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The role of money during the recession in Australia in 1990—92 — Source link

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THE ROLE OF MONEY DURING THE RECESSION IN AUSTRALIA IN 1990-92*

by

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Abstract

What role did money play during the severe recession in Australia in 1990-92? A multivariate time series model of the Australian economy is developed and the influence of each variable - including money - on real GDP is determined. A dramatic fall in the rate of monetary expansion during 1989 accounts for the severity of the recession. Indeed, the recession would have been even more serious without mitigating foreign factors. The Reserve Bank readjusted monetary policy in 1990 and there were no further adverse monetary shocks during the downward phase of the business cycle. The time series technique employed is known as 'historical decomposition'.

1. Introduction

The role of money in business fluctuations remains a controversial issue. In the 1980s, the so-called 'real business cycle economists' started a research program that, to all intents and purposes, dismisses monetary disturbances as a source of business fluctuations. Instead, this group of researchers attributes business fluctuations to technological shocks and other real factors. So far, the real business cycle economists have failed to persuade Keynesian and monetarist macroeconomists alike. Clearly, the majority of economists holds the view that money affects economic activity - although Keynesians and monetarists are sharply divided on the merits of discretionary monetary policy. [1]

What role did money play during the recession in Australia in 1990-92? In this paper the joint dynamics of key macroeconomic variables will be examined. A multivariate time series model of the Australian economy will be developed, and the influence of each variable - including money - on real GDP is determined. The time series technique to be employed is known as 'historical decomposition'. Two questions will be asked: (1) Did monetary factors provoke the recession in 1990? (2) Did monetary factors aggravate the course of the recession during the following two years? The first question is answered by a decomposition of the path of real GDP from the fourth quarter 1989 until the second quarter 1992, and the second question by a decomposition from the second quarter 1991 onward.

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1. Plosser (1989) and Huh and Trehan (1991) summarize the real business cycle approach to macroeconomics. Macfarlane (1993) discusses monetary and real business cycle theories from an Australian perspective.

Since World War II, Australia has experienced only two severe recessions during which real GDP dropped for several consecutive quarters - the most recent one and that of 1982-83. Real GDP fell by 2.5 percent from the peak in the first quarter 1990 to the trough in the third quarter 1991. A dramatic fall in the money growth rate preceded the recession. The money stock M1 grew at an average annual rate of 19.2 percent from the beginning of 1986 until the end of 1988. In the first quarter 1989, money growth came to a sudden standstill, and the money stock did not change much for about one year. Figure 1 juxtaposes indices of real GDP and the money stock M1, using logarithmic scales. Although it is suggestive that the start of the recession was preceded by a dramatic drop in money growth, not too much should be made of this bivariate relationship. In this paper the role of money during the recession will be analyzed in a much richer multivariate setting.

The model to be used is a vector autoregression. Macroeconomic modelling with VARs was pioneered by Sims (1980a,b). His three and four variable models have been extensively used in macroeconometric research. The three variable model includes a measure of economic activity, an indicator of the price level and a monetary aggregate, and - in the four variable model - a short-run interest rate is added. The model in this paper is based upon Sims' three variable model because identification of monetary shocks is difficult in the four variable model (see Sims 1992). The three variable model is augmented by the British three months

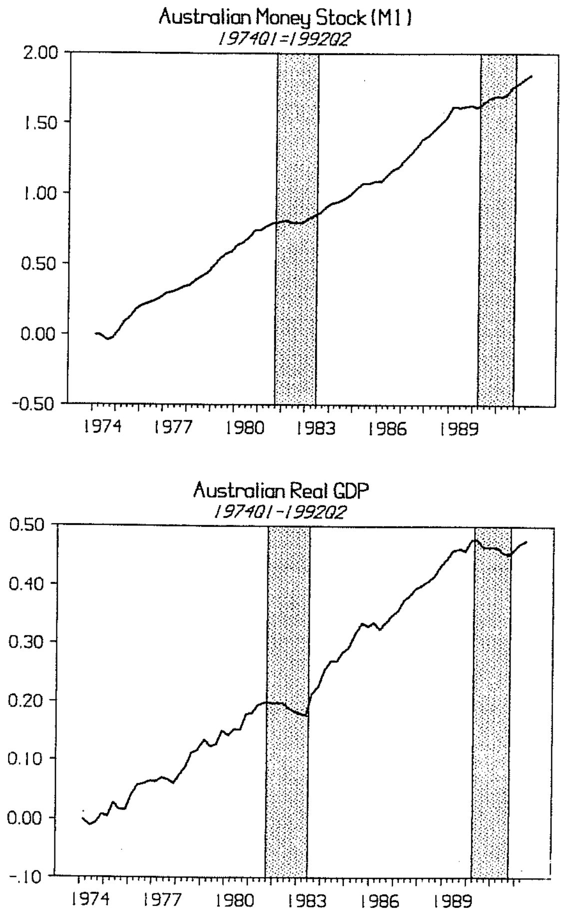

Figure 1.

Treasury bill rate and American real GDP to take account of foreign influences on Australian economic activity. Indeed, the variance decompositions of forecast errors indicate that the foreign variables exert a stronger influence on Australian GDP than the domestic ones. The impulse responses confirm that the effect of American GDP is positive and that of the UK Treasury bill rate is negative. The sample period covers the first quarter 1976 to the fourth quarter 1992 and, except for the interest rate, all variables are in logarithmic form. [2]

Macroeconomic modelling of the Australian economy with multivariate time series models is still in its infancy. The model in this paper is designed to assess the effect of monetary shocks on economic activity. Moreno (1992) developed a real business cycle model of the Australian economy that includes aggregate output, the price level, employment and the oil price. Stevens (1992) provides a general discussion of inflation and output in Australia since World War II.

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2. There was a break in the trend of real GDP during the oil crisis in 1973-74. The sample period starts two years later to allow for lagged variables. Equation specific Akaike information criteria suggest a VAR with six lags. The Q-values indicate that serial correlation is no problem. The findings in this paper do not depend on the overall lag length of the model. The data are described in appendix A.

2. Historical Decomposition

The innovations in a VAR process show the dynamics in a group of economic variables. A variable depends on another variable if it is influenced by random shocks to that variable. On the other hand, a variable is statistically exogenous if it is completely determined by its own innovations. Equation 1 expresses each variable as the sum of past innovations:

$$y_t = \sum_{i=0}^{\infty} C_i u_{t-i} \qquad (1)$$

where y_t is a column vector of n endogenous variables, u_t is an n-variate white noise process, and C_i is a matrix of coefficients. In general, the covariance matrix of innovations $\Sigma = E(u_t u_t')$ is not diagonal and shocks are correlated across variables. [3]

In a historical decomposition the sample period is split into two subperiods, say at time T, and the dynamics in the second subperiod is analyzed. Each series is decomposed into a base projection that includes all information available in period T, and the effect of innovations that have occurred since T. A variable x is an important determinant of another variable y if innovations in x account for a large share of the gap between the base projection of y and the actual value. In equation 2, the index j runs from 1 until the end of the sample period is

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3. The issue of stationarity is unimportant in innovation accounting. The matrix C_i can be calculated for stationary and nonstationary VAR processes, although nonstationary processes do not possess a valid moving average representation. See Lütkepohl (1991, pp. 379-382).

reached. During the second subperiod, the vector of endogenous variables y_{T+j} can then be written as:

$$y_{T+j} = \sum_{i=0}^{j-1} C_i u_{T+j-i} + \sum_{i=j}^{\infty} C_i u_{T+j-i} \qquad (2)$$

The second summation is the base projection which uses information until period T, and the first summation adds the effect of innovations since T. The first term decomposes the gap between the projection and actual value into shocks to each variable. For example, money was an important determinant of real GDP during the recession if monetary shocks explain most of the gap between the projection of GDP and the actual value.

Historical decompositions are performed with orthogonal and nonorthogonal shocks. In this paper shocks are orthogonalized because the movements in a variable cannot truly be assigned to innovations in specific variables if innovations are correlated across variables. The model with orthogonal innovations is:

$$y_{T+j} = \sum_{i=0}^{j-1} C_i G G^{-1} u_{T+j-i} + \sum_{i=j}^{\infty} C_i G G^{-1} u_{T+j-i} \qquad (3)$$

Here, G is a lower triangular matrix that provides a Choleski factorization of the covariance matrix of innovations Σ. If G is chosen in a way that $G^{-1}\Sigma G'^{-1} = I$, the new innovations $v_t = u_t G^{-1}$ are orthogonal.

The Choleski factorization does not provide a unique orthogonalization of shocks. The contemporaneous correlation between innovations is assigned to the variable that is listed first

Table 1. Covariance/Correlation Matrix of Innovations. *

	USGDP	UKTB3	AUSM1	AUSDFL	AUSGDP
USGDP	.35E-04	-.24	.16E-01	-.33	.37
UKTB3	-.12E-02	.76	-.18	.55E-01	.44E-01
AUSM1	.12E-05	-.20E-02	.16E-03	-.43E-01	-.34
AUSDFL	-.12E-04	.28E-03	-.32E-05	.35E-04	-.29
AUSGDP	.14E-04	.25E-03	-.28E-04	-.11E-04	.42E-04

* The variance/covariance matrix is on and below the diagonal and the correlation coefficients are above the diagonal.

because the matrix G is lower triangular. In this paper the ordering of variables is: US real GDP - UK three months Treasury bill rate - domestic money stock M1 - domestic GDP deflator - domestic real GDP. While it is natural to list foreign variables first in a small open economy, the ordering of domestic variables is less obvious. However, the ordering only matters if innovations are highly correlated. The historical decompositions of real GDP that are shown in the next two sections remain virtually unchanged if money and real GDP are interchanged. The estimated covariance-correlation matrix in table 1 confirms that correlations between innovations are small. In particular, the correlation between shocks to money and real GDP is only -0.34.

3. Did Monetary Factors Cause the Recession?

Figure 2 shows the historical decomposition of real GDP in the period from the fourth quarter 1988 to the second quarter 1992. The solid line indicates actual real GDP and the dotted line shows the base projection that includes information until the third quarter 1988. The sample period was split at the end of 1988 because money growth came to a standstill in the first quarter 1989. The solid and dotted lines are the same in each panel. In early 1989, economic activity was largely predetermined and actual and projected GDP match. Afterwards, economic activity was strongly influenced by innovations since the cutoff point at the end of 1988. Actual GDP substantially exceeded the projected value in the first half of 1990 and by a smaller margin in the second half of the year. From the second to the fourth quarter 1991, actual GDP was less than projected.

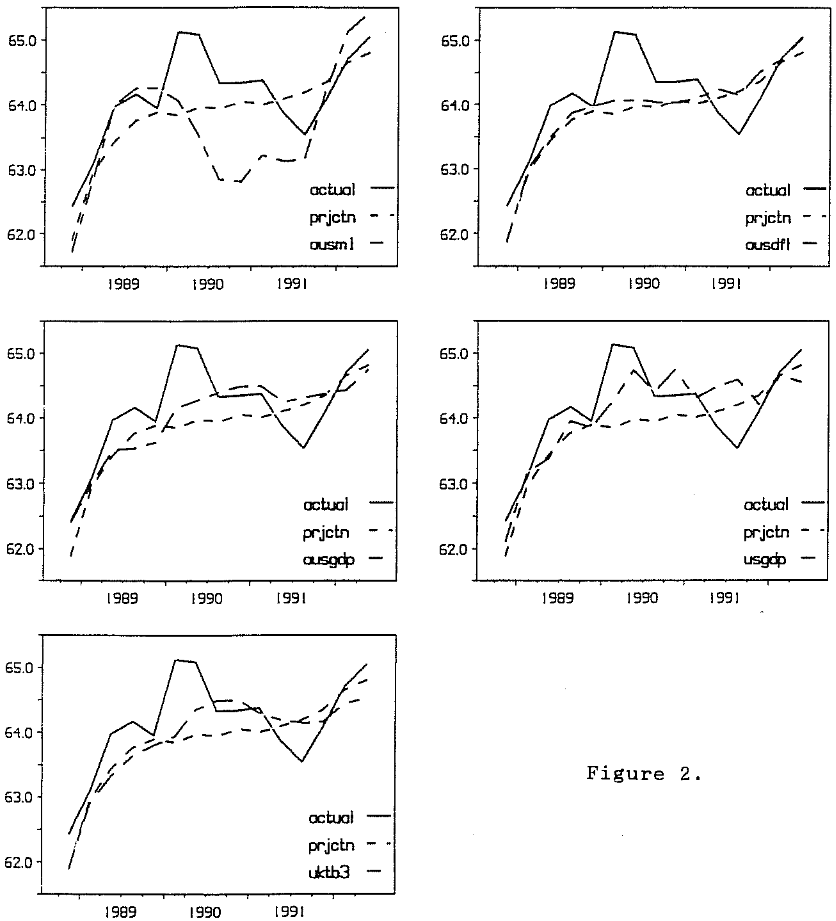

Figure 2.

In each panel a third graph is displayed that adds the effect of innovations since the end of 1988 to the base projection of GDP. A particular variable did not affect GDP if the adjusted projection is close to the base projection. On the other hand, the variable was an important determinant of GDP if the adjusted projection exhibits a strongly different pattern than the base projection. The dashed line shows the adjusted projection. For example, the top-left panel contains the base-plus-money projection of GDP (ausm1) along with the base projection (prjctn) and the actual value (actual).

Monetary factors accounted for both the economic downturn in 1990 and the severity of the recession during the following 18 months. The fall in the base-plus-money projection matches the actual fall in GDP and the adjusted projection lies below the base projection until the end of 1991. The base-plus-money projection shows that the monetary contraction alone would have led to a much stronger recession if economic activity had not been supported by nonmonetary factors. By the end of 1991, the positive effect of nonmonetary factors had ceased and the base-plus-money projection approached actual GDP.

Foreign factors produced the economic boom in the first half of 1990 and they partially offset the adverse effect of money during the recession. Two panels in figure 1 show GDP projections that include the influence of innovations in US real GDP (usgdp) and the three months UK treasury bill rate (uktb3). In the second quarter 1990, American GDP accounted for about two thirds and European interest rates for about one third of the gap between actual and projected domestic GDP. American GDP continued to have a positive effect until the recession started to bite in the United States in the mid-1991. At the same time, European interest rates rose because of the German unification. The base-plus-interest projection of GDP crosses the base projection in the third quarter 1991.

The remaining panels show the effects of innovations in the GDP deflator (ausdfl) and GDP itself (ausgdp). Domestic price shocks were unimportant and the base-plus-price projection stays close to the base projection. The direct shocks to GDP involve an array of nonmonetary domestic shocks, including fiscal and technological shocks. These domestic shocks provided some support to the economy in 1990 and early 1991.

4. Did Monetary Factors Prolong the Recession?

In this section the cutoff point for the base projection of real GDP is moved forward to the second quarter 1990. The base projection now includes the effect of the monetary contraction in 1989, and the new cutoff point makes it possible to analyze the role of concomitant monetary shocks during the recession. Figure 3 shows the historical decomposition with the new cutoff point. Again, in each panel the solid line indicates actual GDP (actual), the dotted line the base projection (prjctn), and the dashed line the adjusted projection.

The course of the recession was largely predetermined at the start of 1990. During the downward phase of the business cycle, there were no further negative monetary shocks - or shocks of any

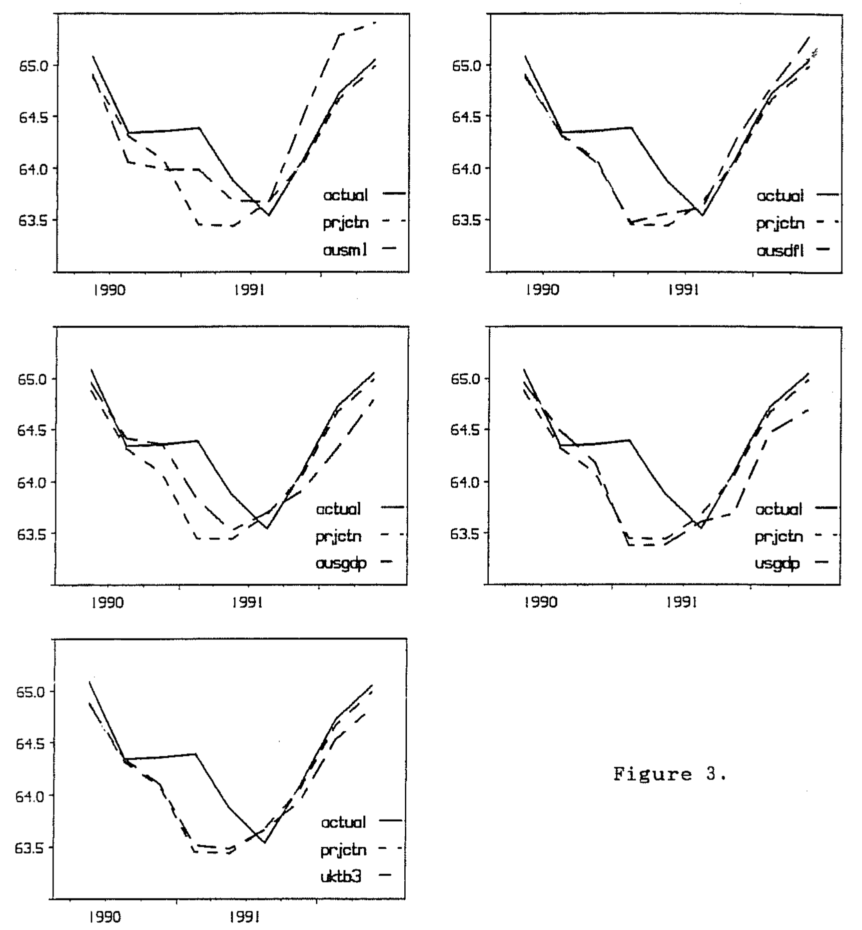

Figure 3.

kind - and actual and projected GDP moved close together. Indeed, actual GDP fell somewhat less rapidly than projected. Inspection of the top-left panel in figure 3 indicates that money slowed down the decline in economic activity. It accounted for about half of the gap between actual and projected GDP in the first half of 1991. Furthermore, money contributed to the economic recovery in the second half of the year. Yet the base-plus-money projection never moved far from the base projection and the monetary stimulus was weak. In particular, the effect of money was negligible during the trough in the third quarter 1991. These findings suggest that concomitant monetary innovations played only a minor role during the recession.

5. Monetary Policy

After the stock market crash in 1987, most OECD countries adopted an easy monetary policy in view of the disastrous consequences of the deflationary policy that was necessitated by the gold standard after the crash in 1929. [4] The need for an expansionary monetary policy posed a dilemma for Australia because the Reserve Bank had raised the money growth rate already before the crash, in 1986 (figure 1). In this situation, the Reserve Bank had no choice but to continue the monetary expansion - although it did not engineer a further increase in money growth. By 1988, the rapid monetary expansion had lasted for three years and there

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4. Friedman and Schwartz (1963) attribute the severity of the Great Depression in the United States to the decline in the money stock. Burbidge and Harrison (1985) provide a historical decomposition of the Great Depression.

arose substantial inflation and a speculative boom in the real estate market. At the beginning of 1989, the Reserve Bank responded to the inflationary pressure by slashing the money growth rate to zero. This was the most dramatic about-face in monetary policy since World War II. In 1989, the money stock remained almost unchanged, after an increase by 71.5 percent during the previous three years.

Two major conclusions can be drawn from the historical decompositions of Australian real GDP in the preceding two sections. (1) The abrupt reversal in monetary policy in 1989 accounts for the severity of the recession in Australia in 1990-92. In fact, the recession would have been even more serious without mitigating foreign factors. (2) The Reserve Bank readjusted monetary policy in 1990, and there were no further adverse monetary shocks during the downward phase of the business cycle.

Today, real business cycle economists are at the frontier of macroeconomic research. At the same time, traditional macroeconomic theories have remained influential in the economic policy debate because real business cycle models fail to explain the short-run trade-off between nominal and real variables. [5] The findings in this paper suggest a monetarist approach to macroeconomics. Monetarists stress that money affects economic activity

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5. Robert Lucas is a leading macroeconomist who still calls himself a monetarist (see the interview in McTaggart, Findlay and Parkin, 1992, pp. 605-607).

in the short-run.[6] The findings also support the monetarist notion that monetary policy does not provide a suitable instrument for economic stabilization purposes. The excessively tight monetary policy in 1989 put into motion an economic contraction that lasted for two years and that could not be stopped by a renewed relaxation of monetary policy in 1990.

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6. Money does not affect real GDP in the long-run in the estimated VAR model. The sum of the coefficients of money is close to zero in the autoregressive version of the model. This includes the direct and indirect influence of money on GDP in all equations. I owe this observation to Adrian Pagan.

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Appendix: Data Sources

The data are from the DX data base by EconData. All series are quarterly and, except for the British interest rate, they are seasonally adjusted. The DX file and identifier are shown in the bracket.

AUSGDP: *Australian real gross domestic product* (TSS-A: NOQQ.AK85_GDP).

AUSDFL: *Implicit price deflator of Australian GDP* (TSS-A: NOQQ.AD85_GDP).

AUSM1: *Australian money stock M1.* This series was calculated by adding currency and current deposits with banks. The entries are quarterly averages of monthly figures (BN-D: DMACSA and DMACDTSA).

USGDP: *American real gross domestic product* (QNA-USA: USA.SA.GDPEV).

UKTB3: *British three months Treasury bill rate.* The frequency was changed from monthly to quarterly by averaging (BN-F, FOIRYUKTB3).

APPENDIX B: PROGRAM

The software package RATS 3.11 was used for the econometric work. The package is distributed by Estima, 1800 Sherman Ave., Suite 612, Evanston, IL 60201, USA.

********************** DATA TRANSFORMATIONS *********************

```
cal 1970 1 4
all 0 1992:2
open data \data\macro.rat
data(format=rats)  1970:1  1992:2  usargdp  uktb3  qm1s  $
   ausdefl ausrgdp

set usgdp = log(usargdp(t))
set ausm1 = log(qm1s(t))
set ausdfl = log(ausdefl(t))
set ausgdp = log(ausrgdp(t))
```

********************** ESTIMATED VAR MODEL **********************

```
system 1 to 5
variables usgdp uktb3 ausm1 ausdfl ausgdp
lags 1 to 6
det constant
end(system)

scratch 5 / resids
estimate(noftests,outsigma=v,sigma) 1976:1 1992:2 resids+1
```



```
EQUATION     1
DEPENDENT VARIABLE   16      USGDP
FROM     1976: 1 UNTIL     1992: 2
TOTAL OBSERVATIONS        66      SKIPPED/MISSING           0
USABLE OBSERVATIONS       66      DEGREES OF FREEDOM       35
R**2                0.99750857    RBAR**2           0.99537306
SSR             0.23210025E-02    SEE           0.81433627E-02
DURBIN-WATSON   2.10871156
Q(  24)=      20.6159         SIGNIFICANCE LEVEL 0.66126975
```

NO.	LABEL	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC
***	*******	***	***	***********	************	***********
1	USGDP	16	1	1.029332	0.1871285	5.500668
2	USGDP	16	2	-0.4115268	0.2414137	-1.704654
3	USGDP	16	3	0.2120193	0.2522330	0.8405692
4	USGDP	16	4	-0.2255779	0.2618785	-0.8613839
5	USGDP	16	5	0.3796092	0.2475331	1.533570
6	USGDP	16	6	-0.1178125	0.1852598	-0.6359316
7	UKTB3	12	1	-0.7819841E-03	0.1111398E-02	-0.7036038
8	UKTB3	12	2	-0.1055648E-02	0.1384374E-02	-0.7625454
9	UKTB3	12	3	0.1827389E-04	0.1370433E-02	0.1333439E-01
10	UKTB3	12	4	-0.2526928E-03	0.1256083E-02	-0.2011752
11	UKTB3	12	5	-0.3029643E-03	0.1271829E-02	-0.2382115
12	UKTB3	12	6	-0.4426976E-03	0.9974342E-03	-0.4438364
13	AUSM1	17	1	0.1370173	0.7230938E-01	1.894875
14	AUSM1	17	2	-0.1913558	0.1137020	-1.682959
15	AUSM1	17	3	0.1373119	0.1100707	1.247489
16	AUSM1	17	4	-0.1322452	0.1068962	-1.237136
17	AUSM1	17	5	0.7196666E-01	0.1120897	0.6420450
18	AUSM1	17	6	-0.3122768E-01	0.8056430E-01	-0.3876118
19	AUSDFL	18	1	-0.3581228	0.1675393	-2.137546
20	AUSDFL	18	2	0.3970807	0.2065264	1.922663
21	AUSDFL	18	3	-0.2745341E-01	0.2343082	-0.1171680
22	AUSDFL	18	4	0.1701999	0.2291028	0.7428975
23	AUSDFL	18	5	-0.8142212E-01	0.2338583	-0.3481687
24	AUSDFL	18	6	-0.7165982E-01	0.1844552	-0.3884944
25	AUSGDP	19	1	0.2308867	0.1591959	1.450331
26	AUSGDP	19	2	-0.3318927	0.1896253	-1.750255
27	AUSGDP	19	3	0.2418251	0.1745887	1.385113
28	AUSGDP	19	4	-0.3666151E-01	0.1655846	-0.2214065
29	AUSGDP	19	5	-0.6549524E-01	0.1676371	-0.3906966
30	AUSGDP	19	6	0.1465386E-01	0.1380593	0.1061417
31	CONSTANT	0	0	0.5276827	0.6765062	0.7800116

EQUATION 2
DEPENDENT VARIABLE 12 UKTB3
FROM 1976: 1 UNTIL 1992: 2
TOTAL OBSERVATIONS 66 SKIPPED/MISSING 0
USABLE OBSERVATIONS 66 DEGREES OF FREEDOM 35
R**2 0.86291876 RBAR**2 0.74542056
SSR 50.112374 SEE 1.1965710
DURBIN-WATSON 1.88479516
Q(24)= 23.6385 SIGNIFICANCE LEVEL 0.48241690

NO.	LABEL	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC
***	*******	***	***	***********	************	***********
1	USGDP	16	1	-11.89754	27.49632	-0.4326956
2	USGDP	16	2	-0.7829378	35.47289	-0.2207144E-01
3	USGDP	16	3	98.02647	37.06267	2.644884
4	USGDP	16	4	-80.80909	38.47995	-2.100031
5	USGDP	16	5	29.18804	36.37207	0.8024851
6	USGDP	16	6	4.325878	27.22173	0.1589127
7	UKTB3	12	1	0.8721874	0.1633069	5.340788
8	UKTB3	12	2	-0.1086767	0.2034175	-0.5342544
9	UKTB3	12	3	-0.1687114	0.2013689	-0.8378222
10	UKTB3	12	4	0.1812973	0.1845666	0.9822866
11	UKTB3	12	5	-0.1432968	0.1868803	-0.7667839
12	UKTB3	12	6	0.6175725E-01	0.1465612	0.4213752
13	AUSM1	17	1	-5.761817	10.62501	-0.5422881
14	AUSM1	17	2	-5.759729	16.70716	-0.3447461
15	AUSM1	17	3	12.02846	16.17358	0.7437101
16	AUSM1	17	4	8.707735	15.70714	0.5543806
17	AUSM1	17	5	-0.1173641	16.47026	-0.7125819E-02
18	AUSM1	17	6	-3.832330	11.83797	-0.3237319
19	AUSDFL	18	1	22.35673	24.61791	0.9081487
20	AUSDFL	18	2	-34.30094	30.34661	-1.130305
21	AUSDFL	18	3	22.09425	34.42882	0.6417371
22	AUSDFL	18	4	47.45437	33.66394	1.409650
23	AUSDFL	18	5	-66.20394	34.36271	-1.926621
24	AUSDFL	18	6	5.973557	27.10352	0.2203979
25	AUSGDP	19	1	31.66432	23.39196	1.353641
26	AUSGDP	19	2	-53.34649	27.86320	-1.914586
27	AUSGDP	19	3	-9.078682	25.65375	-0.3538931
28	AUSGDP	19	4	18.77069	24.33071	0.7714817
29	AUSGDP	19	5	-30.58203	24.63229	-1.241543
30	AUSGDP	19	6	3.421713	20.28619	0.1686721
31	CONSTANT	0	0	70.27121	99.40460	0.7069211

EQUATION 3
DEPENDENT VARIABLE 17 AUSM1
FROM 1976: 1 UNTIL 1992: 2
TOTAL OBSERVATIONS 66 SKIPPED/MISSING 0
USABLE OBSERVATIONS 66 DEGREES OF FREEDOM 35
R**2 0.99930735 RBAR**2 0.99871365
SSR 0.10719058E-01 SEE 0.17500252E-01
DURBIN-WATSON 1.96046910
Q(24)= 26.1078 SIGNIFICANCE LEVEL 0.34771564

NO.	LABEL	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC
***	******	***	***	************	************	***********
1	USGDP	16	1	-0.5410311E-01	0.4021430	-0.1345370
2	USGDP	16	2	-0.1647024	0.5188029	-0.3174661
3	USGDP	16	3	0.5360120	0.5420539	0.9888536
4	USGDP	16	4	-0.5608411	0.5627821	-0.9965510
5	USGDP	16	5	0.2107151	0.5319537	0.3961155
6	USGDP	16	6	0.3484954	0.3981270	0.8753372
7	UKTB3	12	1	0.8970520E-03	0.2388418E-02	0.3755842
8	UKTB3	12	2	-0.1680309E-02	0.2975049E-02	-0.5648004
9	UKTB3	12	3	-0.1355511E-02	0.2945088E-02	-0.4602614
10	UKTB3	12	4	-0.5553451E-03	0.2699348E-02	-0.2057330
11	UKTB3	12	5	0.8570882E-03	0.2733187E-02	0.3135857
12	UKTB3	12	6	-0.7438693E-03	0.2143506E-02	-0.3470339
13	AUSM1	17	1	1.252585	0.1553943	8.060686
14	AUSM1	17	2	-0.3751320	0.2443479	-1.535237
15	AUSM1	17	3	0.1916272	0.2365441	0.8101123
16	AUSM1	17	4	-0.3676449	0.2297222	-1.600389
17	AUSM1	17	5	0.6177712	0.2408831	2.564610
18	AUSM1	17	6	-0.4511464	0.1731343	-2.605759
19	AUSDFL	18	1	-0.5942757	0.3600453	-1.650558
20	AUSDFL	18	2	0.5882923	0.4438294	1.325492
21	AUSDFL	18	3	0.5058040E-01	0.5035330	0.1004510
22	AUSDFL	18	4	-0.9766436E-02	0.4923465	-0.1983651E-01
23	AUSDFL	18	5	0.2523267	0.5025662	0.5020765
24	AUSDFL	18	6	-0.2085866	0.3963980	-0.5262049
25	AUSGDP	19	1	0.1871587	0.3421153	0.5470634
26	AUSGDP	19	2	-0.2751225	0.4075086	-0.6751330
27	AUSGDP	19	3	-0.2284470	0.3751946	-0.6088760
28	AUSGDP	19	4	0.2211670	0.3558447	0.6215267
29	AUSGDP	19	5	-0.5551996E-01	0.3602554	-0.1541128
30	AUSGDP	19	6	0.1087454	0.2966923	0.3665259
31	CONSTANT	0	0	-1.151545	1.453826	-0.7920791

EQUATION 4
DEPENDENT VARIABLE 18 AUSDFL
FROM 1976: 1 UNTIL 1992: 2
TOTAL OBSERVATIONS 66 SKIPPED/MISSING 0
USABLE OBSERVATIONS 66 DEGREES OF FREEDOM 35
R**2 0.99973879 RBAR**2 0.99951489
SSR 0.22988959E-02 SEE 0.81044888E-02
DURBIN-WATSON 1.88586108
Q(24)= 18.2685 SIGNIFICANCE LEVEL 0.78979348

NO.	LABEL	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC
***	******	***	***	***********	************	***********
1	USGDP	16	1	-0.2410832	0.1862352	-1.294509
2	USGDP	16	2	0.1021195	0.2402613	0.4250351
3	USGDP	16	3	0.1701406	0.2510290	0.6777727
4	USGDP	16	4	-0.3023407	0.2606283	-1.160045
5	USGDP	16	5	0.3139065	0.2463515	1.274222
6	USGDP	16	6	0.1701950E-01	0.1843754	0.9230897E-01
7	UKTB3	12	1	-0.1390426E-04	0.1106093E-02	-0.1257061E-01
8	UKTB3	12	2	-0.7949067E-03	0.1377766E-02	-0.5769534
9	UKTB3	12	3	0.3770278E-03	0.1363891E-02	0.2764354
10	UKTB3	12	4	0.7367842E-03	0.1250087E-02	0.5893863
11	UKTB3	12	5	-0.1115358E-02	0.1265758E-02	-0.8811779
12	UKTB3	12	6	0.4001734E-04	0.9926727E-03	0.4031272E-01
13	AUSM1	17	1	0.8362232E-01	0.7196420E-01	1.161999
14	AUSM1	17	2	-0.1055370	0.1131592	-0.9326415
15	AUSM1	17	3	-0.8345553E-01	0.1095452	-0.7618364
16	AUSM1	17	4	0.1539376	0.1063860	1.446973
17	AUSM1	17	5	0.4634405E-01	0.1115547	0.4154380
18	AUSM1	17	6	-0.1422275	0.8017971E-01	-1.773859
19	AUSDFL	18	1	0.7019296	0.1667395	4.209739
20	AUSDFL	18	2	0.5469574	0.2055405	2.661069
21	AUSDFL	18	3	-0.8019788E-01	0.2331897	-0.3439169
22	AUSDFL	18	4	-0.1419155E-01	0.2280091	-0.6224115E-01
23	AUSDFL	18	5	-0.7821148E-01	0.2327419	-0.3360438
24	AUSDFL	18	6	-0.3830370E-01	0.1835747	-0.2086546
25	AUSGDP	19	1	0.1754847	0.1584360	1.107607
26	AUSGDP	19	2	-0.6142352E-01	0.1887201	-0.3254742
27	AUSGDP	19	3	-0.1941415	0.1737553	-1.117327
28	AUSGDP	19	4	0.8024300E-01	0.1647942	0.4869286
29	AUSGDP	19	5	0.4616969E-01	0.1668368	0.2767356
30	AUSGDP	19	6	-0.6692633E-01	0.1374003	-0.4870902
31	CONSTANT	0	0	0.4488127E-01	0.6732768	0.6666095E-01

EQUATION 5
DEPENDENT VARIABLE 19 AUSGDP
FROM 1976: 1 UNTIL 1992: 2
TOTAL OBSERVATIONS 66 SKIPPED/MISSING 0
USABLE OBSERVATIONS 66 DEGREES OF FREEDOM 35
R**2 0.99794693 RBAR**2 0.99618715
SSR 0.27836883E-02 SEE 0.89181809E-02
DURBIN-WATSON 2.06682987
Q(24)= 20.4132 SIGNIFICANCE LEVEL 0.67305358

NO.	LABEL	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC
***	******	***	***	************	***********	***********
1	USGDP	16	1	0.4559893	0.2049333	2.225062
2	USGDP	16	2	-0.5871353	0.2643835	-2.220771
3	USGDP	16	3	0.6336300	0.2762323	2.293830
4	USGDP	16	4	-0.5733536	0.2867955	-1.999173
5	USGDP	16	5	0.2003624	0.2710852	0.7391124
6	USGDP	16	6	-0.8869832E-01	0.2028867	-0.4371815
7	UKTB3	12	1	0.7393146E-03	0.1217145E-02	0.6074171
8	UKTB3	12	2	0.9664230E-03	0.1516094E-02	0.6374428
9	UKTB3	12	3	-0.6204367E-03	0.1500826E-02	-0.4133968
10	UKTB3	12	4	-0.1365842E-02	0.1375596E-02	-0.9929095
11	UKTB3	12	5	-0.1356131E-03	0.1392840E-02	-0.9736441E-01
12	UKTB3	12	6	0.1295717E-02	0.1092337E-02	1.186188
13	AUSM1	17	1	0.1311505	0.7918942E-01	1.656162
14	AUSM1	17	2	0.1351652E-01	0.1245204	0.1085487
15	AUSM1	17	3	-0.2171761E-01	0.1205436	-0.1801640
16	AUSM1	17	4	-0.9855192E-01	0.1170671	-0.8418411
17	AUSM1	17	5	0.1025866	0.1227548	0.8357035
18	AUSM1	17	6	-0.1372931	0.8822977E-01	-1.556086
19	AUSDFL	18	1	0.4850967E-01	0.1834801	0.2643865
20	AUSDFL	18	2	-0.2724497E-01	0.2261768	-0.1204587
21	AUSDFL	18	3	-0.1789594	0.2566020	-0.6974201
22	AUSDFL	18	4	0.1681481	0.2509012	0.6701765
23	AUSDFL	18	5	0.9399053E-01	0.2561092	0.3669939
24	AUSDFL	18	6	-0.2869191E-01	0.2020056	-0.1420352
25	AUSGDP	19	1	0.6674071	0.1743430	3.828127
26	AUSGDP	19	2	0.1656899E-01	0.2076676	0.7978609E-01
27	AUSGDP	19	3	0.1945170E-02	0.1912003	0.1017347E-01
28	AUSGDP	19	4	-0.1434479	0.1813395	-0.7910459
29	AUSGDP	19	5	0.3623904	0.1835873	1.973941
30	AUSGDP	19	6	-0.1112487	0.1511953	-0.7357946
31	CONSTAN	0	0	1.653176	0.7408739	2.231387

COVARIANCE MATRIX OF RESIDUALS

```
COVARIANCE/CORRELATION MATRIX
VARIABLE            USGDP          UKTB3          AUSM1          AUSDFL
    SERIES LAG    16    0        12    0        17    0        18    0
USGDP   16    0  0.35167E-04 -0.24142         0.15817E-01 -0.33203
UKTB3   12    0 -0.12475E-02  0.75928        -0.18182        0.55286E-01
AUSM1   17    0  0.11953E-05 -0.20191E-02  0.16241E-03 -0.42971E-01
AUSDFL  18    0 -0.11621E-04  0.28432E-03 -0.32320E-05  0.34832E-04
AUSGDP  19    0  0.14149E-04  0.24956E-03 -0.28021E-04 -0.11074E-04

VARIABLE            AUSGDP
    SERIES LAG    19    0
USGDP   16    0  0.36737
UKTB3   12    0  0.44100E-01
AUSM1   17    0 -0.33857
AUSDFL  18    0 -0.28892
AUSGDP  19    0  0.42177E-04
```

```
declare rect f(5,5)
ewise f(i,j) = v(i,j)/(sqrt(v(i,i))*sqrt(v(j,j)))
declare rect g(5,5)
ewise g(i,j) = v(i,j)*(i>=j)+f(i,j)*(i<j)
write(format='(5g12.2)') g
```

```
    .35E-04     -.24         .16E-01     -.33         .37
   -.12E-02      .76        -.18          .55E-01     .44E-01
    .12E-05     -.20E-02     .16E-03     -.43E-01    -.34
   -.12E-04      .28E-03    -.32E-05      .35E-04    -.29
    .14E-04      .25E-03    -.28E-04     -.11E-04     .42E-04
```


************************ DIAGNOSTIC TESTS **********************

GRAPHS OF RESIDUALS:

```
labels 10 11 12 13 14
# 'rsusgdp' 'rsuktb3' 'rsausml' 'rsausdfl' 'rsausgdp'
grparm(bold,portrait) keylabeling 8 axislabeling 8
spgraph(vfields=3,hfields=2)
   dofor i= 12 14 11 13 10
      graph(style=bargraph,height=7.5,width=6.0,key=loright, $
         ybase=2.0,xbase=1.0) 1
      # i
   end do
spgraph(done)
```

(SEE FIGURE B-1)

AUTOCORRELATIONS OF RESIDUALS:

```
set upper 1 17 = 1.96/sqrt(nobs)
set lower 1 17 = -upper(t)
labels upper lower
# 'upper' 'lower'

scratch 5 / corrs
labels 17 18 19 20 21
# 'rsusgdp' 'rsuktb3' 'rsausml' 'rsausdfl' 'rsausgdp'

grparm(bold,portrait) keylabeling 8 axislabeling 8
spgraph(vfields=3,hfields=2)
   dofor i = 12 14 11 13 10
      corr(noprint) i / 16 i+7
      graph(height=7.5,width=6.0,number=0,max=1.0,min=-1.0, $
         nodates, style=bargraph,patterns,key=loright, $
         ybase=2.0,xbase=1.0) 3
      # i+7
      # upper / 2
      # lower / 2
   end do
spgraph(done)
```

(SEE FIGURE B-2)

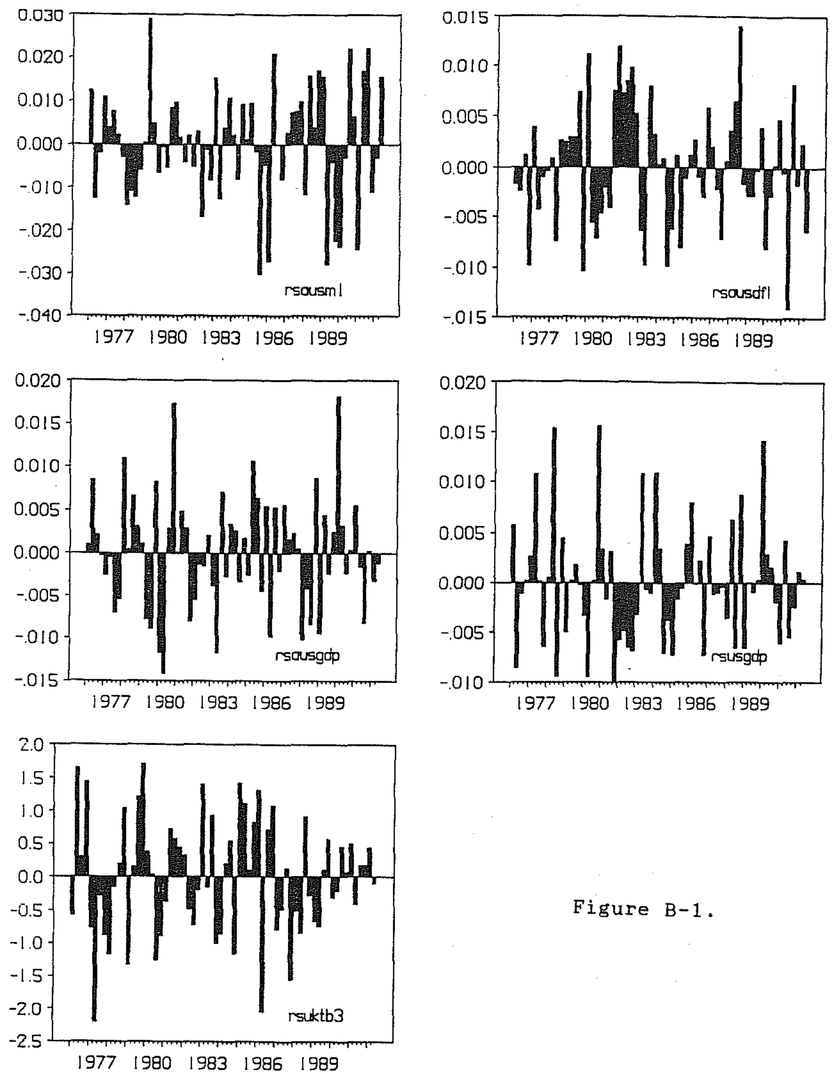

Figure B-1.

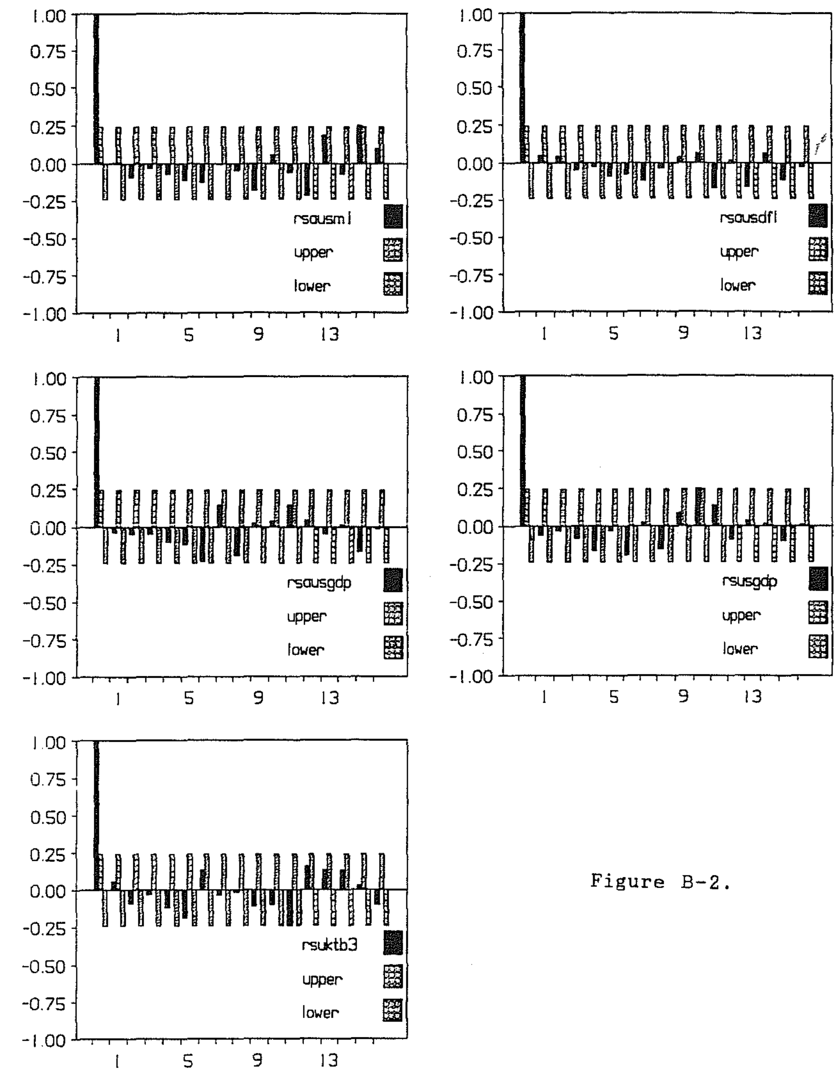

Figure B-2.

******************** HISTORICAL DECOMPOSITIONS ******************

SUBPERIOD 1988:4 TO 1992:2

```
smpl 88:4 92:2
scratch 30 / decomp

history(noadd) 5 15 88:4 v
# 1 decomp+1
# 2 decomp+7
# 3 decomp+13
# 4 decomp+19
# 5 decomp+25

set 46 = exp(46(t))
dofor I = 47 48 49 50 51
   set I = exp(I(t))*46(t)-46(t)
end do I

{
display 'Historical Decomposition of Series RGDP'
display @12 'Actual' @20 'Prjctn' @28 'USGDP' @36 'UKTB3'  $
   @44 'AUSM1' @52 'AUSDFL' @60 'AUSGDP'
copy(unit=output,org=obs,format='(A10,7i8)',dates) / $
   5 decomp+25 to decomp+30
}
```

Historical Decomposition of Series RGDP

	Actual	Prjctn	USGDP	UKTB3	AUSM1	AUSDFL	AUSGDP
1988: 4	62438	61902	217	2	-174	-22	512
1989: 1	63101	62962	211	-57	-120	56	49
1989: 2	63984	63441	-54	-106	578	43	81
1989: 3	64180	63780	174	-137	496	94	-227
1989: 4	63959	63899	-45	-90	372	78	-253
1990: 1	65137	63853	409	97	227	220	318
1990: 2	65084	63983	759	381	-442	94	305
1990: 3	64347	63959	445	547	-1108	69	447
1990: 4	64362	64057	694	455	-1243	-23	439
1991: 1	64395	64016	302	295	-792	91	489
1991: 2	63882	64108	384	94	-980	132	150
1991: 3	63543	64211	396	-59	-1045	-64	111
1991: 4	64102	64365	-140	-187	-118	157	26
1992: 1	64729	64667	-11	-212	470	37	-219
1992: 2	65054	64820	-254	-264	609	219	-72

(Actual real GDP (column 1) is equal to the sum of the projected value (column 2) plus all innovation components (columns 3 to 7).


```
history(add) 5 15 88:4 v
# 1 decomp+1
# 2 decomp+7
# 3 decomp+13
# 4 decomp+19
# 5 decomp+25

set 46 = exp(46(t))
dofor I = 47 48 49 50 51
   set I = exp(I(t))
end do I

{
display 'Historical Decomposition of Series RGDP'
display @12 'Actual' @20 'Prjctn' @28 'USGDP' @36 'UKTB3'  $
   @44 'AUSM1' @52 'AUSDFL' @60 'AUSGDP'
copy(unit=output,org=obs,format='(A10,7i8)',dates) / $
   5 decomp+25 to decomp+30
}
```

Historical Decomposition of Series RGDP

	Actual	Prjctn	USGDP	UKTB3	AUSM1	AUSDFL	AUSGDP
1988: 4	62438	61902	62120	61905	61728	61879	62415
1989: 1	63101	62962	63173	62904	62841	63018	63011
1989: 2	63984	63441	63386	63334	64019	63484	63522
1989: 3	64180	63780	63954	63642	64277	63875	63553
1989: 4	63959	63899	63853	63809	64271	63977	63645
1990: 1	65137	63853	64263	63951	64081	64073	64171
1990: 2	65084	63983	64743	64365	63540	64078	64289
1990: 3	64347	63959	64404	64507	62851	64028	64406
1990: 4	64362	64057	64751	64513	62813	64034	64497
1991: 1	64395	64016	64318	64311	63224	64107	64505
1991: 2	63882	64108	64493	64203	63128	64241	64259
1991: 3	63543	64211	64608	64151	63165	64147	64323
1991: 4	64102	64365	64224	64178	64246	64523	64391
1992: 1	64729	64667	64655	64454	65137	64705	64447
1992: 2	65054	64820	64566	64556	65429	65040	64747

(Here, the innovation components are added to the base projection. The following code yields figure 2 in the main text.)

```
set 5 = 5(t)/1000
dofor I = 46 47 48 49 50 51
  set I = I(t)/1000
end do I

labels 5 46 47 48 49 50 51
# 'actual' 'prjctn' 'usgdp' 'uktb3' 'ausml' 'ausdfl' 'ausgdp'
```

```
grparm(portrait) axislabeling 8 keylabeling 10
spgraph(vfields=3,hfields=2)
   dofor i = 3 5 2 4 1
     graph(ybase=1.5,vticks=8,height=8.0,key=loright) 3
     # 5
     # 46
     # 46+i
   end do i
spgraph(done)

set 5 = 5(t)*1000
```

SUBPERIOD 1990:2 TO 1992:4

```
smpl 90:2 92:2

history 5 9 90:2 v
# 1 decomp+1
# 2 decomp+7
# 3 decomp+13
# 4 decomp+19
# 5 decomp+25

set 46 = exp(46(t))
dofor I = 47 48 49 50 51
  set I = exp(I(t))*46(t)-46(t)
end do I

{
display 'Historical Decomposition of Series RGDP'
display @12 'Actual' @20 'Base' @28 'USGDP' @36 'UKTB3'  $
  @44 'AUSM1' @52 'AUSDFL' @60 'AUSGDP'
copy(unit=output,org=obs,format='(A10,7i8)',dates) / $
  5 decomp+25 to decomp+30
}
```

Historical Decomposition of Series RGDP

	Actual	Base	USGDP	UKTB3	AUSM1	AUSDFL	AUSGDP
1990: 2	65084	64880	74	-7	34	27	73
1990: 3	64347	64314	168	27	-255	-6	99
1990: 4	64362	64078	97	24	-88	-28	279
1991: 1	64395	63453	-74	66	538	25	382
1991: 2	63882	63440	-54	42	244	123	83
1991: 3	63543	63686	-67	-12	-15	-64	15
1991: 4	64102	64063	-367	-114	464	206	-147
1992: 1	64729	64673	-194	-139	622	118	-347
1992: 2	65054	64993	-292	-153	428	286	-204

(Actual real GDP (column 1) is equal to the sum of the projected value (column 2) plus all innovation components (columns 3 to 7).


```
history(add) 5 9 90:2 v
# 1 decomp+1
# 2 decomp+7
# 3 decomp+13
# 4 decomp+19
# 5 decomp+25

set 46 = exp(46(t))
dofor I = 47 48 49 50 51
  set I = exp(I(t))
end do I

{
display 'Historical Decomposition of Series RGDP'
display @12 'Actual' @20 'Base' @28 'USGDP' @36 'UKTB3'  $
   @44 'AUSM1' @52 'AUSDFL' @60 'AUSGDP'
copy(unit=output,org=obs,format='(A10,7i8)',dates) / $
   5 decomp+25 to decomp+30
}
```

Historical Decomposition of Series RGDP

	Actual	Base	USGDP	UKTB3	AUSM1	AUSDFL	AUSGDP
1990: 2	65084	64880	64955	64873	64914	64908	64954
1990: 3	64347	64314	64482	64341	64059	64307	64413
1990: 4	64362	64078	64176	64102	63989	64049	64357
1991: 1	64395	63453	63378	63520	63992	63479	63835
1991: 2	63882	63440	63385	63483	63685	63563	63524
1991: 3	63543	63686	63619	63674	63671	63622	63701
1991: 4	64102	64063	63695	63949	64528	64270	63916
1992: 1	64729	64673	64478	64533	65295	64791	64325
1992: 2	65054	64993	64700	64839	65421	65279	64789

(Here, the innovation components are added to the base projection. The following code yields figure 3 in the main text.)

```
set 5 = 5(t)/1000
dofor I = 46 47 48 49 50 51
  set I = I(t)/1000
end do I

grparm(portrait) axislabeling 8 keylabeling 10
spgraph(vfields=3,hfields=2)
   dofor i = 3 5 2 4 1
     graph(ybase=1.5,vticks=8,height=8.0,min=63.0,key=loright) 3
     # 5
     # 46
     # 46+i
   end do i
spgraph(done)

set 5 = 5(t)*1000
```