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A TIME SERIES ANALYSIS OF FEDERAL BUDGET POLICY

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A Time Series Analysis of Federal Budget Policy

This paper uses a time series approach to investigate the stability of macroeconomic relationships across different budget policy regimes. The premise is that estimated macroeconomic relationships are not invariant with respect to changes in the budget policy rule.

The approach involves estimating a vector autoregression (VAR), testing for a break in the budget policy rule, and then reestimating the VAR separately over each subperiod ending and beginning with the break in policy. The significance of the differences between the two subperiod models is qualitatively assessed by comparing impulse response functions, decompositions of variance, within-sample fits, and out-of-sample predictions conditioned on identical information. By these measures, the estimated relationships change dramatically under the different budget policies. While the VAR estimated over the entire period appears very monetarist, those estimated over each subperiod assign much less importance to money and more importance to deficits.

An implication of these findings is that the effects of deficit policies cannot be ascertained by regressing variables against some transformation of actual deficits.[1/] Such an approach assumes a single deficit policy was in place over the sample period. If the sample period is sufficiently short to encompass a single deficit policy, then such regressions have no implications about the effects of different policies. If the sample period does cut across different policy regimes, however, then this study indicates that estimated coefficient distributions are likely to be complicated functions of different distributions. Thus, a stationarity assumption underlying the estimation procedure is likely to be violated.

The methodology used in this study is discussed in the next section. Properties of the VAR estimated over the full period are described in the following section. The test results for structural change then are reported. The paper concludes with comparisons of descriptive output from the subperiod and full period models.

I. Discussion of Methodology

The VARs contain five quarterly time series: real GNP (RGNP), GNP deflator (GNPD), 90-day Treasury bill rate (RTB), bank reserves (TR), and federal debt (DEBT). The measure of bank reserves is the St. Louis Federal Reserve Bank's total reserves, seasonally adjusted, and adjusted for changes in reserve requirements. It is intended as a measure of outside money.[2/] The measure of federal debt is constructed by taking total public debt net of government account holdings in 1948 as the base and adding to that the accumulated, quarterly NIA deficit (not annualized). It is intended as a measure of outside federal debt. In the regressions all series except the bill rate are logged.

The set of variables was chosen to form the smallest system able to capture major channels of policy influence: namely, monetary and fiscal policies together determine the inflation rate and interest rate, which in turn affect real output by their impact on the rate of investment.[3/] Monetary and fiscal policies are represented as feedback rules which determine the current levels of bank reserves and federal debt, respectively, as functions of lagged values of all the variables in the system.

Each variable in the system is regressed on a constant and on three lags of all five variables. Thus the system can be written,

$$X_t = C + \sum_{i=1}^{3} A_i X_{t-i} + \mu_t, \text{ where}$$

$$X = \begin{pmatrix} \ln(RGNP) \\ \ln(GNPD) \\ RTB \\ \ln(DEBT) \\ \ln(TR) \end{pmatrix}, \quad \mu = \begin{pmatrix} \mu_1 \\ \cdot \\ \cdot \\ \cdot \\ \mu_5 \end{pmatrix}, \text{ and } \underset{5x1}{C} \text{ and } \underset{5x5}{A_i} \text{ are matrices of coefficients.}$$

The coefficients in the matricies C and A_i are estimated by OLS and $E\mu\mu' = \Sigma$ is estimated by the variance-covariance matrix of residuals. This simple form of the system was chosen to conserve on degrees of freedom and to facilitate testing for structural change, while not sacrificing much in terms of goodness of fit.

Three lags were chosen after comparing out-of-sample Theil U's for univariate autoregressions and unconstrained vector autoregressions of varying lag lengths. The models first were estimated from 1948:1 through 1966:4 and forecast errors were generated over the next twelve quarters.[4/] The models then were reestimated on data for one additional quarter and forecast errors were generated over the next twelve quarters. This process was repeated over the full sample period 1948:1 - 1981:4. Sixty observations were generated on one-step ahead forecast errors, falling to 49 observations on twelve-step ahead errors. The errors across steps four through twelve were averaged for each variable. The table below lists Theil U's for each variable and the average across variables for models of varying lag lengths.

In both the univariate and VAR models little gain in fit is found for any variable beyond a three-quarter lag length. Moreover, the average of Theil U's across variables is minimized in the univariate model at a three-quarter lag length, while the average in the VAR at a three-quarter lag length is only marginally higher than the minimum which occurs at a two-quarter lag length.

Although Litterman-type prior constraints were found to improve the fit of the VAR, they were not used for the following three reasons.[5/] First,

Table 1
Theil U's (Average over forecast steps 4-12)

Lag Length	Univariate RGNP	Univariate GNPD	Univariate RTB	Univariate DEBT	Univariate TR	Univariate Ave	Unconstrained VAR RGNP	Unconstrained VAR GNPD	Unconstrained VAR RTB	Unconstrained VAR DEBT	Unconstrained VAR TR	Unconstrained VAR Ave
1	.6473	.2894	1.0560	.8873	.4031	.6566	1.1947	.2174	.8818	.5243	.7702	.7177
2	.6544	.2739	1.1136	.8595	.4052	.6613	.9418	.2120	.9722	.5078	.7229	.6713
3	.6625	.2630	1.0577	.8013	.4066	.6382	1.0126	.2186	.9116	.5644	.7688	.6952
4	.6460	.2797	1.0929	.7928	.4126	.6448	1.0451	.2402	.9607	.6060	.8482	.7400
5	.6147	.3057	1.0961	.7907	.4397	.6494	1.2970	.3333	.9559	.5381	1.0495	.8348
6	.6163	.3239	1.0736	.8105	.4462	.6541	1.4144	.3566	1.0088	.6452	1.1102	.9070
7	.6250	.3253	1.0780	.8096	.4371	.6550	1.6714	.3818	.9886	.6996	1.2013	.9885
8	.6401	.3327	1.0789	.8427	.4462	.6681	1.8636	.4522	1.0243	.7227	1.3705	1.0867

when the equations are estimated by OLS, simple F-tests can be used for tests for structural change. Second, by not using any prior constraints, the output of the regressions better describes what is in the data, rather than what the econometrician thinks should be in the data. Third, the improvement was not dramatic, as the table below illustrates.

Table 2*
Theil U's by Restrictions on 3-lag Models
(Averages over forecast steps 4 through 12)

Restrictions on VAR: Tightness i/	General Prior ii/	RGNP	GNPD	RTB	DEBT	TR	Ave
1.0	Symmetric	.9936	.4877	.6101	.5614	.7117	.6729
1.0	Nonsymmetric	.9818	.4833	.6135	.5675	.7155	.6723
0.2	Symmetric	.9520	.4618	.6029	.5362	.6768	.6460
0.2	Nonsymmetric	.8919	.4538	.5985	.5318	.6793	.6311
Univariate		.6924	.2461	1.0565	.7988	.3931	.6374

i. The tightness parameter determines the concentration of lagged coefficient distributions about zero. A value of .2 minimizes the average Theil U's given the symmetric general prior, while a value of 1.0 implies no prior constraint.

ii. The general prior is a matrix which weights the importance of each explanatory variable in each equation. The nonsymmetric prior gives .1 weight to TR and DEBT in the equation for RGNP and 1.0s elsewhere in the matrix. The symmetric prior is a matrix of 1.0s and implies no prior constraint. The nonsymmetric prior is meant to capture the theoretical implication that policies affect real GNP primarily through their effects on inflation and interest rates.

*The initial estimation period for these Theil U's is 1948:1 - 1968:1, so the entries in this table are not fully comparable to those in Table 1.

II. VAR, Full Period: 1948:1 - 1981:4 [6]

The VAR estimated over the full period is described in terms of summary statistics, impulse response function, and decomposition of variance.[7] (Detailed equation descriptions including coefficient estimates and significance levels are available from the author.) The ordering of variables in the impulse response function and decomposition of variance is the same one used in the tables above: RGNP, GNPD, RTB, DEBT, TR.[8]

Given this ordering, the system can be written

$$X_t = C + \sum_{i=1}^{3} A_i X_{t-i} + R\varepsilon_t \equiv C + \sum_{i=1}^{3} A_i X_{t-i} + \mu_t,$$

where R_{5x5} is a lower triangular matrix with 1s on the diagonal and ε_{5x1} is a vector of random errors which are serially and contemporaneously uncorrelated.

Table 3 reports the adjusted R-squared statistic, the standard error of estimate, and the Durbin-Watson statistic, respectively, for each equation in the VAR.

Table 3
Summary Statistics for Equations in VAR: 1948:1 - 1981:4

Dependent Variable [i]	$\bar{R}^2$	SEE	DW
RGNP	.9993	.0091	2.0169
GNPD	.9999	.0042	1.9178
RTB	.9559	.6487	1.7451
DEBT	.9997	.0054	1.8744
TR	.9992	.0116	2.0081

[i] All variables except RTB are logged.

Table 4 reports F-statistics for the significance of the lag distributions of each variable in each equation.

Table 4
F Statistics

	Lag Distributions				
Equation	RGNP	GNPD	RTB	DEBT	TR
RGNP	563.984***	0.627	3.002**	2.123	2.244
GNPD	4.167***	978.653***	5.592***	2.020	14.732***
RTB	1.452	0.559	93.797***	5.541***	0.058
DEBT	5.358***	3.003**	1.962	2557.458***	0.453
TR	1.342	1.084	1.917	1.353	181.968***

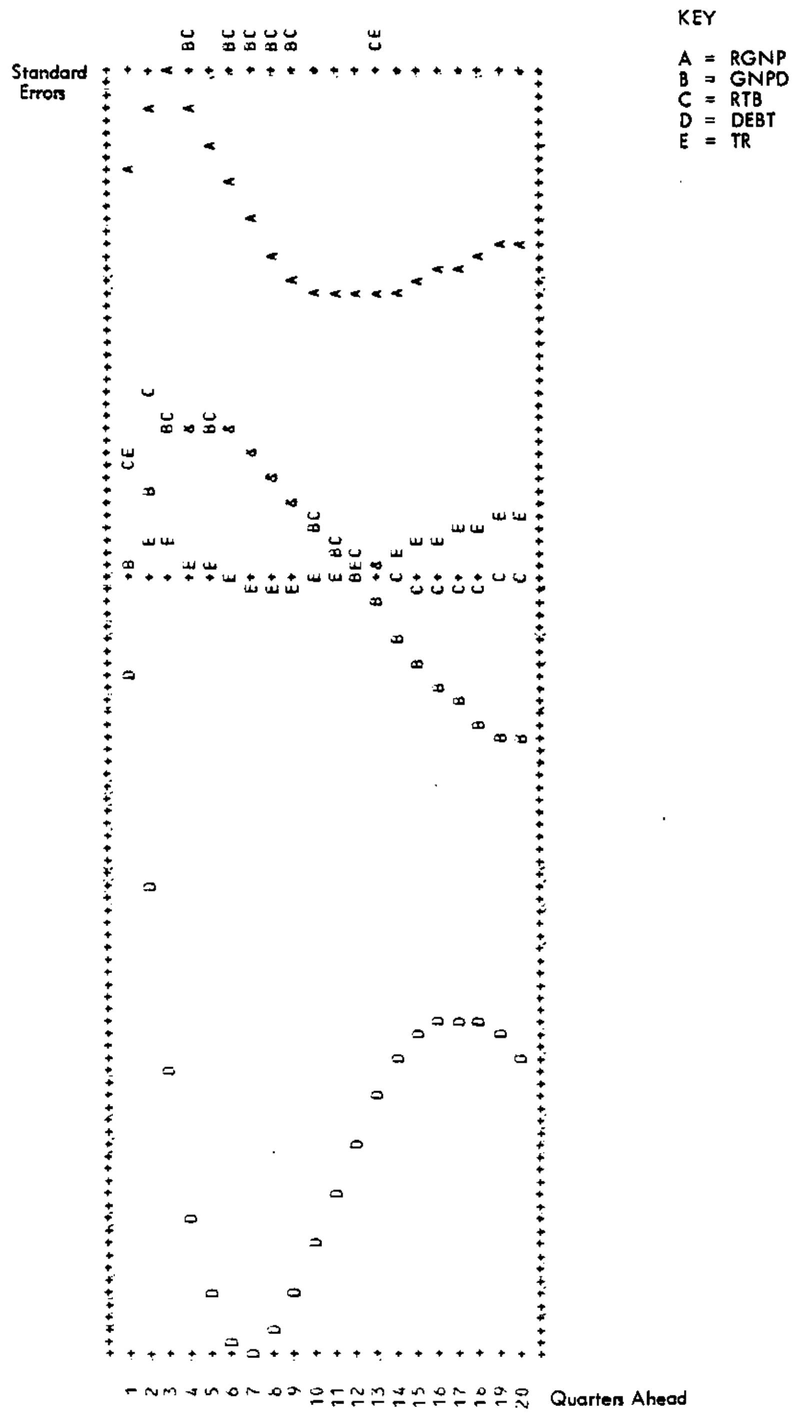
Key: **marginal significance level < .05
***marginal significance level < .01

The table indicates that federal debt has significant explanatory power for interest rates, and total reserves has significant explanatory power for inflation. While federal debt seems to have been affected significantly by other variables, total reserves seems to have been largely exogenous.

We next examine the impulse response function, which is a scaled version of the moving average representation of the model. It gives the *dynamic response of the system to an innovation in variable* X_i *in period t of* magnitude equal to one standard deviation of ε_i. In the graphs which follow, the impulses and responses of each variable X_i are divided by the standard deviations of μ_i.

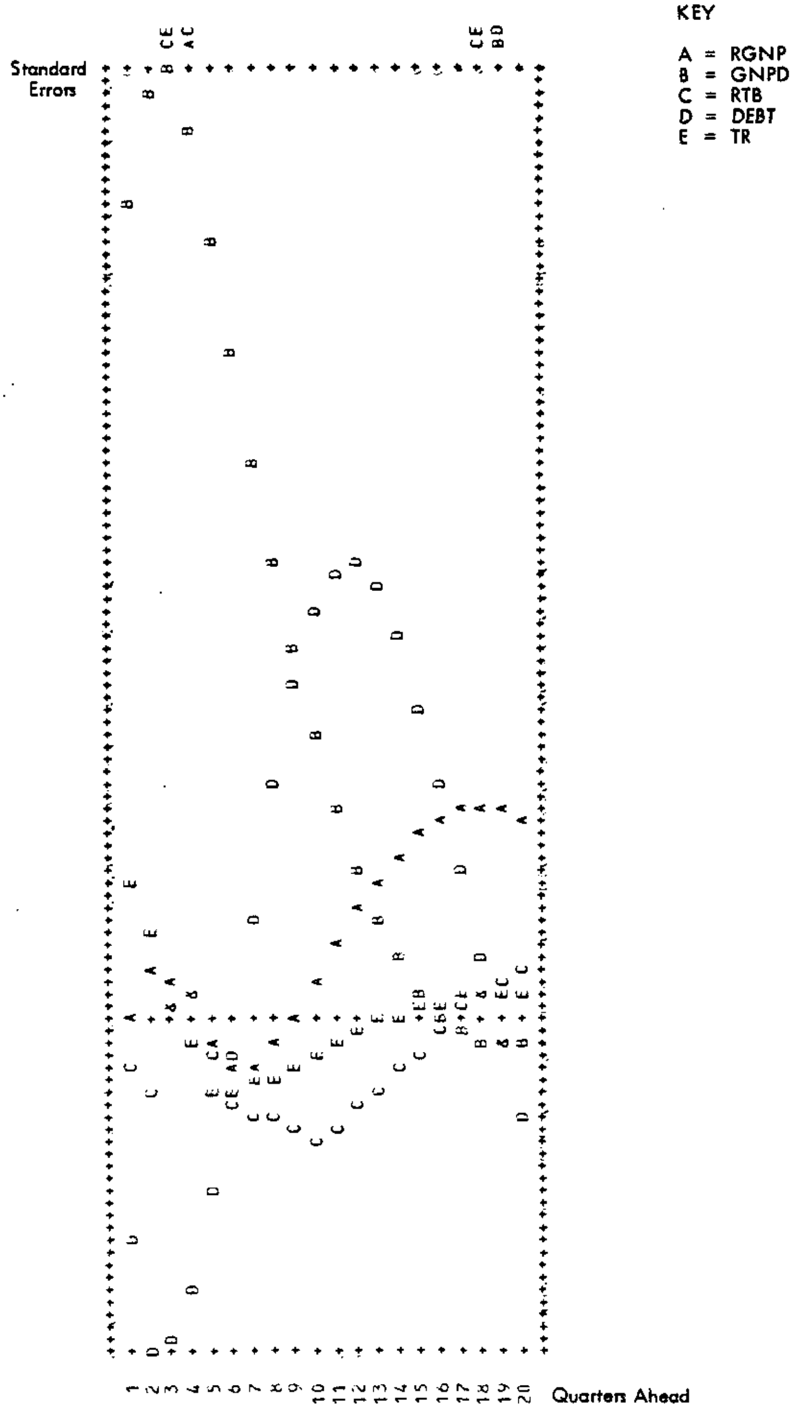
Graph 1

PLOT OF RESPONSES TO RGNP



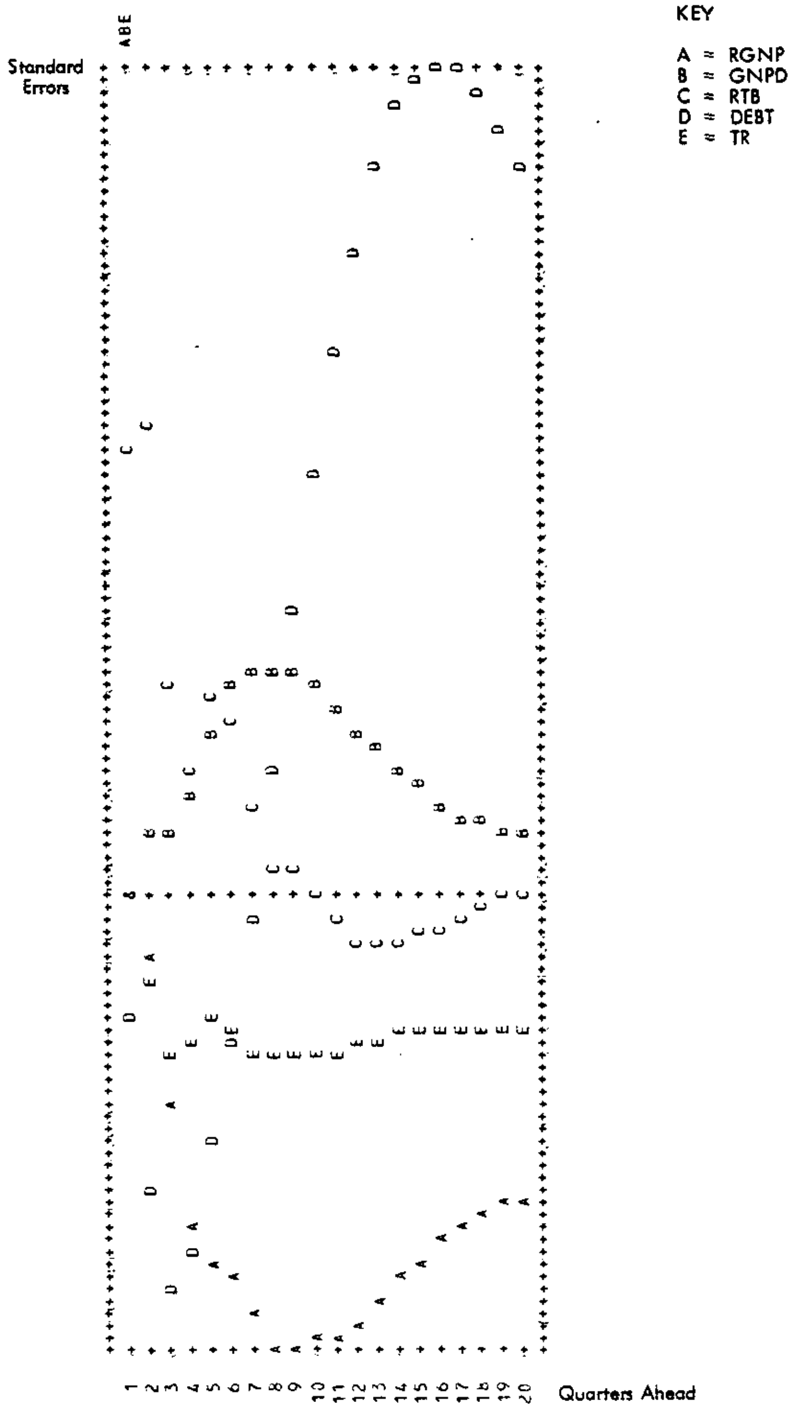
Graph 2

PLOT OF RESPONSES TO GNPD



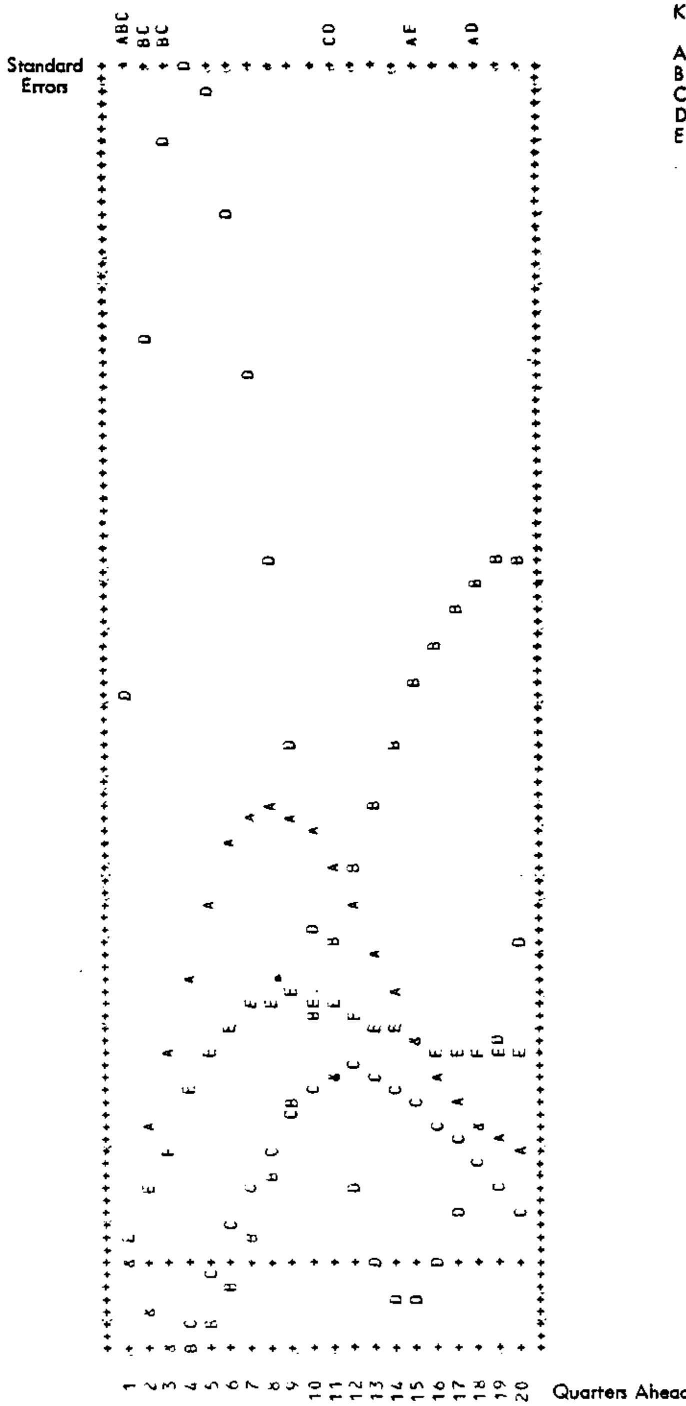
Graph 3

PLOT OF RESPONSES TO RTB



Graph 4

PLOT OF RESPONSES TO DEBT

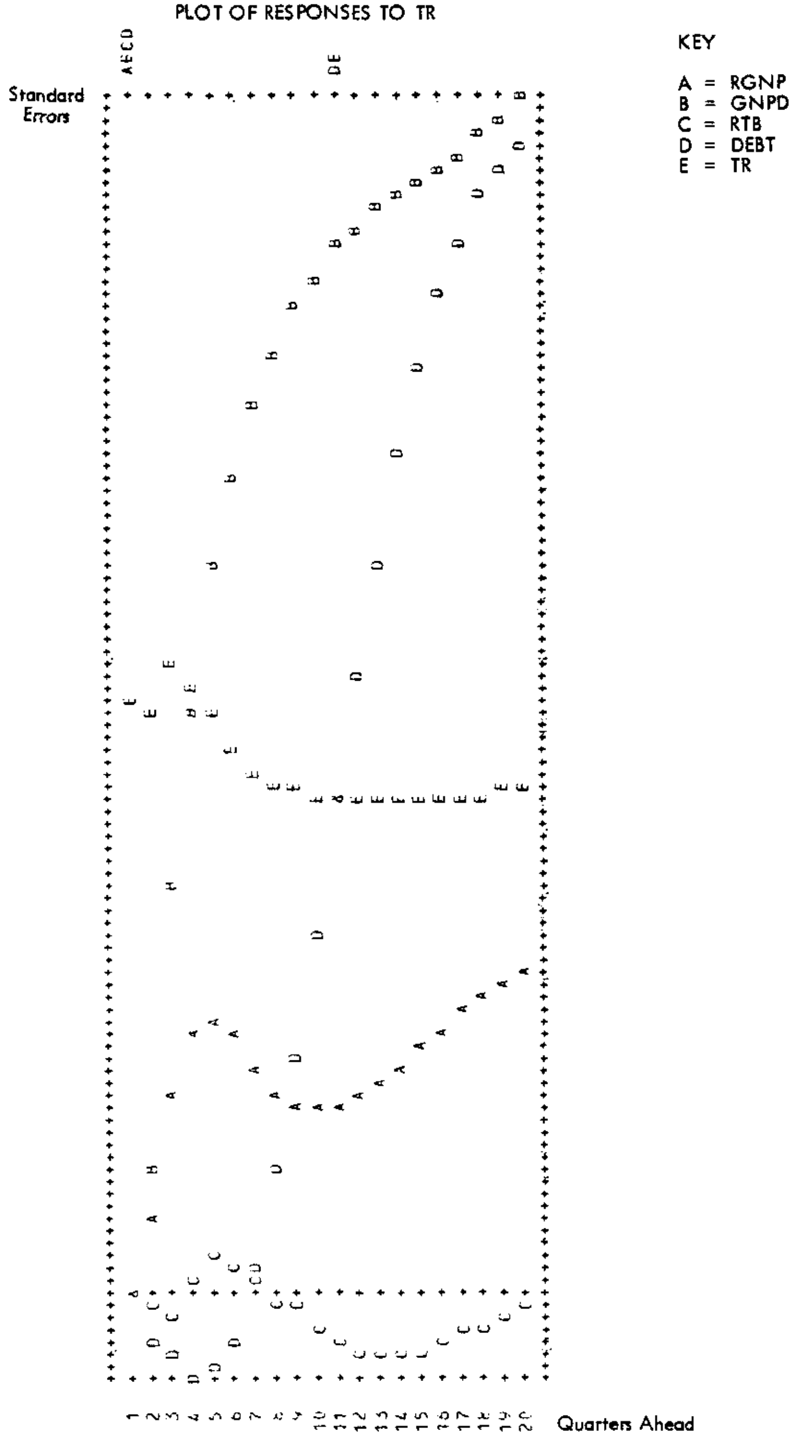


KEY

A = RGNP
B = GNPD
C = RTB
D = DEBT
E = TR

Graph 5

PLOT OF RESPONSES TO TR



The first three graphs indicate that over the entire post-war period fiscal policy, as measured by the log of the NIA debt series, was much more responsive to shocks in output, prices, and interest rates than was monetary policy, as measured by the log of total reserves. A shock to real GNP tended to persist and to result in a response of federal debt which was relatively large, persistent, and of opposite sign. Its effect on total reserves was negligible. A shock to the GNP deflator built up in the early quarters and then steadily dissipated. It set off a long cycle in federal debt of moderate amplitude and resulted in a slight response of total reserves. Finally, a shock in the Treasury bill rate tended to dissipate quite fast, but it resulted in a fairly persistent change in real GNP of the opposite sign. Largely due to the change in real GNP, federal debt eventually responded in a positive direction to the interest rate shock. Total reserves, meanwhile, tended to respond with a once-and-for-all change of opposite sign to an interest rate shock.

The final two graphs indicate that shocks to either federal debt or bank reserves tended to have significant longer-term effects on output and prices and much smaller longer-term effects on interest rates. The graphs do not shed much light on which policy tended to have greater impact on the economy, because a shock to one tended to evoke a sympathetic response from the other.

The final set of statistics used to describe the model is the decomposition of variance. This divides the forecast error in a given variable at a given forecast step into the proportions attributable to innovations in each variable in the system. The decomposition assumes the orthogonolization of errors associated with the ordering used before. Table 5 contains the decomposition at selected steps.

Table 5
Decomposition of Variance

Series: RGNP

Step	Standard Error	Proportion (%) Attributable to Innovations in				
		RGNP	GNPD	RTB	DEBT	TR
1	.0090	100.00	0.00	0.00	0.00	0.00
2	.0140	97.24	0.10	0.53	1.44	0.68
5	.0261	74.02	0.07	14.56	6.61	4.74
10	.0385	51.23	0.10	29.35	14.60	4.72
15	.0457	44.99	0.51	34.51	14.69	5.31
20	.0513	44.67	1.19	34.26	12.44	7.45

Series: GNPD

Step	Standard Error	Proportion (%) Attributable to Innovations in				
		RGNP	GNPD	RTB	DEBT	TR
1	.0041	0.05	99.95	0.00	0.00	0.00
2	.0064	1.67	95.74	0.63	0.24	1.72
5	.0125	4.49	63.87	2.55	0.52	28.57
10	.0202	2.94	32.71	5.52	1.16	57.67
15	.0268	1.91	18.88	4.30	6.55	68.37
20	.0334	2.33	12.13	2.93	12.13	70.47

Series: RTB

Step	Standard Error	Proportion (%) Attributable to Innovations in				
		RGNP	GNPD	RTB	DEBT	TR
1	.6463	6.51	0.36	93.13	0.00	0.00
2	.9506	11.62	0.48	87.63	0.26	0.01
5	1.1335	20.64	0.44	77.86	0.96	0.10

10	1.2541	24.54	2.39	68.09	4.72	0.25
15	1.3328	21.90	3.15	61.11	12.56	1.28
20	1.3544	21.32	3.17	59.36	14.54	1.60

Series: DEBT

Step	Standard Error	Proportion (%) Attributable to Innovations in				
		RGNP	GNPD	RTB	DEBT	TR
1	.0054	6.73	8.46	6.75	78.05	0.00
2	.0109	16.05	6.35	10.59	66.84	0.17
5	.0255	34.36	2.63	8.67	54.07	0.28
10	.0374	50.41	2.29	6.87	39.13	1.28
15	.0472	42.66	3.22	19.22	24.67	10.22
20	.0573	34.58	2.35	25.37	17.12	20.59

Series: TR

Step	Standard Error	Proportion (%) Attributable to Innovations in				
		RGNP	GNPD	RTB	DEBT	TR
1	.0115	8.62	2.70	0.00	0.11	88.57
2	.0159	5.06	1.93	1.56	0.76	90.69
5	.0260	2.04	0.92	5.77	4.11	87.16
10	.0358	1.13	0.80	8.44	9.87	79.76
15	.0427	0.83	0.58	9.24	11.70	77.64
20	.0486	1.02	0.46	9.22	11.88	77.42

The decomposition of variance reveals some interesting relationships. One is the high degree of interdependence between real GNP and the Treasury bill rate. Another is the relative endogeneity of federal debt compared to the relative exogeneity of total reserves. Yet another is the importance of movements in total reserves in explaining long-term movements in the GNP deflator. Together, the last two relationships suggest a monetarist explanation of the data: movements in prices over the long run have reflected changes in the stock of money which, in turn, have been determined by the Federal Open Market Committee.

III. Tests for Structural Change

The sample period was divided into two subperiods: 1948:1 to 1966:4 and 1967:1 to 1981:4. Equations were estimated separately in each subperiod. Tests for structural change were performed for both the univariate autoregressions and the vector autoregression. Each test compares the residuals from the equations estimated over each subperiod with the residuals from the equation estimated over the entire period. The test statistic is distributed as F(n, k), where n is the number of regressors and k is the number of degrees of freedom in the subperiod regressions (the number of observations - 2n). The test statistics are reported in the table below.[9]

Table 6
Test for Structural Change

Dependent Variable	Univariate F(4,125)	Vector Autoregression F(16,101)
RGNP	0.634	1.794**
GNPD	1.027	1.379
RTB	0.804	1.147
DEBT	1.474	2.034**
TR	2.389	1.215

Key: **marginal significance level < .05

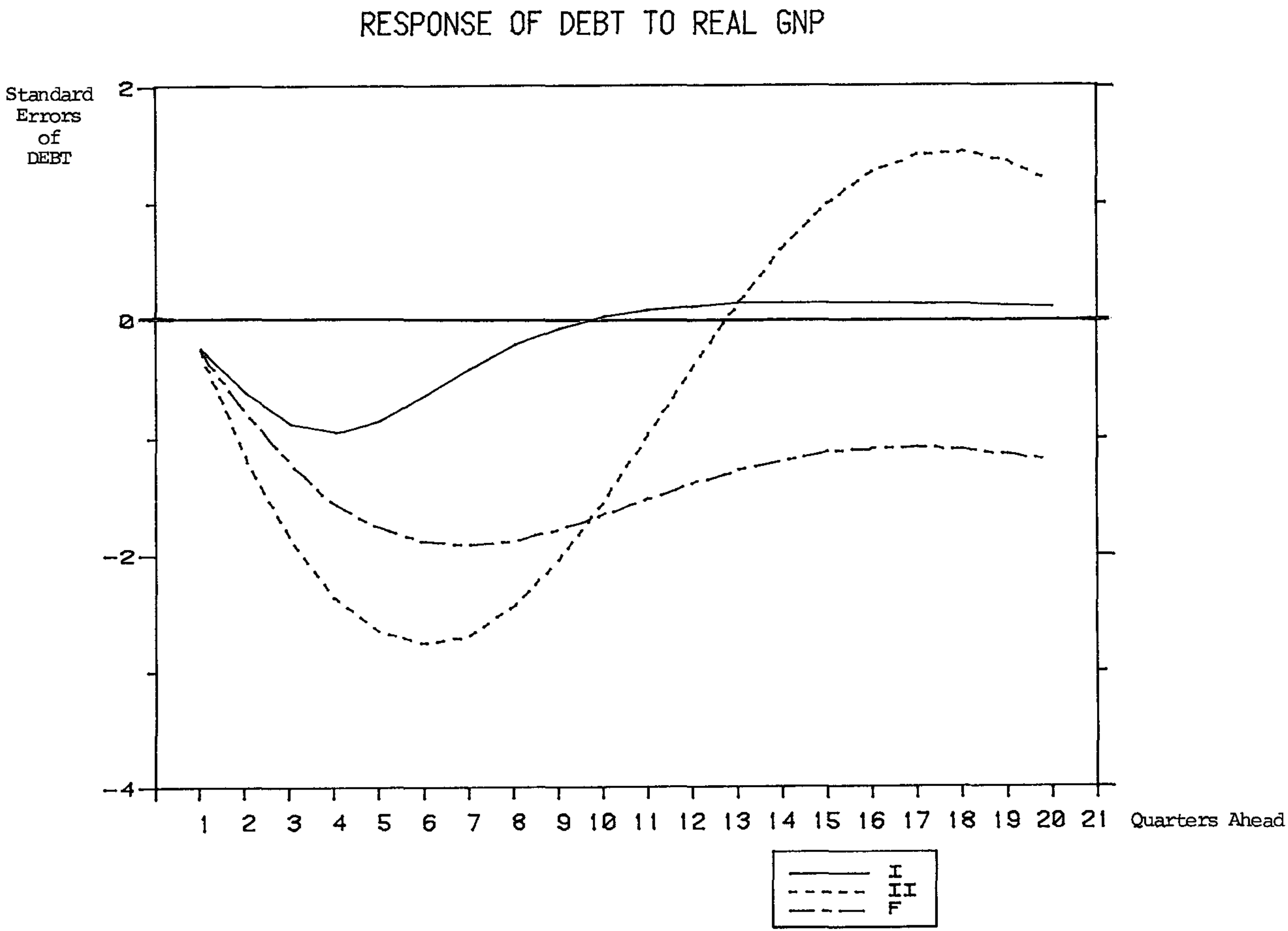
The tests indicate that the assumption of structural stability cannot be rejected at a high level of confidence for any of the univariate equations, while it can be for the real GNP and federal debt equations in the vector autoregression. The rejection of stability in the federal debt equation is interpreted as evidence of a change in the deficit policy feedback rule.

IV. Changes in Estimated Relationships in the Two Subperiods

In this section descriptive output is contrasted from the model estimated over the full period 1948:1 - 1981:4--VAR (F), the model estimated over the first subperiod 1948:1 - 1966:4--VAR(I), and the model estimated over the second subperiod 1967:1 - 1981:4--VAR(II). The purpose is to highlight some major changes in estimated relationships over the two subperiods. Only a small sample of output is reported to illustrate some of the more dramatic differences.

According to the impulse response functions, the effects of the economy on policy variables are very different in each subperiod from what they are in the full period.[10] Graph 6 below shows a sharp contrast in the response pattern of federal debt to real GNP in the two subperiods and the full period. In graph 7, meanwhile, total reserves are shown to be more responsive to shocks in real GNP in each subperiod than they are in the full period.

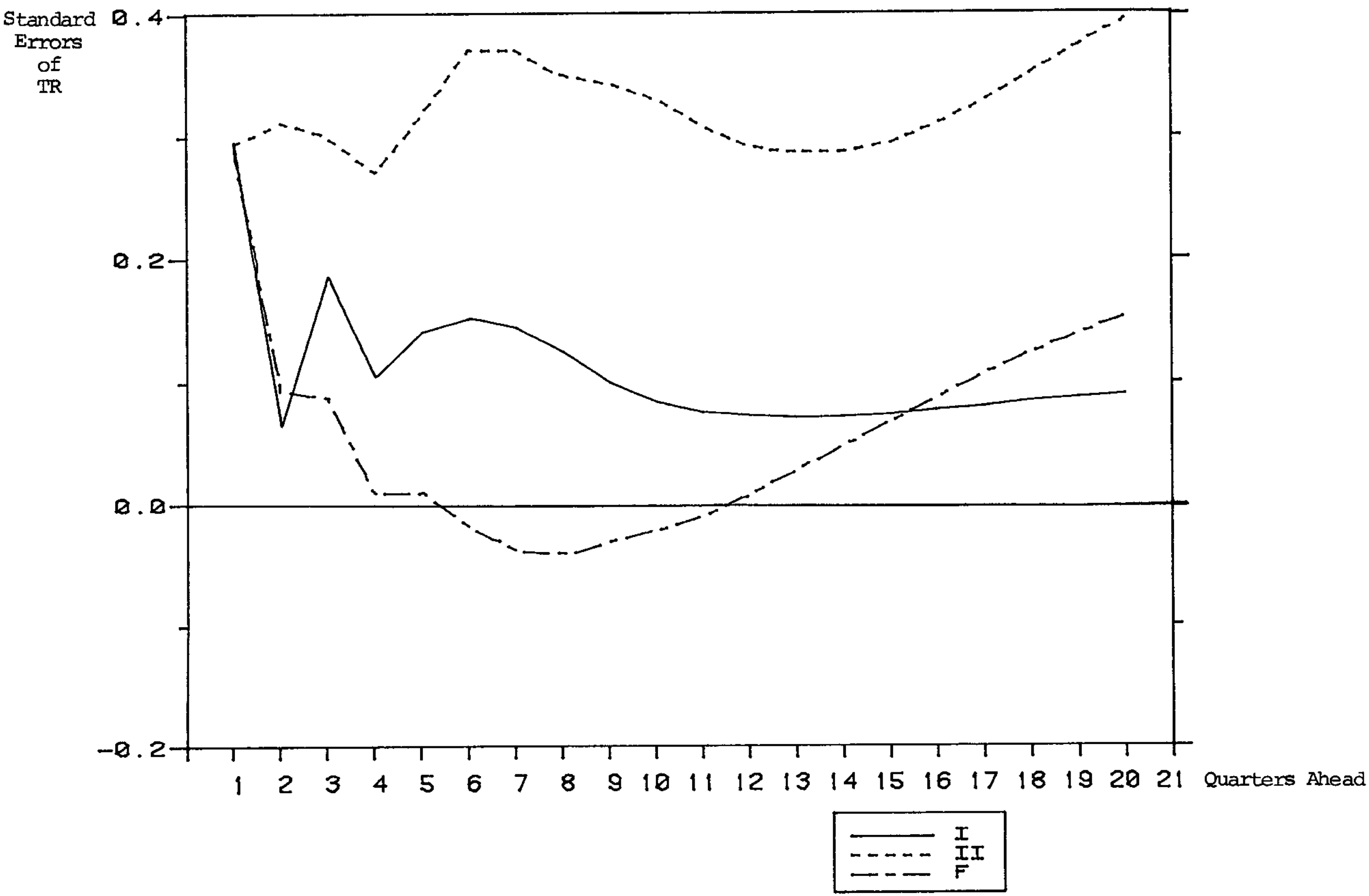
Graph 6



RESPONSE OF DEBT TO REAL GNP
Standard Errors of DEBT
2
0
-2
-4
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
Quarters Ahead
I
II
F

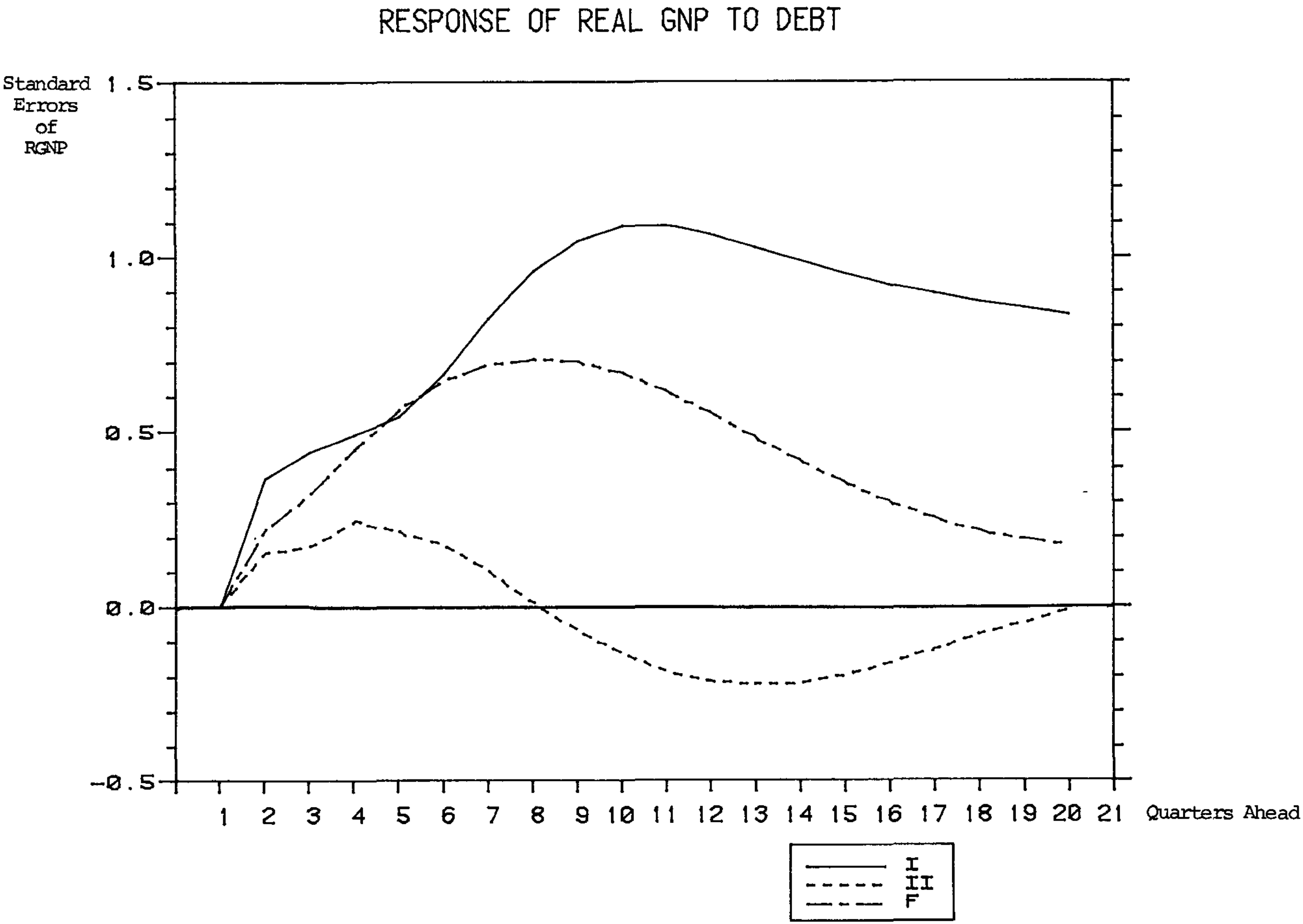
Graph 7

RESPONSE OF TOTAL RESERVES TO REAL GNP

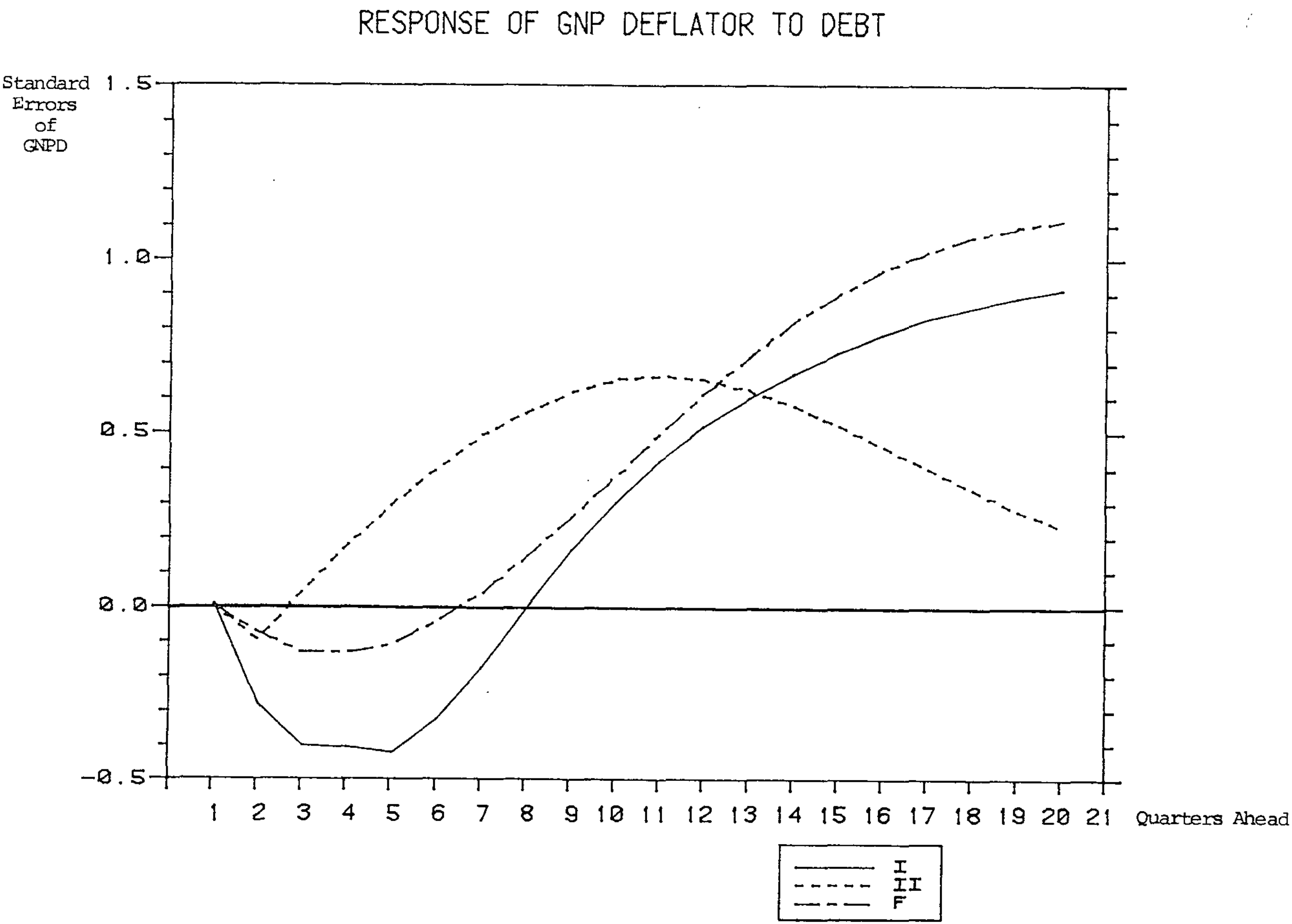


The next six graphs compare across models the responses of real GNP, the GNP deflator, and the Treasury bill rate to innovations in federal debt and total reserves. Two interesting results are that a given increase in debt or reserves boosted output more according to VAR(I) than it did according to VAR(II) or VAR(F). A given increase in debt, meanwhile, had a larger short-run impact on inflation according to VAR(II) than according to the other two models.

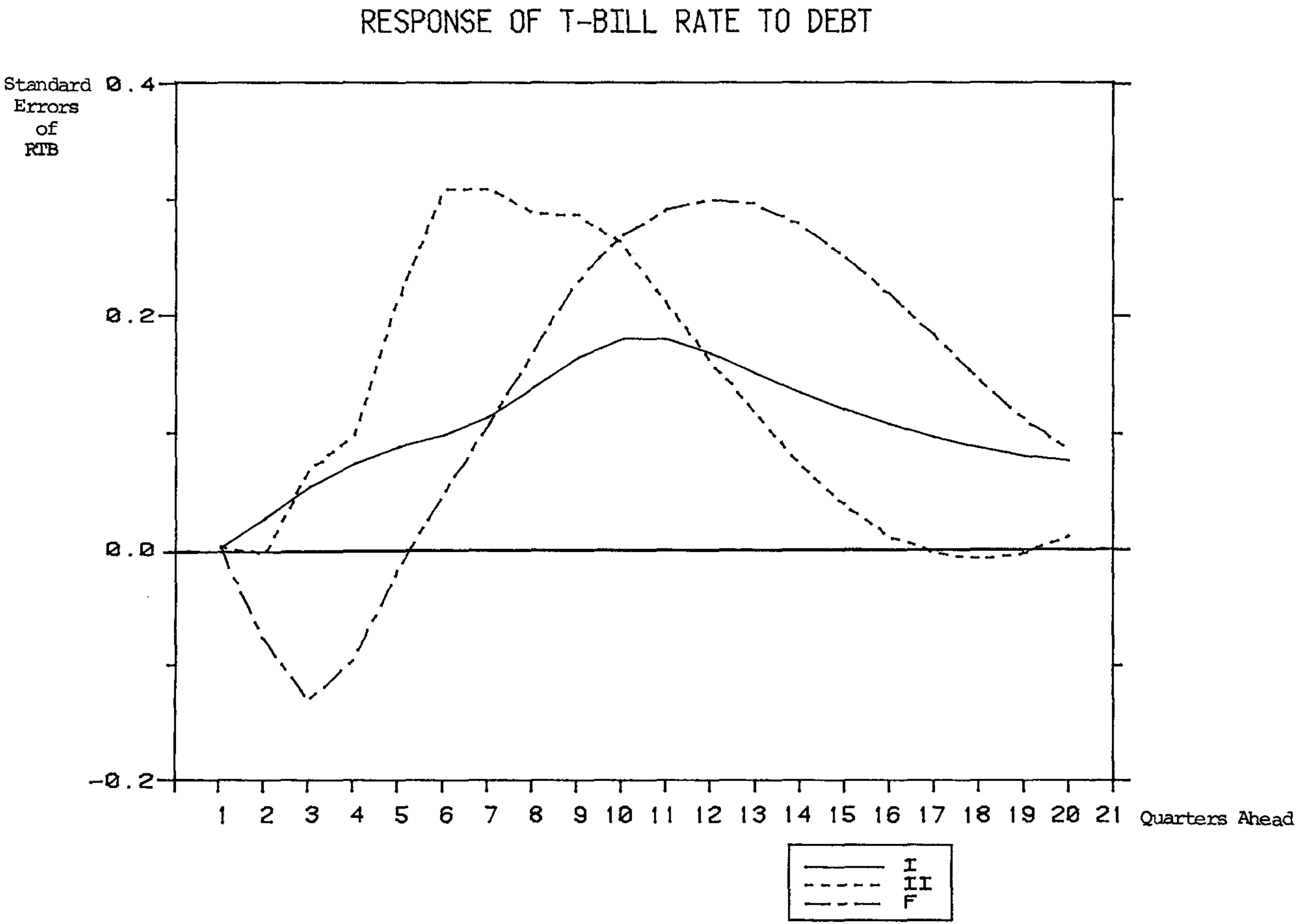
Graph 8


RESPONSE OF REAL GNP TO DEBT
Standard Errors of RGNP
1.5
1.0
0.5
0.0
-0.5
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
Quarters Ahead
I
II
F

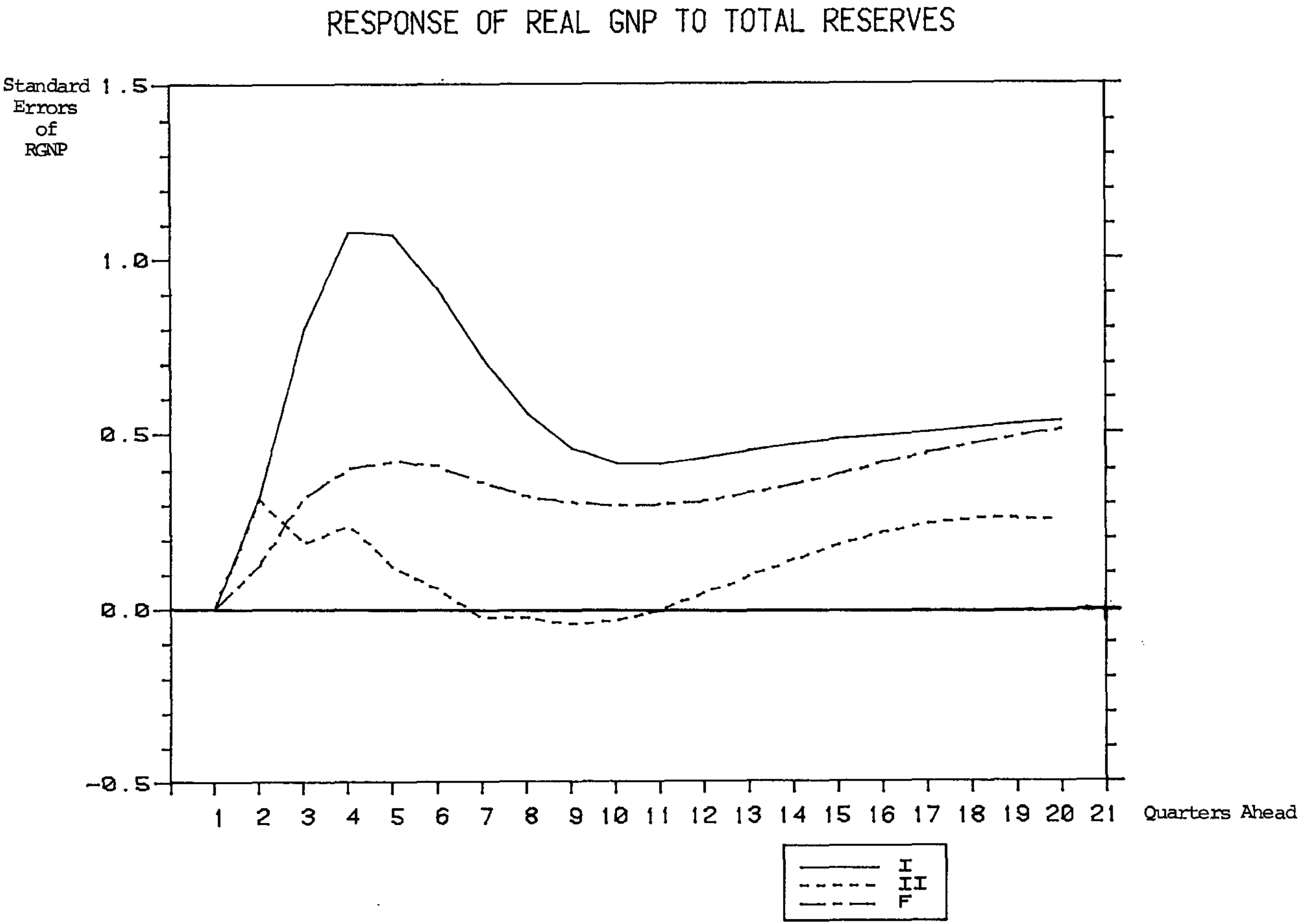
Graph 9


RESPONSE OF GNP DEFLATOR TO DEBT
Standard Errors of GNPD
1.5
1.0
0.5
0.0
-0.5
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
Quarters Ahead
I
II
F

Graph 10

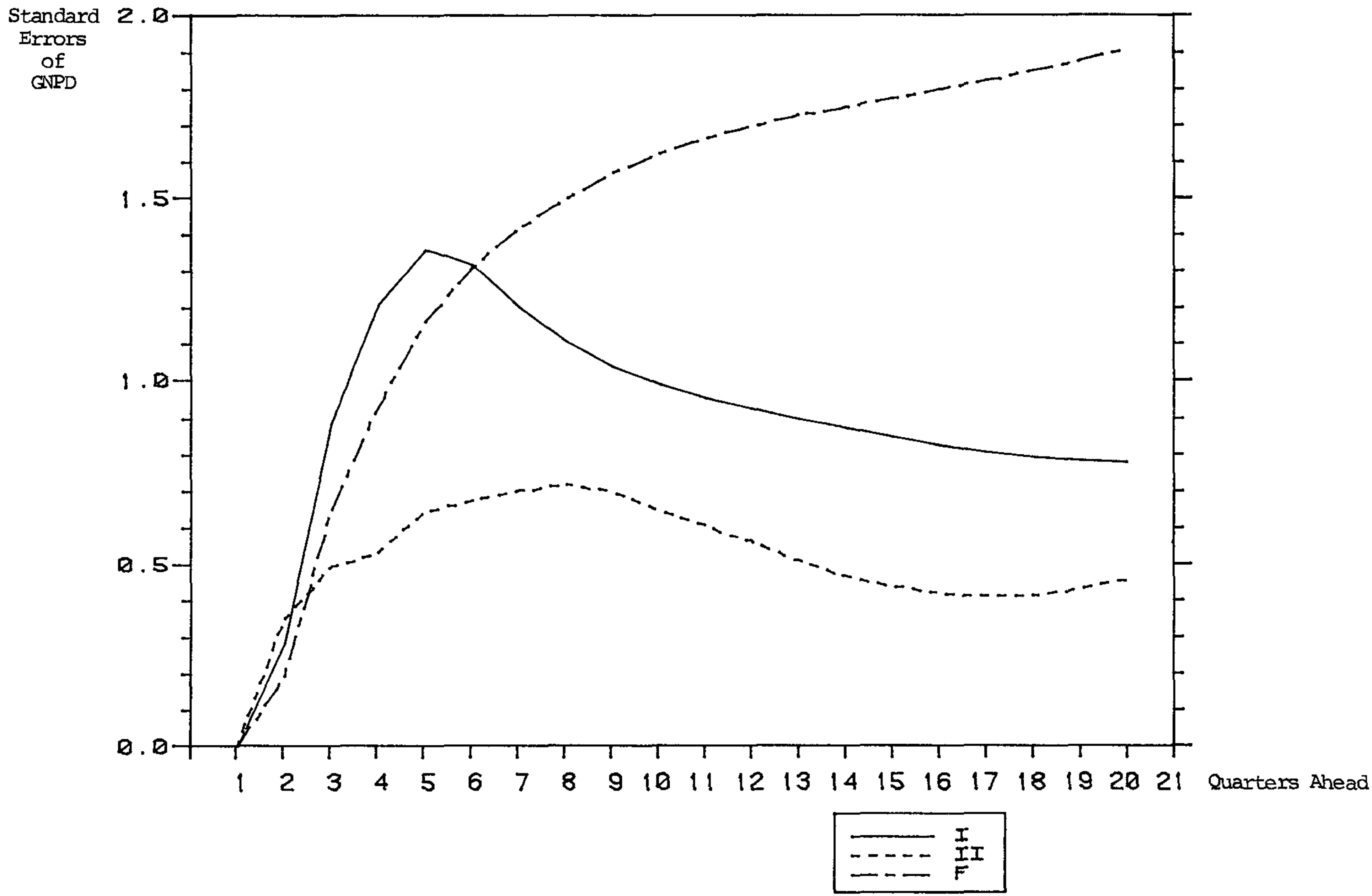

RESPONSE OF T-BILL RATE TO DEBT
Standard Errors of RTB
0.4
0.2
0.0
-0.2
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
Quarters Ahead
I
II
F

Graph 11

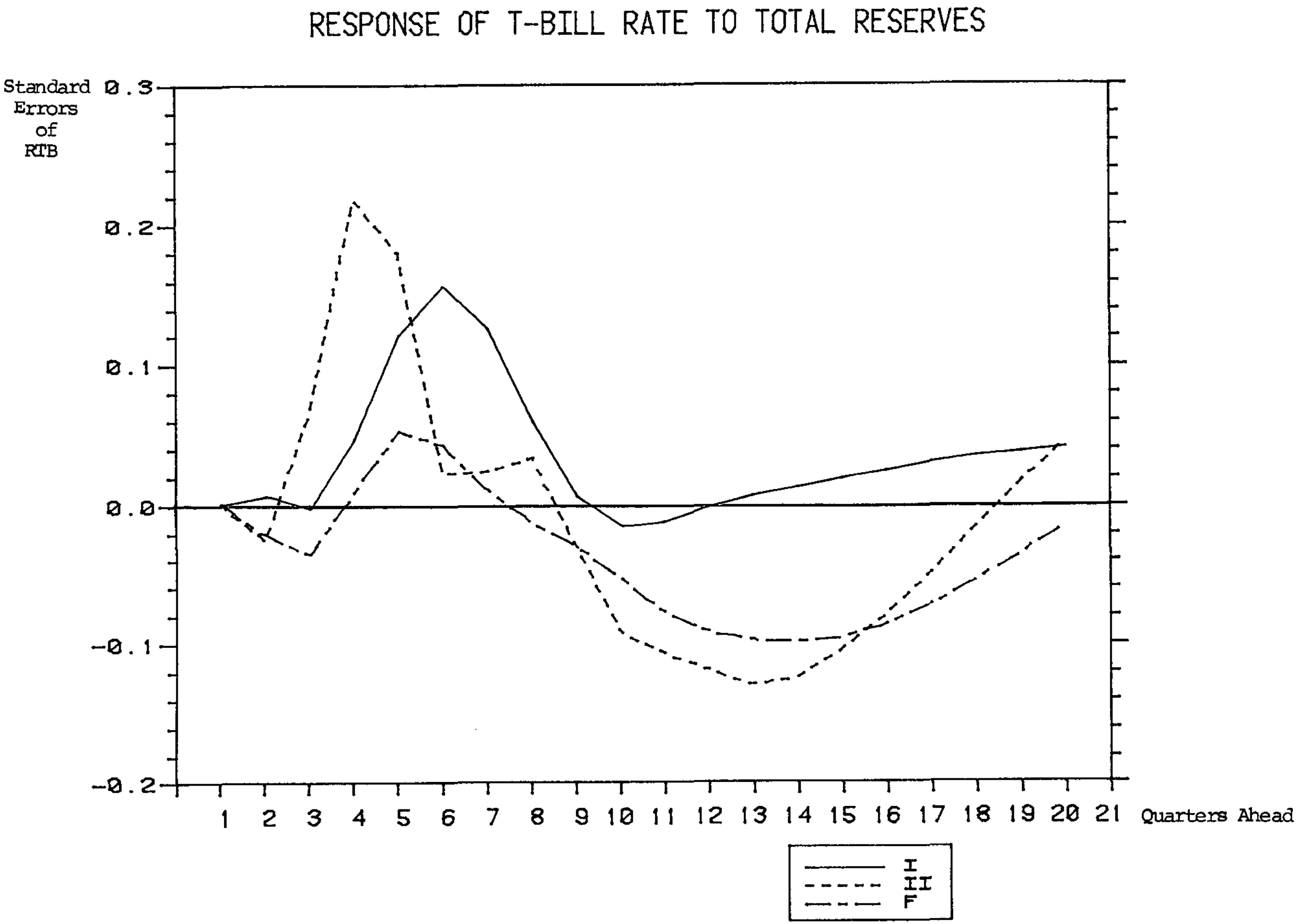

RESPONSE OF REAL GNP TO TOTAL RESERVES
Standard Errors of RGNP
1.5
1.0
0.5
0.0
-0.5
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
Quarters Ahead
I
II
F

Graph 12

RESPONSE OF GNP DEFLATOR TO TOTAL RESERVES



Graph 13


RESPONSE OF T-BILL RATE TO TOTAL RESERVES
Standard Errors of RTB
0.3
0.2
0.1
0.0
-0.1
-0.2
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
Quarters Ahead
I
II
F

Looking directly at the total reserves regressions, monetary policy appears to have had a larger feedback element in the second subperiod than in the first. Table 7 reports F statistics for the significance of the lag distributions of each variable in the total reserves equation of each model.

Table 7
F Statistics for TR Equation

			Lag Distributions		
Model	RGNP	GNPD	RTB	DEBT	TR
VAR(F)	1.342	1.084	1.917	1.353	181.968***
VAR(I)	1.485	0.542	1.562	0.304	11.323***
VAR(II)	6.652***	0.453	3.764**	4.142***	49.164***

Key: **marginal significance level < .05.
***marginal significance level < .01.

According to the decompositions of variance, monetary policy appears much more endogenous when each subperiod is viewed separately then when the two are combined.

Table 8
Proportion of Standard Error of Total Reserves Attributable
to Innovations in Total Reserves

Step	VAR(F)	VAR(I)	VAR(II)
1	88.57	45.77	86.61
2	90.69	44.05	81.47
5	87.16	31.76	52.44
10	79.76	24.57	29.37
15	77.64	21.07	21.65
20	77.42	19.42	18.52

Also according to the decompositions of variance, monetary policy is less important in explaining movements in inflation when each subperiod is viewed separately than when the data are pooled. Fiscal policy seems more important in explaining inflation in the second subperiod than in the first.

Table 9
Proportion of Standard Error of GNP Deflator Attributable
to Innovations in DEBT and TR

Step	VAR(F)		VAR(I)		VAR(II)	
	DEBT	TR	DEBT	TR	DEBT	TR
2	0.24	1.72	0.48	1.77	0.09	6.40
5	0.52	28.57	0.57	19.15	5.98	18.88
10	1.16	57.67	0.48	25.74	23.07	21.61
15	6.55	68.37	1.70	26.39	32.58	19.76
20	12.13	70.47	3.43	25.43	28.50	17.04

Finally, differences in the model as a whole over the two subperiods are illustrated by within-sample Theil U's and by out-of-sample predictions conditioned on identical information. The Theil U measures the average Theil U statistic across forecast steps 4 through 12. Errors were generated over the entire estimation period using a given set of estimated coefficients and actual values for lagged data. The measure was constructed for univariate and vector autoregressive models.

Table 10
Within-Sample Theil U's
(Averages over forecast steps 4 through 12)

I. Coefficients Estimated over 1948:4 - 1966:4

Variable Model	Theil U Measure Constructed from Errors over Period: I ∪ II 1948:4 - 1981:4	I(Estimation Period) 1948:4 - 1966:4	II 1967:1 - 1981:4
RGNP			
Univariate	0.5112	0.4833	0.6127
VAR(I)	2.9095	0.3837	5.3184
GNPD			
Univariate	0.5640	0.4651	0.5845
VAR(I)	1.0457	0.3715	1.6275
RTB			
Univariate	1.0144	0.8488	1.0368
VAR(I)	0.8122	0.4790	1.0010
DEBT			
Univariate	2.0312	0.8073	2.1078
VAR(I)	1.4424	0.4774	1.5134
TR			
Univariate	0.6463	0.4834	0.7346
VAR(I)	1.6257	0.5123	1.8701

Average			
Univariate	0.9534	0.6176	1.0153
VAR(I)	1.5671	0.4448	2.2661

II. Coefficients Estimated over 1967:1 - 1981:4

Variable Model	Theil U Measure Constructed From Errors Over Period I ∪ II 1948:4 - 1981:4	I 1948:4 - 1966:4	II (Estimation Period) 1967:1 - 1981:4
RGNP			
Univariate	0.7207	0.8121	0.5825
VAR(II)	2.3234	2.9146	0.2419
GNPD			
Univariate	0.3404	0.7990	0.1669
VAR(II)	1.8760	3.9340	0.1191
RTB			
Univariate	1.0276	1.6513	0.9212
VAR(II)	1.7607	4.4653	0.2953
DEBT			
Univariate	0.6559	1.8470	0.4909
VAR(II)	1.6925	5.3229	0.2599
TR			
Univariate	0.6683	1.0889	0.3028
VAR(II)	2.0865	5.0598	0.3095
Average			
Univariate	0.6826	1.2397	0.4929
VAR(II)	1.9478	4.3394	0.2451

Table 10 suggests economic relationships changed dramatically in the two subperiods. The subperiod VARs fit the data very well over the subperiod in which they were estimated. But the fit deteriorates dramatically over the other subperiod. Measured by the Theil U averaged over variables, the fit of VAR(I) is five times worse in the second subperiod than in its subperiod of estimation, while the fit of VAR(II) is almost eighteen times worse in the first subperiod than in its subperiod of estimation. The fact that the univariate autoregressions deteriorate by a factor of only two suggests that the major structural change in the two subperiods occurred in the dynamic relationships across variables rather than in the stochastic processes followed by each variable taken individually.

The final illustration of the magnitude of difference in the VARs is a contrast among the deterministic forecasts of the models for the 20 quarter horizon beginning with 1982:1. The forecasts were made by using the estimated coefficients of a given model with actual data for 1981:2 - 1981:4. The forecasts are in Table 11.

The differences among the models in predicting real GNP and NIA debt are striking. Comparison of the debt predictions suggests that the current level of debt is much higher than would have been predicted based on the experience through 1966. This statement also applies to total reserves, but to a lesser extent. Thus, VAR(I) interprets policy as being very expansionary. Since it also implies an innovation in policy variables of given magnitude has a greater impact on real GNP than does either VAR(F) or VAR(II), it predicts a much higher path of real GNP than does either of the other two models.

Table 11
Comparison of Forecasts

	RGNP (Billions, $72)			GNPD (1972 = 100.0)			RTB (Percent)			DEBT ($ Billions)			TR ($ Billions)		
	VAR(F)	VAR(I)	VAR(II)	VAR(F)	VAR(I)	VAR(II)	VAR(F)	VAR(I)	VAR(II)	VAR(F)	VAR(I)	VAR(II)	VAR(F)	VAR(I)	VAR(II)
(actual)															
1981:4	1497.6	1497.6	1497.6	200.0	200.0	200.0	12.0	12.0	12.0	641.0	641.0	641.0	46.6	46.6	46.6
(forecast)															
1982:1	1490.5	2214.8	1493.1	204.1	210.3	203.7	11.5	9.6	11.6	671.0	582.7	670.4	47.7	41.4	47.2
2	1497.5	2915.5	1506.0	208.3	224.9	208.1	12.6	10.4	12.6	703.0	485.6	701.4	48.6	38.1	47.9
3	1509.1	3375.8	1519.7	212.6	232.2	211.9	12.7	13.7	12.3	733.9	400.8	734.4	49.2	39.6	48.4
4	1515.2	3439.1	1531.6	216.7	227.8	215.2	12.2	16.7	11.8	764.6	344.9	768.8	49.8	41.1	49.0
1983:1	1522.0	3312.4	1548.6	221.0	220.0	218.7	12.2	17.4	11.8	796.3	313.7	803.4	50.7	42.8	49.6
2	1532.4	3155.8	1569.2	225.5	212.7	222.3	12.6	16.0	12.0	828.2	298.3	837.4	51.5	44.3	50.2
3	1543.4	3047.5	1589.5	230.3	207.7	225.8	12.9	14.0	12.2	859.1	292.7	869.8	52.3	45.7	50.8
4	1552.5	3005.6	1609.6	235.1	204.2	229.5	13.1	12.5	12.5	889.6	292.5	900.0	53.1	47.1	51.4
1984:1	1560.6	3017.6	1629.2	240.3	201.6	233.3	13.4	11.8	13.0	920.0	294.7	927.7	53.9	48.3	52.1
2	1568.1	3062.2	1647.3	245.6	199.3	237.4	13.8	11.5	13.5	950.7	297.4	953.0	54.7	49.1	52.7
3	1574.7	3119.1	1663.1	251.3	197.2	241.8	14.1	11.5	14.1	981.6	299.5	976.1	55.5	49.8	53.3
4	1579.8	3175.4	1676.6	257.1	195.2	246.4	14.5	11.6	14.7	1013.3	300.8	997.5	56.3	50.5	53.8
1985:1	1583.6	3227.5	1687.5	263.2	193.4	251.3	14.8	11.6	15.4	1046.2	301.4	1018.1	57.1	51.2	54.4
2	1586.5	3277.4	1695.8	269.6	191.7	256.5	15.2	11.6	16.0	1080.7	301.6	1038.6	57.8	52.1	55.0
3	1588.5	3328.7	1702.0	276.2	190.3	261.9	15.5	11.7	16.5	1117.1	301.6	1060.0	58.6	52.9	55.5
4	1589.7	3383.2	1706.3	283.0	189.2	267.5	15.8	11.8	17.0	1155.9	301.2	1083.0	59.4	53.8	56.0
1986:1	1590.2	3440.9	1709.4	290.1	188.4	273.3	16.1	11.9	17.4	1197.	300.6	1108.5	60.2	54.7	56.5
2	1590.2	3500.5	1711.9	297.3	188.0	279.2	16.3	12.0	17.8	1241.6	299.6	1137.2	61.0	55.5	57.0
3	1589.9	3560.2	1714.3	304.9	187.7	285.2	16.6	12.1	18.0	1289.0	298.5	1169.3	61.9	56.3	57.5
4	1589.3	3618.9	1717.2	312.6	187.7	291.2	16.8	12.2	18.2	1339.7	297.3	1205.3	62.7	57.1	58.0

V. Conclusion

There is evidence of a break in the budget policy rule, occurring in the middle 1960s. Dynamic relationships between economic variables are found to have changed appreciably and sometimes in very complicated ways. The behavior of the model estimated over the entire period is not some simple weighted average of its behavior when estimated separately over each sub-period.

Footnotes

1/ Such an approach is used in large macroeconometric models, most time series analyses, and single-equation regression analyses.

2/ It was chosen over the Board of Governors' series on the monetary base and total reserves and the St. Louis Fed's series on the monetary base because it is the only one that goes back to 1948.

3/ These channels of influence are found in Bryant-Wallace and Miller.

4/ The first quarter for estimation is adjusted forward as lag length increases.

5/ These methods for constraining VARs are described in Litterman.

6/ Because of three-quarter lag distributions, the first quarter of estimation is 1948:4.

7/ Impulse response functions and decompositions of variance are formally described in Litterman.

8/ The ordering TR, DEBT, RTB, GNPD, RGNP was also tried and the results were not appreciably different.

9/ Although the test results are reported only for a lag length of three, the tests were performed for lag lengths 1-8. The first quarter of estimation in the first subperiod is 1948:1 plus lag length, while the first quarter of estimation in the second subperiod is always 1967:1. In all cases, except for a lag length of 8, the DEBT equation in the VAR could be rejected for structural stability at a marginal significance level $< .05$. The marginal significance levels by lag lengths 1-8 for this equation are respectively: (1) .0000; (2) .0129; (3) .0176; (4) .0049; (5) .0019; (6) .0002; (7) .0020; and (8) .0702.

[10] The impulse response functions are all scaled in this section by the standard errors of the μ_is from the full-period model in order to facilitate comparisons across models having different standard errors.

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