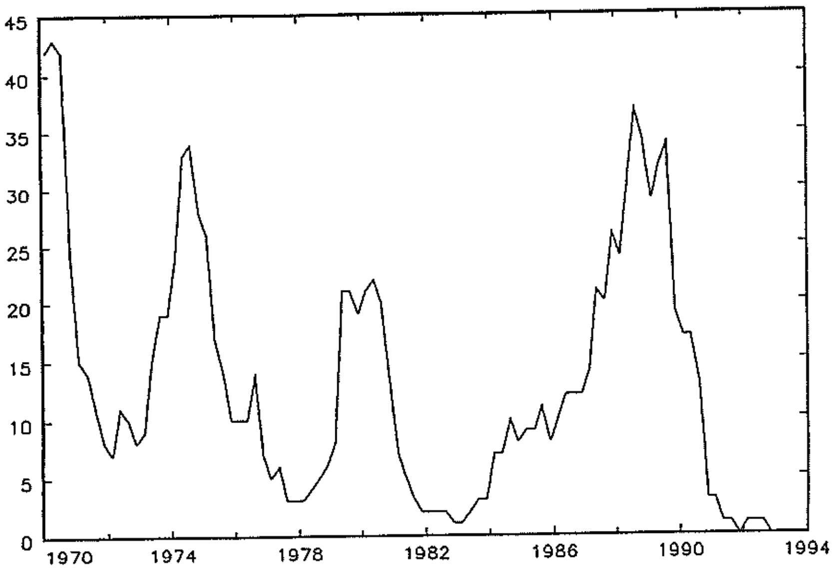

Figure A3. Variable: BOB

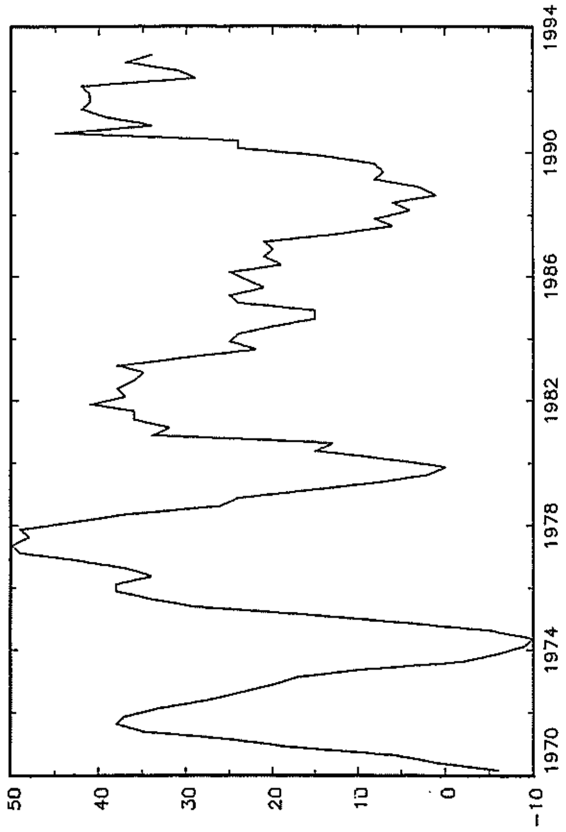

Figure A3. Variable: BOI

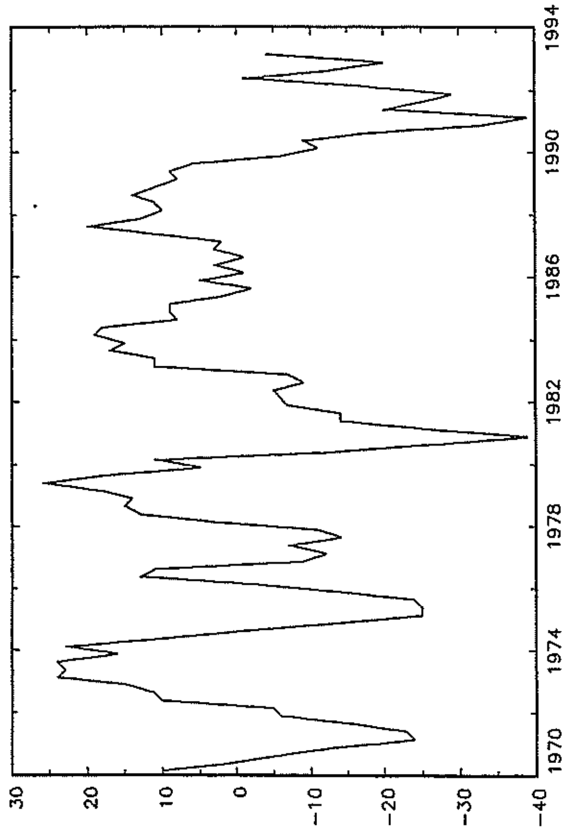

Figure A3. Variable: PFT