

Fluctuations. Organization of the course, and facts

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1 Fluctuations. Overview

Intermediate textbooks have it right (it is essential that you read one)

- In the **short run**
The price level (that should move a lot under the flexible price assumption) adjusts slowly.
So shocks to aggregate demand affect output rather than prices.
Changes in nominal money translate into changes in real money.
Monetary policy can control the interest rate.
Current and expectations of interest rate and income affect aggregate demand.
Aggregate demand determines output and unemployment, which can differ from the natural rate.
IS-LM model, extended to incorporate expectations, captures most of this.
- In the **long run**
Prices/the price level adjust.
Output, unemployment, the real interest rate all return to their natural rate. Money is neutral.
- Some shocks affect the deviations from natural rate, others the natural rate, others both.
- Things can go wrong:
Can take very long to get to the long run. Great Depression. Japan in the 1990s.
And because of expectations of the future matter today, the medium/long run affects the short run. Perverse effects of fiscal expansions. The hi tech boom.

The purpose of this course is to get to roughly the same place, but with a deeper understanding of the mechanisms, of the imperfections. This is needed in particular if we want to think about welfare implications. In the process, improve on the intermediate text models.

2 Organization

- Facts. What are we trying to explain?
- The simplest model. A model with a C/S choice, uncertainty, and shocks. Natural starting point. Ramsey model (really Arrow Debreu). (Why Ramsey, not OLG? No good reason, except convenience.)
Methodological contribution of Prescott here. Before, starting point would have been a more static version (for example, the book by Patinkin, on “Money, interest, and prices”).
Useful methodologically. C/S choice central to any model. But clearly short of the mark. No employment movement (by assumption).
- Allowing for labor/leisure choice. Natural starting point to generate employment fluctuations.
The RBC model (can still think of it as Arrow Debreu).
Empirical problems at two margins. The existence and the nature of technological shocks. The relevance of the labor/leisure choice to fluctuations in employment in the labor market. But again, useful benchmark.
- Allowing for investment decisions. In benchmark RBCs, investment decision is trivial/degenerate; the interest rate is always equal to the marginal product of capital. In fact, investment is a complex decision, and interest rates can/do diverge from marginal products. So, useful to expand by allowing for costs of adjustment.
Now: Both a saving decision and an investment decision. The sequence of intertemporal prices (term structure of interest rates) clears. (This is the mechanism that fails when nominal rigidities are present, below)
A useful model to discuss two issues in particular. The dynamics of the current account (investment minus saving) in an open economy. The macro implications of mispricing of assets, such as bubbles, fads.
- Allowing for two goods. Much of our intuition in macro is based on

a one-good model.

But can be dangerous (some intuitions do not extend).

And, in some contexts, open economy in particular, need to have two goods. Domestic/foreign. Tradable/non tradable. The basic model for international macro.

- Clear evidence that movements in money affect output. (that the Fed is not irrelevant). So next step is to introduce money as a medium of exchange.

Forces us to think how a monetary economy looks like. The decentralization of exchange. The use of money in transactions.

Natural question. Very different economy. What difference does it make? The answer is: Not a lot, per se. Insights into fiscal policy, inflation. Not so much about fluctuations.

- Money as numeraire. Price setting. Monopolistic competition, with price setters. costs of adjusting prices.

Deliver the basic implications, short run/medium run. Allow for welfare analysis. (Non trivial results, because start with imperfections)

- Look more closely at price setting/staggering. So, as to get close to a model we can use to think about policy.

The current workhorse: The “New Keynesian Model”. Staggering of price/wage decisions. An IS curve based on intertemporal consumption choices, and a Taylor rule for monetary policy.

Good enough? Probably not. The evidence on inflation and activity: More inflation inertia than implied by the model.

- Return to monetary policy.

The shift to inflation targeting. Rules for central banks. How should we design monetary policy in a world where expectations matter very much? Inflation targeting, Taylor rules.

The liquidity trap. What does it mean? What does it imply? Policy implications.

- Return to fiscal policy.
Revisiting spending versus taxes as macro policy tools.
Dynamic effects of fiscal policy. Can fiscal expansions lead to such adverse expectational effects as to have adverse effects on output in the short run? Automatic stabilizers.
So, back to the stuff of textbooks. But hopefully, with more solid foundations.

In short. Develop a model with:

- Shocks. Which ones? Still unclear.
- Strong intertemporal mechanisms. Consumption smoothing. Investment.
- Imperfections. Monopolistic competition. Nominal rigidities. Which others?

Enough to start. But clearly many issues left aside, which affect the nature and the effects of fluctuations. Credit market imperfections. Labor market imperfections.

- 14.453. Consumption, Investment decisions. More theory, more evidence.
- 14.454. Imperfections in goods, labor, credit, financial markets. Implications for macro.

A word on the **textbooks**. Each useful in some dimension.

- BF encyclopedic and simple, but a bit old.
- OR more consistent about the use of discrete time, and stronger on open economy.
- LS stronger on techniques.
- Woodford gives a good synthesis of New Keynesian models and applications.
- CW covers monetary issues, in an accessible way.

3 Some Facts

3.1 Covariance stationarity

We can hope to characterize facts is only if there are some regularities. If things repeat themselves, in some well defined way.

This is what the expression “Business cycles” captures. If output high now, it is likely to still be high next quarter, next year, low two years from now.

For this, covariance stationarity is the relevant concept (for one variable, or a vector of variables).

Definition.

$$EY_t = \mu \text{ for all } t$$

$$E(Y_t - \mu)(Y_{t-k} - \mu) = g_k \text{ for all } t$$

Then, we can hope to actually learn the moments, look at the stochastic process, and do more.

Reasonable assumption?

- Sometimes not. Some episodes appear to be one of a kind. Unemployment during the Great Depression. (Graph). Hyperinflations. Transition in Eastern Europe.
Maybe some deeper process which generates such episodes infrequently. But given the length of the series we have, this point is irrelevant.
- Sometimes yes. Post war US GDP. Not covariance stationarity as trends up (back to this in a minute). But a transformation of it seems to be. Use with care.

Even there, can see that this is not quite true. Decrease in variance of GDP over time. Graph.

3.2 Wold decomposition, MAs and ARMA

If a series is covariance stationary, then it can be represented by a Wold decomposition (an infinite MA representation):

$$Y_t = \sum_j \psi_j \epsilon_{t-j} + k(t)$$

where ϵ is iid, mean 0, constant variance. This may not be the true process generating movements in Y_t . The process may be highly non linear (even deterministic. examples: chaos. Markov processes). But, even in those cases, there is an infinite MA Wold representation.

(Why the deterministic component? Typically the mean. More exotic examples: Suppose $Y(t) = Z_e$ if time is even, and $Y_t = Z_o$ if time is odd, where Z_e and Z_o are one-time draws from a normal distribution. Once the draws have been made, the series is deterministic, with one value in even times, one value in odd times. Before the draws have been made, conditioning on time is not useful however. So Y_t is stationary.)

Very convenient. Infinite MAs cannot be estimated. But they can be approximated quite well by ARMA(n,m) process, or even AR(n) process. Easy to estimate.

Example: AR(1):

$$Y_t = \rho Y_{t-1} + \epsilon_t$$

In this case, $\psi_j = \rho^j$.

Considered one variable (univariate). But same applies to many variables, so Y and ϵ are vectors. (multivariate) VARs.

$$Y_t = A_1 Y_{t-1} + A_2 Y_{t-2} + \dots + \epsilon_t$$

Then, can look at correlations, cross correlations, regression coefficients, and so on. (read Stock Watson JEP 2001 for an intro)

(Can also think of this as the reduced form of a linear structural model with shocks. For example, of a model of the form:

$$Y_t = C Y_t + B_1 Y_{t-1} + \dots + u_t$$

where C , B_1 and so on are matrices of structural parameters, and the u_t 's are structural shocks. The epsilons in the VAR are then linear transformations of the underlying shocks.

Work out the VAR representation of a standard supply demand model. What is the relation of ϵ_t to u_t ?)

3.3 Trends

Many economic time series trend up. So must deal with/remove the trend. Not a statistical issue, but an economic issue.

Example 1. A warning. Suppose a variable follows (in logs):

$$Y_t = d + Y_{t-1} + \epsilon_t$$

So absent shocks, grows linearly. Is there a trend? Turn off the shocks. then continue on the current trend line. No return to anything.

Now suppose you generate data and fit a linear trend. Call the difference the cyclical component. By construction, the difference between the series and the estimated trend will tend to go to zero. In fact, no such component.

Application: Stock prices. To a first approximation, stock prices follow a random walk. Their movements cannot be predicted. What happens if you fit a trend?

Example 2.

$$Y_t = T_t + C_t \quad (1)$$

$$T_t = d + T_{t-1} + e_{Tt} \quad (2)$$

$$C_t = aC_{t-1} + e_{Ct} \quad (3)$$

Can we separate the trend and the cycle components?

- Yes, if we assume that e_T and e_C are uncorrelated, or are perfectly correlated (see Stock and Watson 1988 JEP) Reasonable? Typically not.
- Or if e_T has small variance. Then, can hope to get the trend out by taking out a smooth curve:

Linear trend, or a quadratic trend. Or an HP filter.

$$\min \sum_{t_0}^{t_1} ((Y_t - T_t)^2 + \lambda[(T_t - T_{t-1}) - (T_{t-1} - T_{t-2})]^2)$$

The larger the parameter λ , the smoother the trend. How to choose λ ? Warning: the trend and by implication the cyclical component depends on future values. Using an HP filtered series in a regression is potentially dangerous.

Or look at first differences. Contain mostly the cyclical component, if e_{Tt} is small.

- How much of a difference? Results for GDP. Graph.
- The frequency domain. Instead of the infinite MA representation, can characterize behavior by the spectrum, giving the importance of the components at different frequencies.

Then, can take out the very low frequencies, perhaps the very high ones. Keep the part of the spectrum corresponding to 6 quarters to 8 years. This is the Stock Watson approach (Handbook 19990. Graph.

3.4 Co-movements of output with components.

Stock Watson looks at the correlation between cyclical components of output and other variables.

$$\rho(X_{ct}, Y_{ct+k}) \quad k = -6, \dots, 0, \dots, +6$$

(in quarters)

If ρ is positive and highest for $k < 0$, then X is procyclical and lags.

If ρ is positive and highest for $k > 0$, then X is procyclical and leads.

Does not give us a sense of the amplitudes. Covariances rather than correlations would.

Results (Table 2)

- Output, consumption. high and positive. col 9.
- Output, investment high and positive. col 14.
Surprising? More than you might think. You might have thought that fluctuations came from changes in discount rate (people really liking the present, so consuming more, may be working less, then investment would go down.)
- Output and inventory investment high and positive. col 18.

Should you be surprised by this? Yes, if Keynesian. High demand should be smoothed by firms, leading to negative investment. Change in the 1990s: the correlation has become less positive.

- Little correlation with exports. col 19. In the US, fluctuations do not look export driven. (Look at the same correlation for a small open economy, say Belgium).
- Little correlation with government spending. cols 22 to 24. In the US (and in most other countries) fiscal policy is not a major source of fluctuations.
- Looking across sectors. cols 1 to 8. High correlation for all, except mining. (Similar results in Christiano et al) A clear indication of how far we are from the old cycles.

3.5 Comovements with employment

- correlation with employment high and positive. col 25. lag. suggests output then bodies.
Should also be seen as a surprise: If booms are good times, why take less leisure? Or if value utility more now, then why not take both more consumption and more leisure?
- Coincident with hours. col 27. suggests adjustment at that margin. First, firms adjust with overtime, then over time, through hiring.
- High and positive with total factor productivity (Solow residual) and average labor productivity. cols 32 and 33. Leads.

3.6 Comovements with prices and wages

One central intra-temporal price: the real wage. One central inter-temporal price: the real interest rate.

Not much cyclical movement in either.

- Cyclical component of the wage? (think about detrending)
Real wage (definition of the deflator is not given). col 44. probably real product wage. Slightly pro-cyclical, but not much. A-cyclical is a good characterization.
Clearly inconsistent with only movements along a labor demand curve, or labor supply curve. (Old Keynes/Tarshis discussion) consistent with shifts in labor demand, or a mix. or with a model with further deviations from standard labor market equilibrium.
- Correlation with interest rates.
Nominal: col 47 to 49. strongly procyclical and lags output. High in booms.
Real: col 50. mildly countercyclical: low in booms. Leads output a bit. This suggests a story in which low interest rates lead to high demand and high output, but then leads to higher nominal rates.
- Now look at correlation with inflation (GDP deflator or CPI). cols 39, 41. strong correlation, max at lag 4.
This is the Phillips curve relation. More standard scatter diagram. High GDP, low unemployment, leads to higher inflation with a lag.

3.7 Co movements with money

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Long held belief that money has major effects on output. Friedman and Schwartz on Great Depression. The Volcker recession of 1980-82. Surely, markets believe that the Fed can affect output. Federal funds rate and output.

- Correlations high. Both nominal and real. Columns 54, 56. But what does this prove?
- Need more convincing identification. Will just present the results of the study by Christiano et al. (based on a VAR)

Idea: Look at the federal funds rate. Quarterly data. regresses the fund rate on output and other variables. assumes that residual is exogenous change and traces the effect on output and other variables. (correct if no reaction of variables to ff rate within the quarter).

VAR in Y, P, Pcom (price of sensitive commodities), NBRD (non borrowed reserves), FF, TR, plus whatever variable is under consideration,

Results. 1% increase in the federal funds rate. remains for about 8 quarters (figure 2). then long lasting effect on output, on employment, on unemployment. Not much effect on the price level until 6 quarters. How much data mining? See the handbook paper by Christiano, Eichenbaum, Evans

How convincing? Identifying monetary policy from “exogenous” deviations from the usual rule. Are they really exogenous?

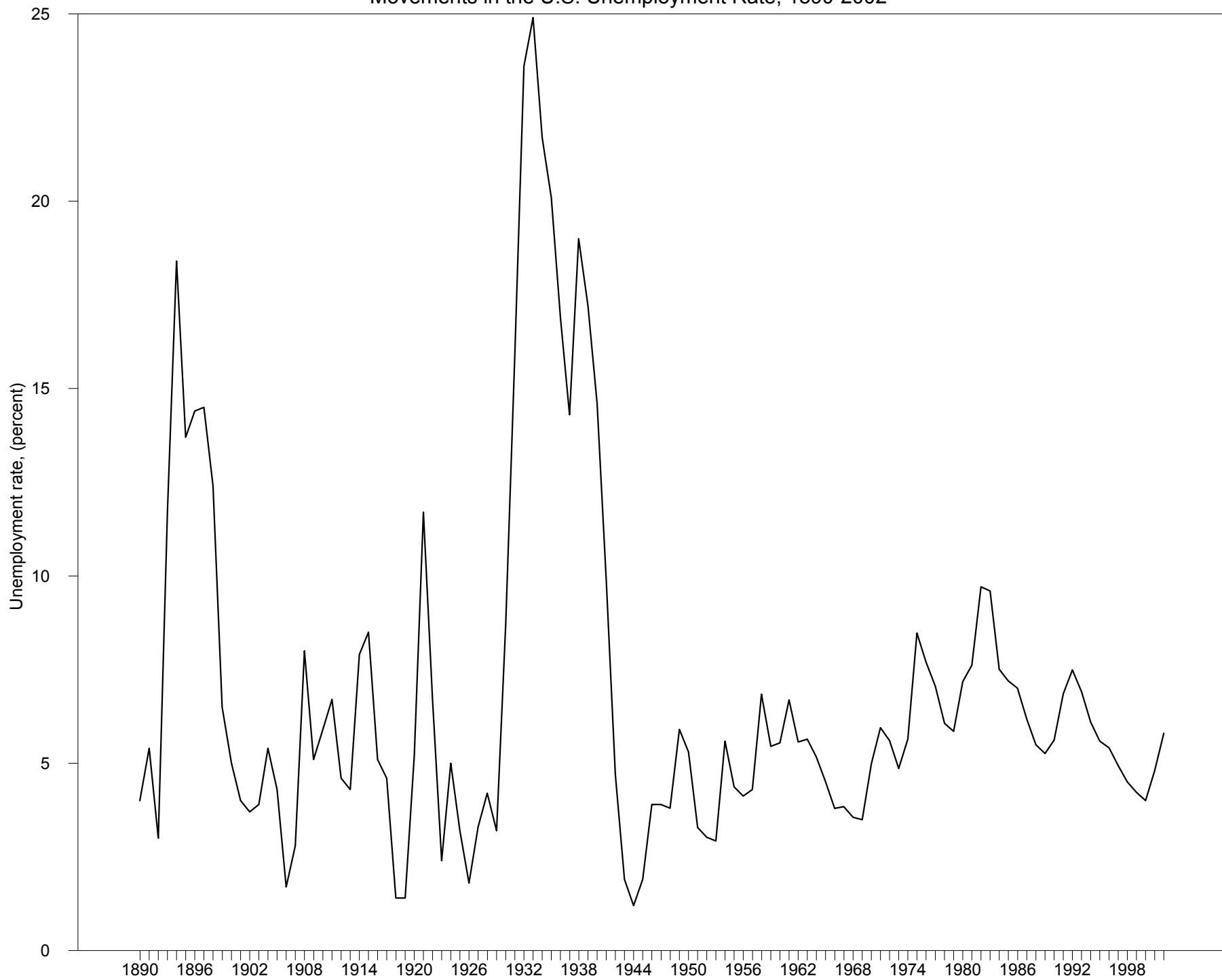
A puzzle: Federal funds rate back to normal far before output is. Not obvious why.

3.8 Summary of facts

- Components move together
- Not much movement of real wages
- Relation with inflation
- Monetary policy appears to affect output, not prices in the short run.

Then all the special episodes. Japan Argentina. Asian crisis. Mexico. European unemployment. And so on, working back in time.

Movements in the U.S. Unemployment Rate, 1890-2002



U.S. inflation, 1900-2003

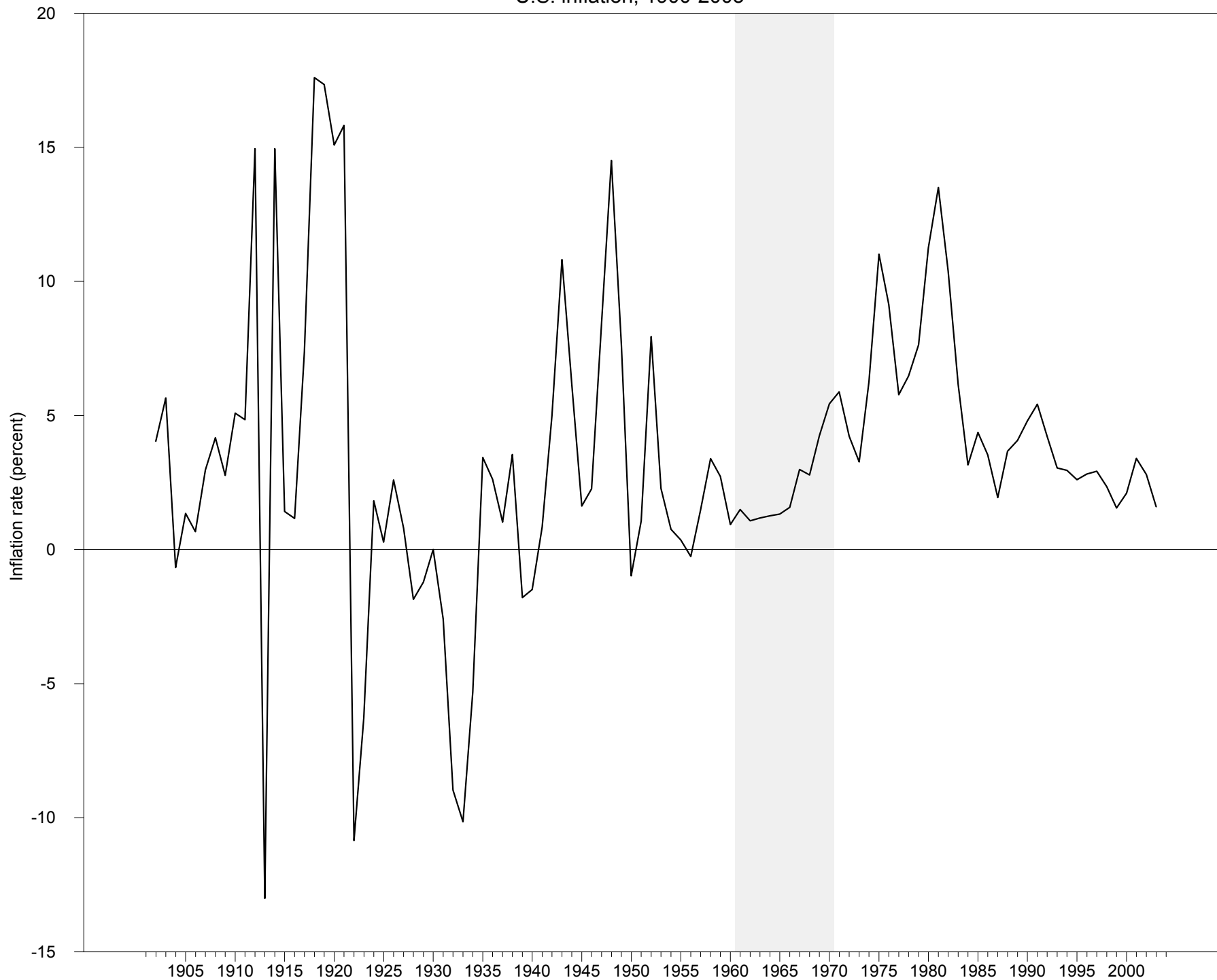
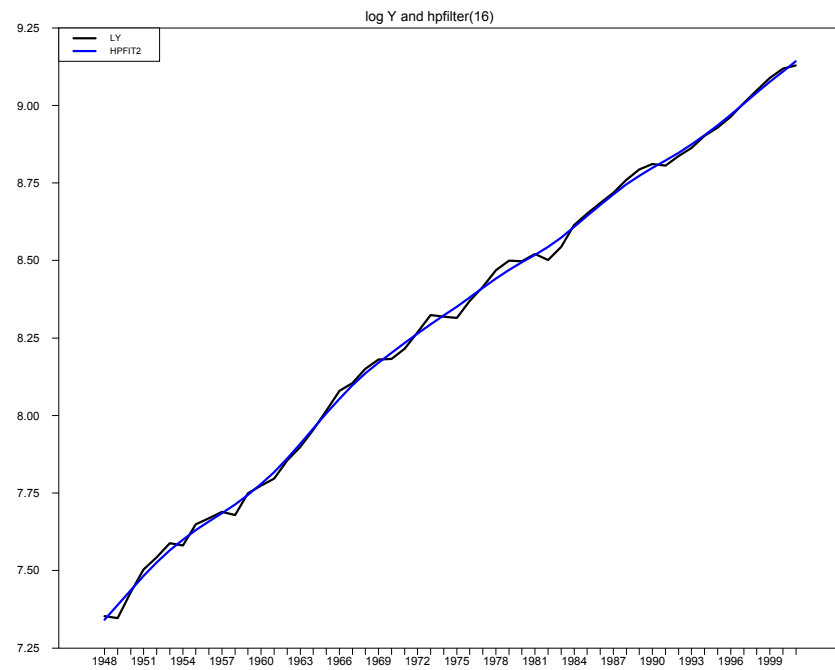
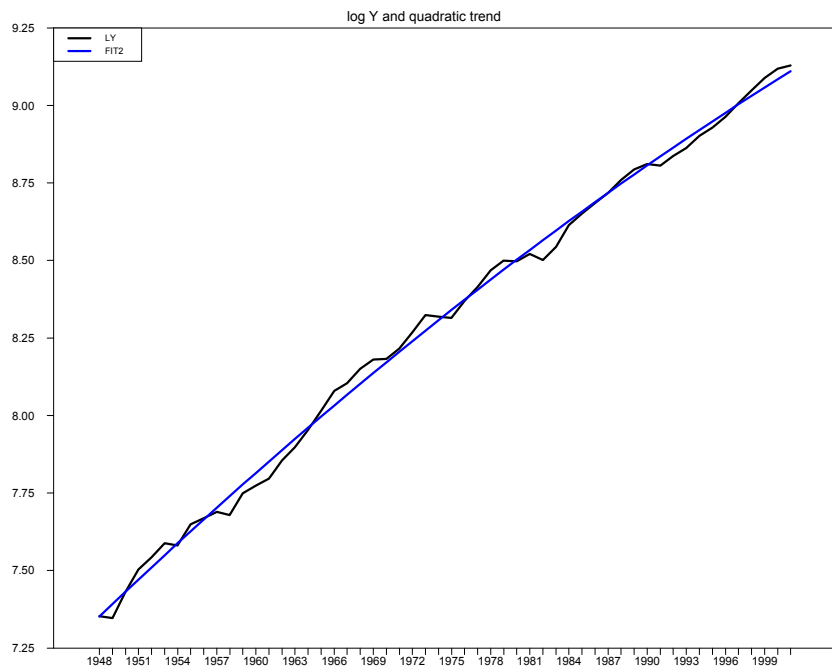
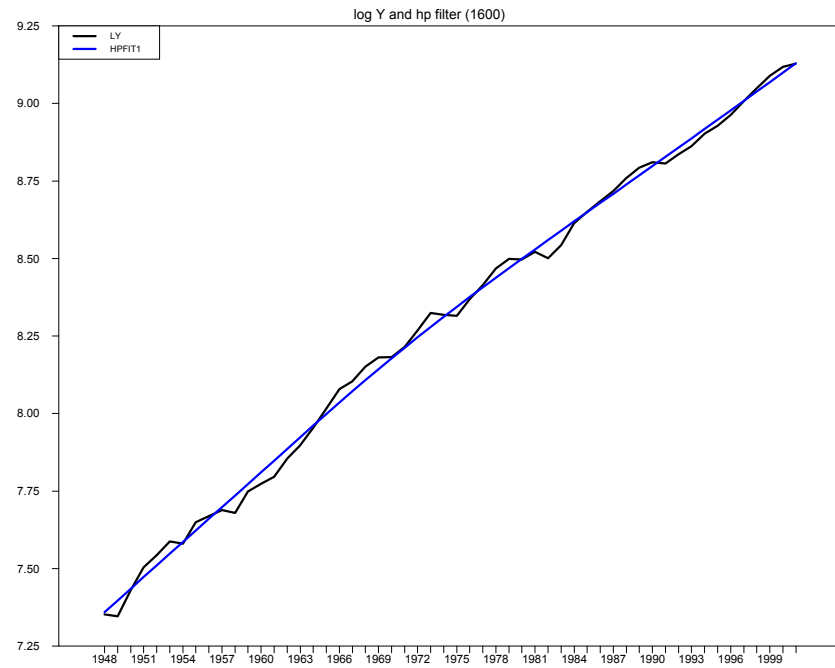
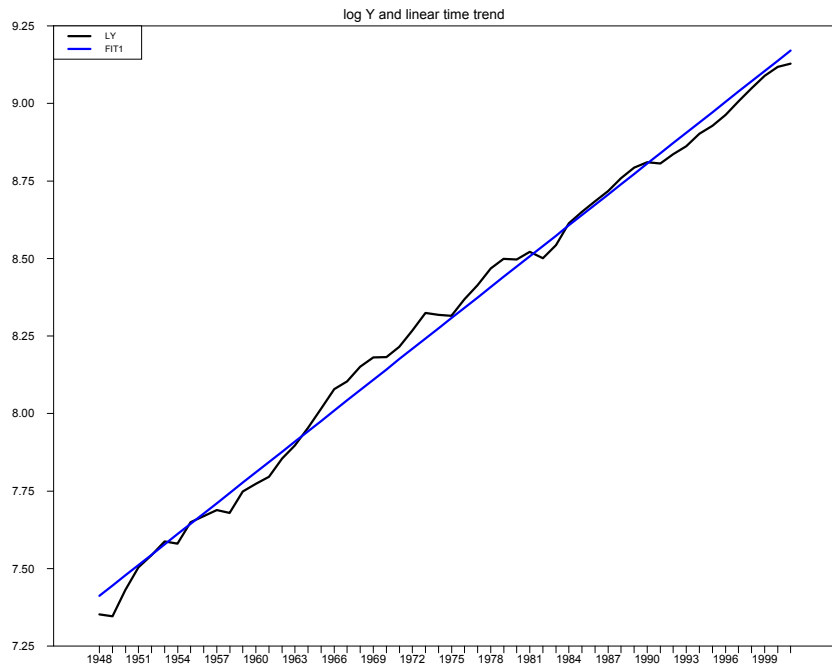
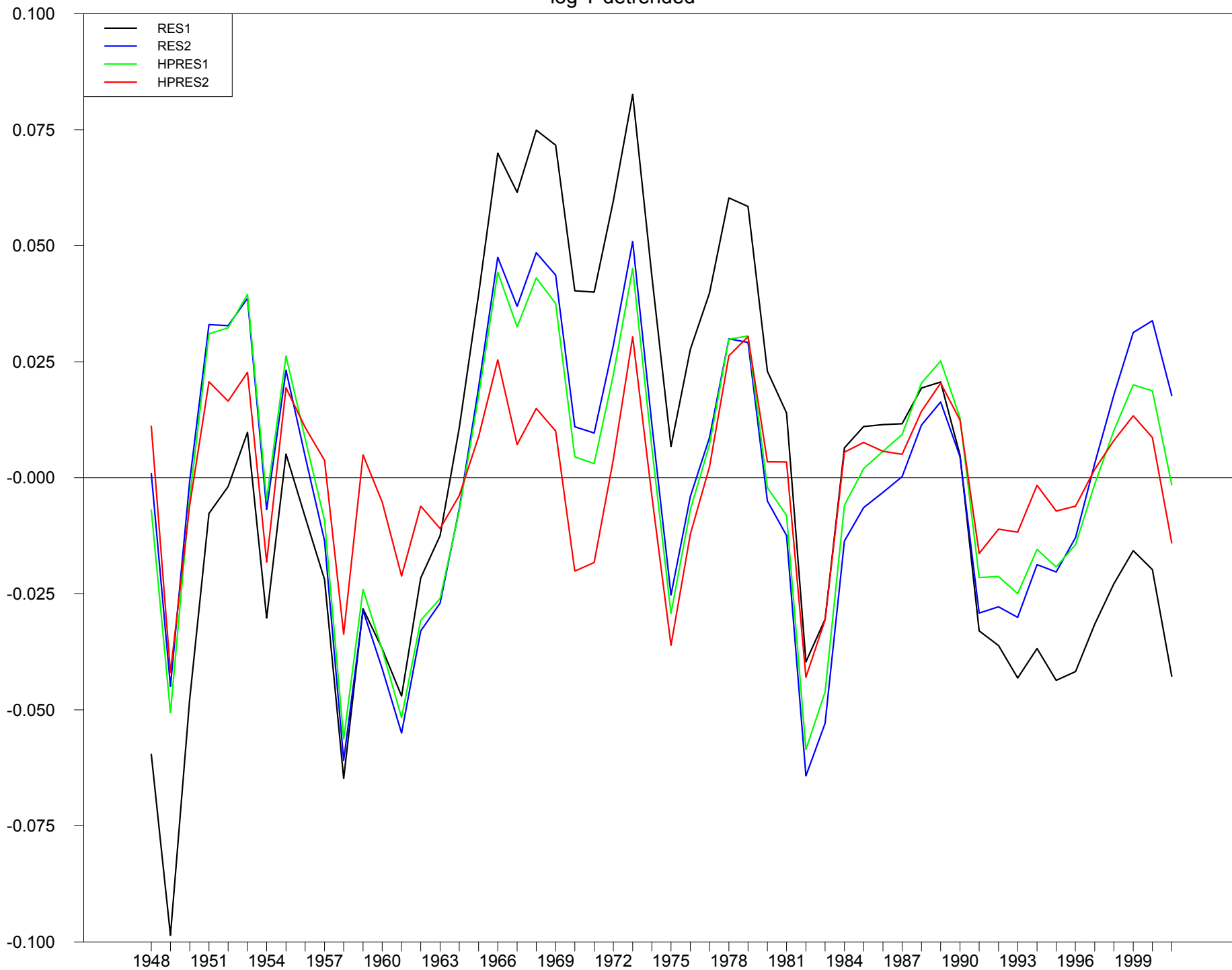


Figure 1. Output growth
Rolling standard deviation

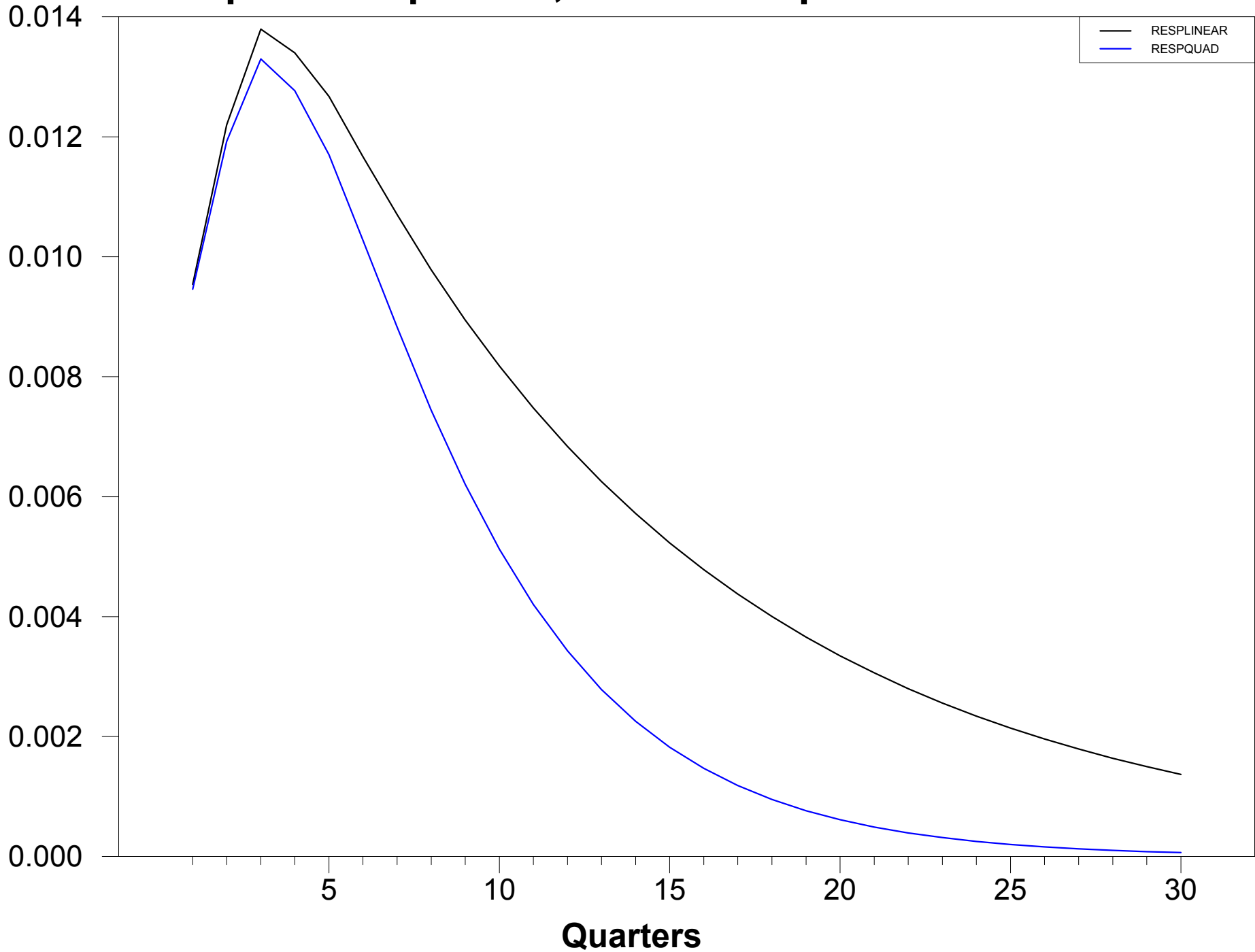




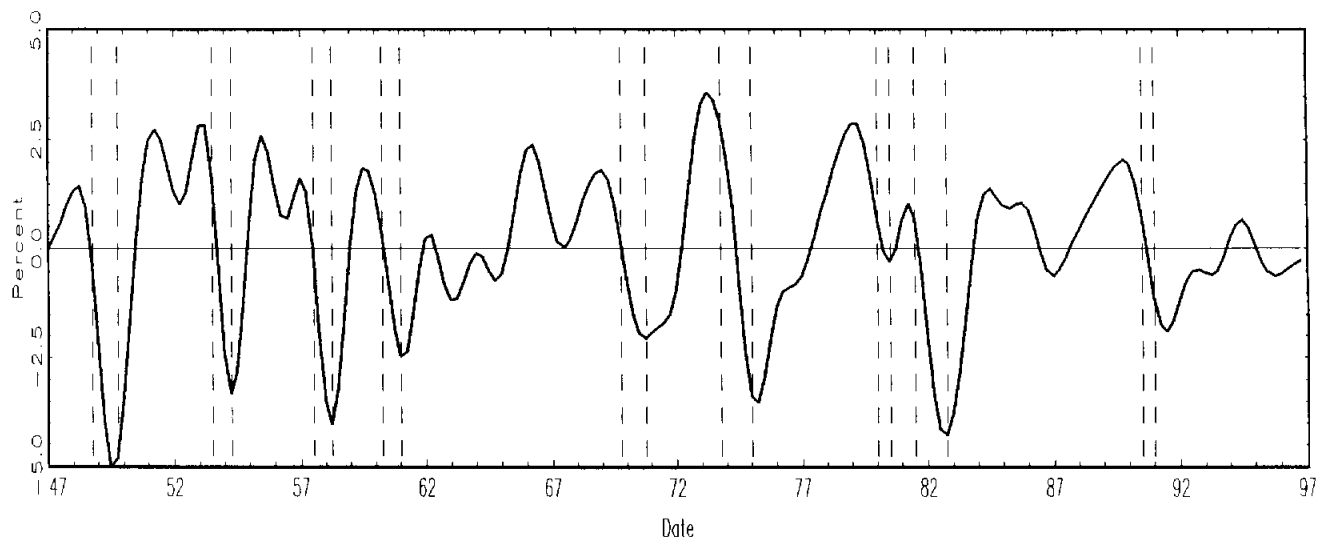
log Y detrended



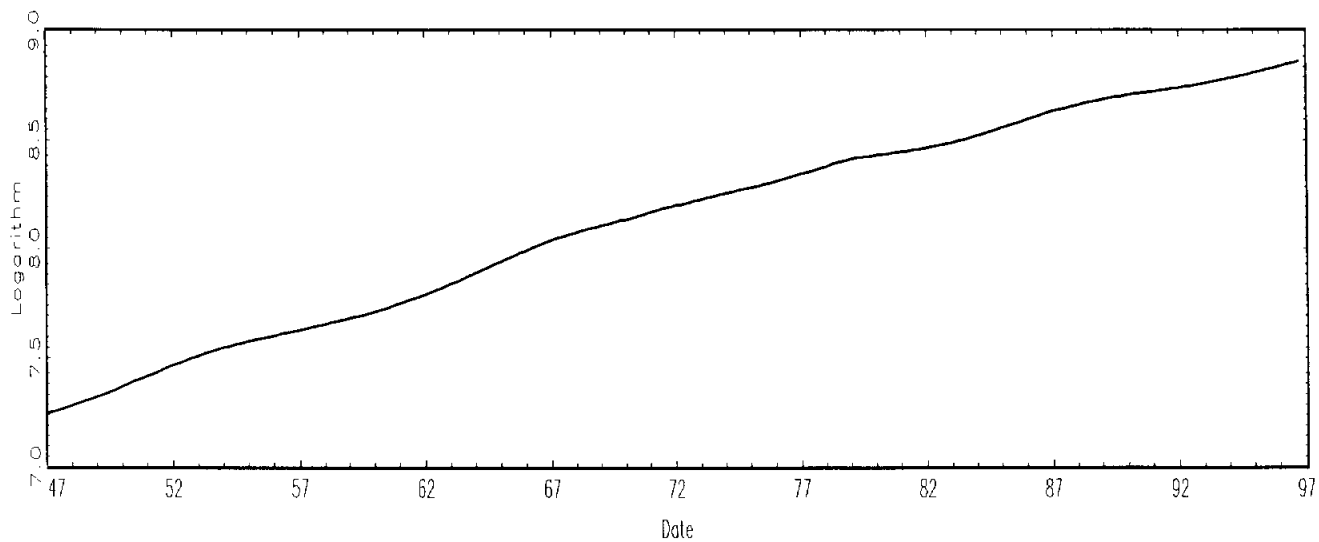
Impulse responses, linear and quadratic trend



2.5 Bandpass-Filtered GDP (Cycle)



2.6 Bandpass-Filtered GDP (Trend)



2.7 Bandpass-Filtered GDP (Irregular)

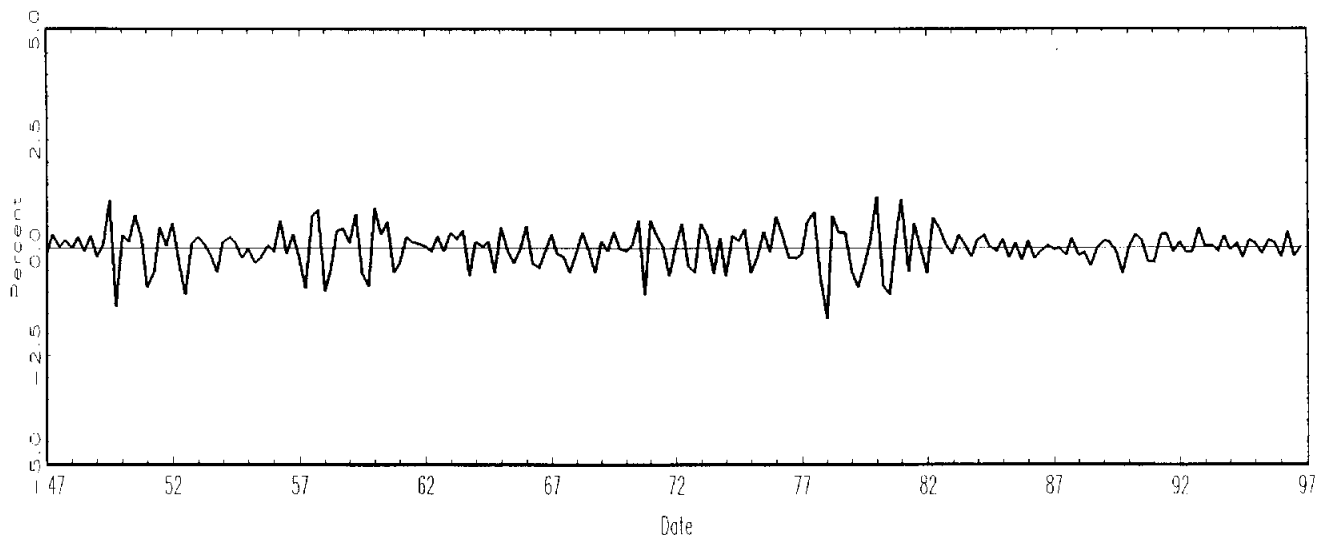


Table 2

Descriptive Statistics for Cyclical Components of Series, 1953 - 1996

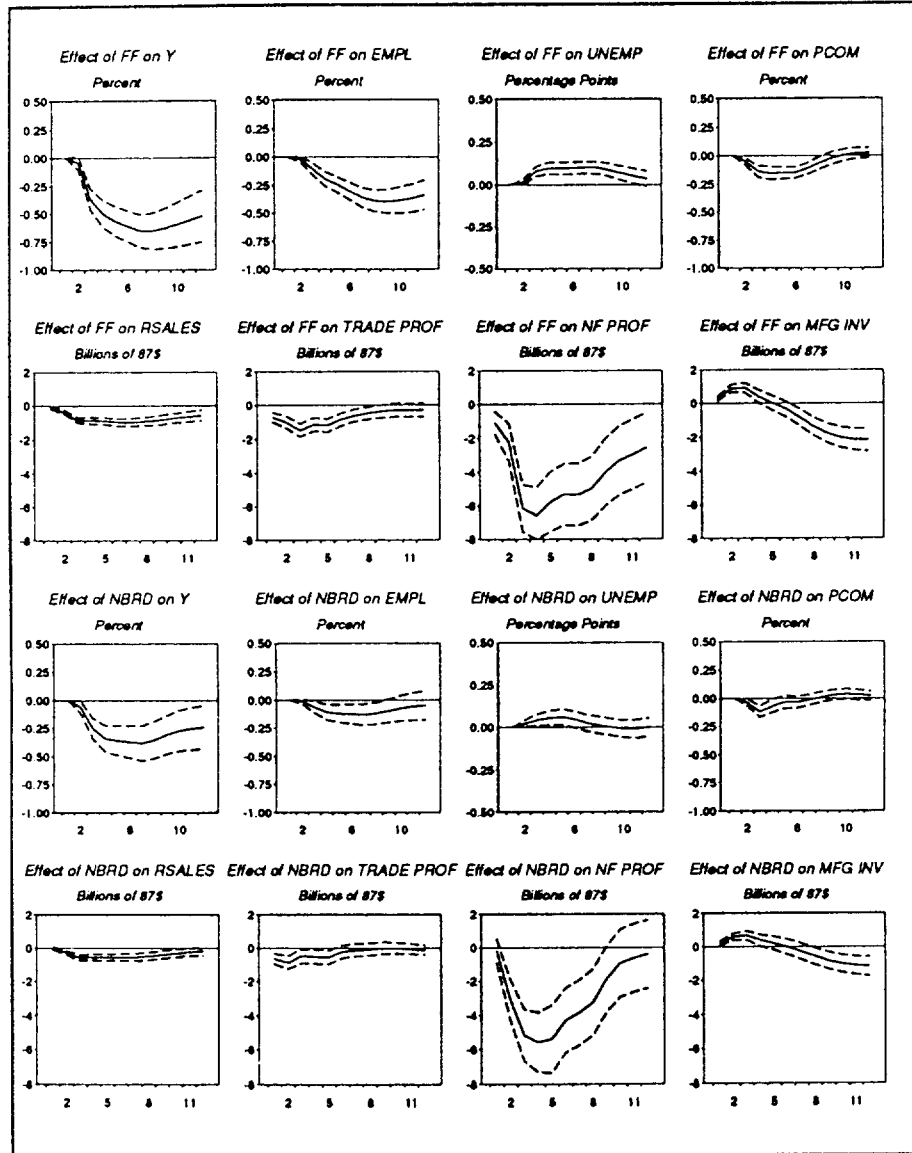
Series	Cross Autocorrelations With Output (Cor(x _t Y _{t+k}))													
	Std Dev	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6
Gross Domestic Product	1.66	-0.29	-0.18	0.03	0.33	0.66	0.91	1.00	0.91	0.66	0.33	0.03	-0.18	-0.29
<u>Sectoral employment</u>														
1. Contract and Construction Employment	3.75	0.02	0.20	0.39	0.58	0.73	0.80	0.77	0.65	0.44	0.19	-0.04	-0.23	-0.35
2. Manufacturing Employment	2.61	-0.06	0.14	0.40	0.67	0.87	0.94	0.84	0.59	0.26	-0.06	-0.30	-0.43	-0.45
3. Finance, Insurance and Real Estate Employment	1.01	0.25	0.35	0.43	0.49	0.50	0.46	0.38	0.28	0.15	0.02	-0.10	-0.20	-0.28
4. Mining Employment	3.79	0.13	0.19	0.25	0.28	0.25	0.16	-0.00	-0.20	-0.40	-0.53	-0.58	-0.55	-0.45
5. Government Employment	0.82	0.51	0.53	0.49	0.43	0.35	0.29	0.23	0.15	0.04	-0.08	-0.21	-0.31	-0.37
6. Service Employment	0.83	0.20	0.33	0.49	0.63	0.71	0.69	0.55	0.34	0.08	-0.15	-0.33	-0.44	-0.50
7. Wholesale and Retail Trade Employment	1.20	-0.01	0.21	0.45	0.68	0.83	0.87	0.79	0.60	0.35	0.10	-0.10	-0.24	-0.32
8. Transportation and Public Utility Employment	1.54	0.23	0.42	0.61	0.77	0.83	0.76	0.56	0.26	-0.06	-0.33	-0.49	-0.53	-0.50
<u>NIPA components</u>														
9. Consumption (Total)	1.26	-0.39	-0.28	-0.07	0.21	0.51	0.76	0.90	0.89	0.75	0.53	0.29	0.09	-0.06
10. Consumption (Nondurables)	1.11	-0.36	-0.24	-0.02	0.25	0.52	0.74	0.83	0.80	0.55	0.43	0.21	0.02	-0.12
11. Consumption (Services)	0.64	-0.13	-0.00	0.14	0.31	0.49	0.66	0.78	0.80	0.70	0.51	0.27	0.05	-0.12
12. Consumption (Nondurables + Services)	0.78	-0.28	-0.15	0.05	0.29	0.55	0.75	0.87	0.85	0.71	0.49	0.25	0.03	-0.13
13. Consumption (Durables)	4.66	-0.46	-0.38	-0.19	0.09	0.42	0.70	0.85	0.86	0.73	0.53	0.32	0.15	0.03
14. Investment (Total Fixed)	4.97	-0.34	-0.19	0.04	0.32	0.61	0.82	0.89	0.83	0.65	0.41	0.18	-0.00	-0.13
15. Investment (Equipment)	5.25	-0.06	0.16	0.41	0.65	0.84	0.92	0.88	0.73	0.49	0.23	-0.01	-0.20	-0.31
16. Investment (Nonresidential Structures)	4.67	0.20	0.40	0.58	0.70	0.74	0.67	0.52	0.30	0.07	-0.14	-0.30	-0.40	-0.44
17. Investment (Residential Structures)	10.04	-0.49	-0.48	-0.37	-0.18	0.09	0.38	0.62	0.77	0.78	0.69	0.53	0.36	0.20
18. Change in Bus. Inventories (Relative to Trend GDP)	0.38	-0.58	-0.50	-0.32	-0.04	0.28	0.57	0.73	0.72	0.56	0.32	0.08	-0.08	-0.15
19. Exports	4.76	0.33	0.42	0.47	0.50	0.48	0.40	0.27	0.09	-0.11	-0.29	-0.43	-0.50	-0.51
20. Imports	4.42	-0.45	-0.28	-0.03	0.27	0.54	0.72	0.78	0.70	0.53	0.34	0.17	0.05	-0.02
21. Trade Balance (Relative to Trend GDP)	0.38	0.54	0.45	0.30	0.10	-0.11	-0.29	-0.42	-0.48	-0.49	-0.48	-0.45	-0.41	-0.35
22. Government Purchases	2.49	0.30	0.25	0.22	0.21	0.21	0.19	0.15	0.03	-0.10	-0.20	-0.23	-0.19	-0.09
23. Government Purchases (Defense)	4.66	0.21	0.18	0.15	0.14	0.12	0.09	0.05	-0.06	-0.18	-0.26	-0.27	-0.20	-0.08
24. Government Purchases (Non-Defense)	1.35	0.21	0.12	0.07	0.08	0.13	0.19	0.22	0.23	0.21	0.18	0.13	0.08	0.01

Table 2 (Continued)

Series	Cross Autocorrelations With Output (Cor(x_t, Y_{t+k}))													
	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	
<u>Money</u>														
54. Money Stock (M2, Nominal Level)	1.48	-0.39	-0.35	-0.27	-0.15	0.03	0.22	0.39	0.53	0.59	0.58	0.51	0.40	0.27
55. Monetary Base (Nominal Level)	1.12	-0.06	-0.05	-0.03	0.01	0.07	0.13	0.18	0.19	0.18	0.16	0.13	0.10	0.07
56. Money Stock (M2, Real Level)	2.00	-0.39	-0.30	-0.17	0.00	0.20	0.40	0.57	0.69	0.73	0.71	0.62	0.49	0.33
57. Monetary Base (Real Level)	1.53	-0.18	-0.11	-0.01	0.12	0.25	0.36	0.45	0.49	0.50	0.46	0.40	0.32	0.23
58. Money Stock (M2, Nominal Rate of Change)	2.07	-0.08	-0.22	-0.36	-0.48	-0.54	-0.50	-0.38	-0.19	0.01	0.19	0.31	0.37	0.38
59. Monetary Base (Nominal Rate of Change)	1.38	-0.01	-0.07	-0.14	-0.18	-0.19	-0.16	-0.08	-0.01	0.05	0.10	0.14	0.17	0.18
60. Consumer Credit	3.29	0.30	0.50	0.67	0.75	0.74	0.63	0.46	0.25	0.06	-0.08	-0.15	-0.18	-0.18
<u>Miscellaneous leading indicators</u>														
61. Consumer Expectations	9.15	-0.61	-0.64	-0.59	-0.46	-0.25	0.00	0.25	0.44	0.54	0.53	0.44	0.32	0.20
62. Building Permits	16.19	-0.51	-0.54	-0.51	-0.41	-0.21	0.07	0.36	0.60	0.74	0.75	0.67	0.52	0.36
63. Vendor Performance	10.87	-0.40	-0.40	-0.32	-0.14	0.09	0.34	0.53	0.61	0.58	0.43	0.23	0.04	-0.11
64. Mfrs' Unfilled Orders, Durable Goods Ind.	6.73	0.48	0.60	0.69	0.72	0.70	0.61	0.47	0.28	0.06	-0.15	-0.32	-0.45	-0.50
65. Mfrs' New Orders, Nondefense Capital Goods	8.11	-0.09	0.09	0.30	0.53	0.72	0.83	0.83	0.71	0.51	0.26	0.02	-0.16	-0.27
<u>International output</u>														
66. Industrial Production - Canada	3.43	-0.19	-0.03	0.19	0.45	0.68	0.84	0.87	0.77	0.56	0.29	0.04	-0.17	-0.30
67. Industrial Production - France	2.58	0.03	0.20	0.35	0.44	0.46	0.39	0.26	0.12	-0.01	-0.11	-0.18	-0.21	-0.22
68. Industrial Production - Japan	4.46	0.09	0.23	0.37	0.49	0.53	0.49	0.35	0.15	-0.06	-0.23	-0.33	-0.36	-0.33
69. Industrial Production - UK	2.60	-0.04	0.11	0.27	0.42	0.51	0.53	0.47	0.39	0.28	0.18	0.10	0.03	-0.02
70. Industrial Production - Germany	3.19	0.01	0.08	0.18	0.29	0.38	0.40	0.35	0.24	0.09	-0.07	-0.19	-0.27	-0.31

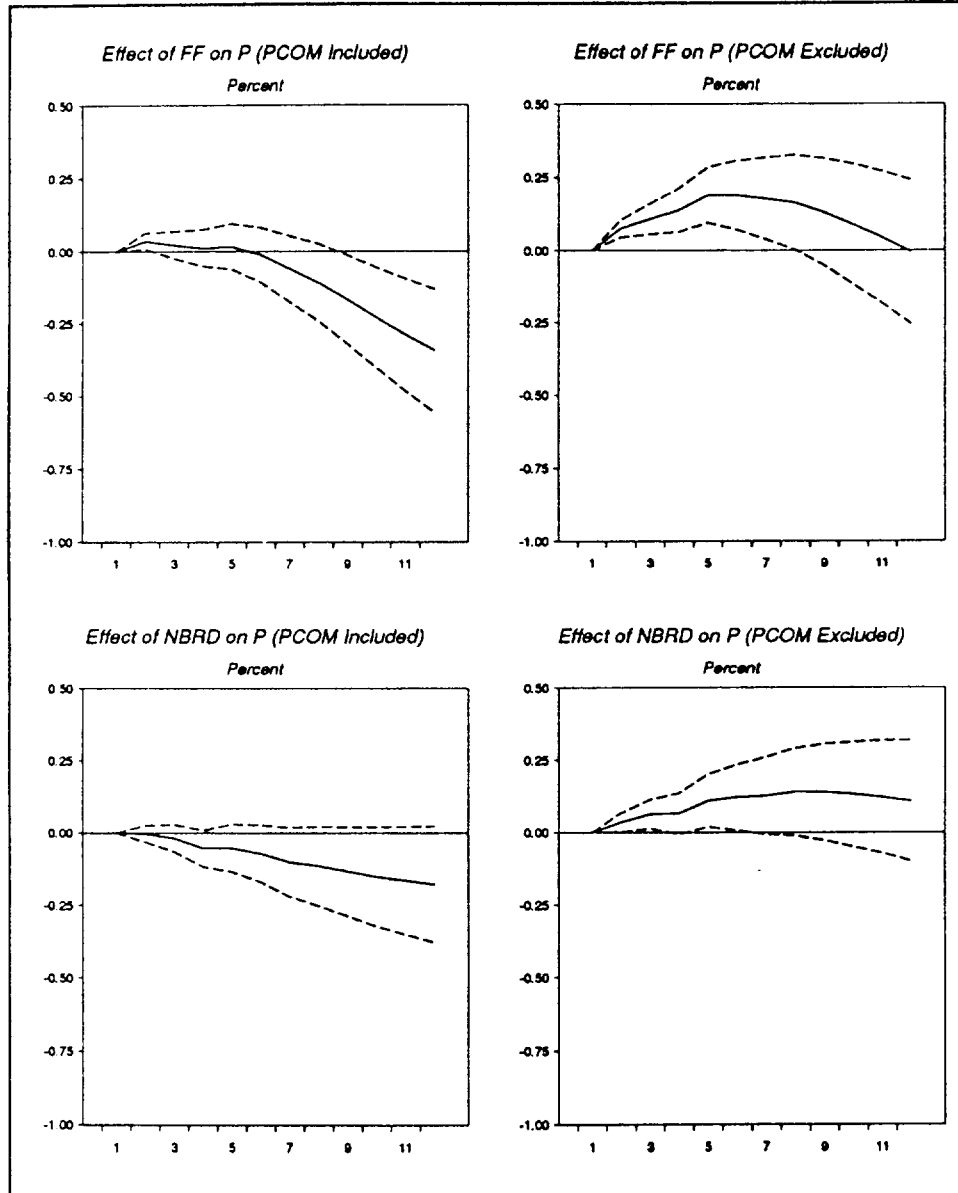
Notes: All statistics are computed using bandpass filtered data. The second column shows the standard deviation of the resulting estimate of the cyclical component. Other columns show the crosscorrelations of the cyclical component of each series with the cyclical component of GDP, led k periods.

Figure 2.3
Effect of Policy Shocks on Macroeconomic Variables



The effects of FF and NBRD policy shocks on selected macroeconomic variables. The estimated impulse response functions were computed from the following VARs: in Rows (1) and (2) the effects on Y and PCOM were estimated from a single 6-variable VAR which includes Y, P, PCOM, FF, NBRD, and TR; the other impulse response functions were estimated from six 7-variable VARs which include Y, P, PCOM, FF, NBRD, TR, and D, where D is EMPL, UNEMP, RSALES, TRADE PROF, NF PROF, and MFG INV (respectively); Rows (3) and (4) are the same as Rows (1) and (2) except that the policy shock is NBRD. The dashed lines are one-standard error bands.

Figure 2.4
Effect of Policy Shocks on the Price Level



The effects of FF and NBRD policy shocks on the price level. The estimated impulse response functions were computed from the following VARs: in Column (1) the effects on P were estimated from a single 6-variable VAR which includes Y, P, PCOM, FF, NBRD, and TR; in Column (2), the effects on P were estimated from a single 5-variable VAR which includes Y, P, FF, NBRD, and TR. The dashed lines are one-standard error bands.

Figure 2

