The use of inputs by the Federal Reserve System: An extended model

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Article:

1. Introduction

Recently it has been argued that bureaucratic incentives play an important role in the formulation of policy and the inflationary bias of the Federal Reserve System [Shughart and Tollison (1983), hereafter S—T].[1] In particular S—T maintain that the Fed can retain profits denominated in amenities but not in dollars as a result of the Congressional constraint that 'excess profits' be returned to the Treasury. This constraint provides bureaucratic incentives for the Fed to purchase more amenities than a for-profit organization and ex-plains (S—T, 1983: 291) "in part the Fed's apparent inflationary bias." Expansionary monetary policy, then, enlarges the Fed's profit-amenities choices and allows it to pursue its goal of bureaucratic enhancement. S—T assume that the dollar value of these amenities is a monotonic transformation of Fed employment. Using this public choice framework, they develop a model in which the monetary base is a function of a number of variables including employment in the Federal Reserve System (SYSEMP).

To confirm their hypothesis, two conditions are required. First, causation must run from SYSEMP to the monetary base. In Section 2 we demonstrate that the first-difference of the log level equation is the appropriate method to detrend the dependent variable rather than the log-level equation that includes time as tested by S—T. Thus, the causality debate between Boyd (1984) and Shughart and Tollison (1984) is not based on a correct functional form.[2] Second, SYSEMP must be positive and significantly related to the base. In Section 3 we show that SYSEMP is statistically insignificant in an extended public choice model that includes government debt which is positive and statistically significant. In Section 4, the bivariate causality test results are consistent with S—T, but the multivariate causality tests which indicate the presence of bidirectional causality between the base and employment do not support the findings of S —T. In addition, the tests indicate that causality runs from the debt and the other right-hand-side variables to the monetary base which supports the Buchanan and Wagner (1977) public choice argument that the Fed has accommodated changes in the Federal government debt. Section 5 summarizes our results.

2. Functional form

Using Federal Reserve System employment as a proxy for Fed amenities, S—T test the relationship between Fed employment and the monetary base in the following equation:

$$B_t = a_0 + a_1 SYSEMP_t + a_2 CD_t + a_3 i_{t-1} + a_4 Y_t + a_5 T + a_6 T^2 + e_t \quad (1)$$

where B is the nominal monetary base; SYSEMP is the number of Federal Re-serve System employees; CD is the currency-demand deposit ratio; i is the 4-6 month commercial paper rate; Y is real GNP; T is a time trend and e is the error term. S—T use natural logs of all variables except i and T.

A fundamental issue in the detrending of a series such as B by the inclusion of T is the appropriate representation of the nonstationarity in the mean of the series. While it is common practice to detrend variables by introducing T in an equation such as (1), inappropriate detrending can lead to misspecification.[3] To

determine the appropriate method of detrending the dependent variable, B, in equation (1) we must consider two types of processes. The first type of process is trend stationary (TS) where the process is expressed as a fixed function of time. The second type of process is difference stationary (DS) where the process is such that first and higher differences are a stationary and invertible autoregressive moving average (ARMA) process.

To test the DS against the TS hypothesis, we used the method proposed by Dickey and Fuller (1979), and estimated the following equation:

$$B_t = \mu + \gamma T + \rho_1 B_{t-1} + \sum_{j=2}^{k} \rho_j (B_{t-j+1} - B_{t-j}) + u_t \qquad (2)$$

where u is the error term. To specify the maximum order of k we evaluated the autocorrelations of the first differences and our empirical results indicated k = 1 is appropriate. Thus, we are interested in testing the null hypothesis $\rho_1 = 1$, $\gamma = 0$. Since, under this null hypothesis, the ratios of the coefficients to their standard errors are not t-distributed, we used the tabulations by Fuller (1976) of the distribution of the test statistic $\tau(\hat{\rho}_1)$, which is the ratio of $(\hat{\rho}_1 - 1)$ to its standard error. We find the statistic $\tau(\hat{\rho}_1) = -1.98$, which is not below the .05 critical values given by Fuller of —3.50 or —3.45 for samples of size 50 or 100, respectively. The results, therefore, show that differencing rather than the introduction of a time trend is appropriate for detrending the dependent variable given the evidence that B is a DS process.

3. Extended public choice model
Having established the appropriate functional form, we consider a reaction function resulting from the Fed minimizing a quadratic loss function of policy objectives to maximize its own utility function. A public choice framework would suggest not only that the Fed may purchase amenities (employment) but also that the Fed may be constrained by the executive and legislative branches to modify its own policy objectives. This would allow the Fed to avoid Congressional review of its budget and thus maintain its independence. Shughart and Tollison cite Friedman (1982: 100) who notes that the central bank has historically been concerned with full employment, economic growth and stable prices.[4] Buchanan and Wagner (1977: 116) point out that "political pressures also impinge on the decisions of monetary authorities, even if somewhat less directly than on elected politicians, and that the same biases toward demand-increasing policy steps will be present."

These arguments suggest that the Federal Reserve may try to maximize its own utility function but is constrained by the objectives of the President, Congress, and the interests of the banking community. Thus other macroeconomic variables such as the log of the level of unemployment (U), prices (P) and the government debt (D) should enter into the S—T model.[5] The following equation represents an extended public choice model with which to test Fed behavior:

$$B = b_0 + b_1 SYSEMP + b_2 CD + b_3 i_{t-1} + b_4 Y + b_5 U + b_6 P + b_7 D + e_t. \qquad (3)$$

The expected signs are $b_1 > 0$ as predicted by S—T, b_2, b_3, b_4, b_5, and $b_7 > 0$, and b_6 is negative. The predicted signs for b_2 and b_4 are positive because the Fed will increase the monetary base in response to an increase in the demand for currency by the public and to an increase in the demand for real balances resulting from an expansion in real income. The predicted signs on b_3 and b_7 are positive if the Fed tries to dampen interest rate movements (a policy of interest rate targeting was attributed to the Fed prior to 1979) and if the Fed tries to reduce the cost of financing the deficit. The predicted signs of the coefficients on the interest rate and the deficit variables are consistent with the thesis advanced by Buchanan and Wagner. They point out that expansion in the "monetary base" by the Federal Reserve makes possible an increase in commercial bank credit which supports the interests of the banking community. In other words, the Federal Reserve authorities seek their own self (political) interest since most of them are bankers. A policy to counteract increases in the unemployment rate results in a predicted positive sign for b_5 while a policy to dampen higher prices would result in a predicted negative sign for b_6.

The result of estimating the first-difference form of equation (3) for 1917-81 is shown by equation (1.1) in Table 1.[6] The estimates of the extended public choice model show that the SYSEMP coefficient is negative and in-significant in equation (1.1).[7] The debt coefficient is positive and significant as would be expected if the Fed

accommodates the Federal debt.[8] The unemployment and price level coefficients also are positive and significant in equation (1.1).

Table 1. Estimates of equation (3)

Equation	SYSEMP	CD	i_{t-1}	Y	U	P	D	R^2/SE	DW/RHO
1917–81									
1.1	−0.09	0.13	−0.004	0.34	0.011	0.48	0.21	.46	2.11
	(1.26)	(1.37)	(1.71)	(1.66)	(1.98)	(3.45)	(3.46)	.0559	0.31
1917–46									
1.2	−0.22	0.01	−0.020	0.79	0.024	0.58	0.32	.31	2.01
	(2.27)	(0.08)	(1.10)	(2.13)	(2.49)	(2.11)	(3.58)	.0757	
1947–81									
1.3	0.18	−0.05	0.006	0.13	−0.013	0.48	0.38	.61	1.75
	(1.67)	(0.27)	(1.12)	(0.71)	(2.36)	(3.35)	(2.07)	.0244	
1917–39									
1.4	−0.23	−0.01	−0.018	0.80	0.025	0.56	0.32	.32	1.94
	(1.77)	(0.05)	(0.96)	(1.52)	(2.30)	(1.78)	(2.70)	.0780	
1940–54									
1.5	−0.50	−0.33	−0.008	−0.16	−0.034	0.06	0.46	.42	2.53
	(1.31)	(0.61)	(0.09)	(0.30)	(1.40)	(0.16)	(2.82)	.0645	
1955–81									
1.6	0.19	−0.05	0.015	0.57	−0.007	−0.23	0.71	.52	1.47
	(1.48)	(0.32)	(2.17)	(2.71)	(1.10)	(0.54)	(2.46)	.0207	

Note. t-scores are in parentheses. Estimates are from the 4.0 version of TSP where autocorrelation corrections (where applicable) are made by the Beach-Mackinnon procedure.

Since the time period examined covers widely varying economic conditions, the stability of the relationship is tested by a Chow test. To conduct this test, we divided the 1917-81 period into two subperiods: 1917-46 and 1947-81. For 1917-46 the SYSEMP coefficient is the wrong sign while the coefficients of debt, real income, the price level and unemployment are all positive and significant. For 1947-81 equations, the SYSEMP coefficient is positive but insignificant for a one-tailed test. The debt coefficient continues to be positive and significant confirming the extended public choice framework that shows the Fed responding to the rate of growth of the debt. The calculated F-statistic for the Chow test is 2.20 with a critical value of $F_{7,51} = 2.21$ at the five-percent level of significance. Thus, the null hypothesis of structural stability cannot be rejected.

A further subdivision of the data considers the periods before, during and after the primary effects of World War II [1917-39, 1940-54, 1955-81]. Chow tests were conducted on the first-difference form for the 1917-54 period with a division at 1939-40 and for 1940-81 with a division at 1954-55. The calculated F-statistics are 0.92 and 1.68 where $F_{7,24} = 2.42$ and $F_{7,28} = 2.36$, respectively. Once again, structural stability is not rejected. Only the coefficient for the debt variable is the correct sign and significant at the five-percent level in each of the subperiods which provides further confirmation that the Fed has accommodated Treasury borrowing.

4. Tests of causality

Having found in the extended model that SYSEMP is statistically insignificant and D is statistically significant, we now test the causal relationships between each of the independent variables and the monetary base, using the tests of causality first discussed by Granger (1969) and further considered by Sims (1972). We implemented the tests in both bivariate and multivariate settings. From a practical standpoint, we are interested in predictability. In defining causality in Granger's sense, we followed the discussion provided by Newbold (1981) and considered $(X_{1,t}, X_{2,t})$ a purely nondeterministic bivariate stationary stochastic process on which the series of observations is available. We let $X_{1,n+1}$ represent the forecast of X_1 generated at time period n. Granting that the future cannot cause the present or past, we inferred causality running from X_2 to X_1 if $X_{1,n+1}$ was better predicted when information provided by X_2 was added to that given by past X_1.

Using the observations of the series, we applied the conventional Box and Jenkins (1976) time-series procedures to obtain stationarity. Except for the interest rate variable which is first differenced, the plots of the

sample autocorrelations for each of the raw data series led to transformation of the data by taking first differences of the logarithms. The technique of ordinary least squares was applied to estimate the relationship between the variables. We are not interested in testing for instantaneous causality for which it is not possible on empirical grounds to ascribe direction. Based upon examination of the multivariate partial autocorrelations (see Ansley and Newbold, 1979), the maximum permitted lag was determined. The results are shown in Tables 2 and 3.

Table 2. Test of leads and lags

Variables**	Dependent variable	Maximum lag (years)	F-statistic
B,SYSEMP	B	4	5.077*
	SYSEMP		1.909
B,CD	B	2	12.258*
	CD		1.014
B,i_{t-1}	B	2	12.987*
	i_{t-1}		0.528
B,Y	B	2	18.533*
	Y		0.120
B,U	B	2	13.761*
	U		0.285
B,P	B	5	5.547*
	P		1.986
B,D	B	3	4.458*
	D		2.565

* Significant at 1% level.
** All variables except i_{t-1} are transformed by taking first differences of logarithms. The interest rate variable is first differenced.

Consistent with the findings of S—T, the bivariate results indicate that, while the monetary base does not cause employment, there is information contained in past values of employment useful for predicting the monetary base. Further, the tests indicate that lagged values of all independent variables in the extended public choice model including Treasury debt contain information useful for predicting the monetary base, while there is never evidence of feed-back at the one or five-percent significance levels.

Table 3. Multivariate causality tests[a]

Dependent variable (lag)		Variables (lag)	Critical value**	F-statistic
Base	(4)	P (5)	2.49	4.20*
		D (3)	2.88	4.78*
		U (4)	2.65	5.59*
		Y (1)	4.13	2.62
		i (1)	4.13	4.86*
		CD (2)	3.28	2.30
		SYSEMP (3)	2.65	2.98*
SYSEMP (3)		CD (2)	3.28	5.86*
		B (4)	2.65	3.01*
CD	(2)	i (1)	4.13	5.98*
i	(1)	Y (1)	4.13	6.28*
Y	(1)	i (1)	4.13	6.01*
D	(3)	P (5)	2.49	6.07*
		U (4)	2.65	5.15*
		CD (2)	3.28	11.19*
		SYSEMP (3)	2.65	7.02*

[a] The results are reported for every variable when the base is the dependent variable but only for the significant cases when the other variables are the dependent variable.
* Significant at the five-percent level.
** Critical value at the five-percent level.

The findings from the multivariate tests, shown in Table 3, do not support the findings S—T because there is bidirectional causality between employment and the monetary base. Thus system employment (SYSEMP) is an endogenous variable in equation (3). In addition, the tests still show that lagged values of the three independent variables (U, P and D) contain information useful for predicting the monetary base while there is never evidence of feedback from the base to these three variables. Thus, the multivariate causality tests still indicate the presence of causality from the debt, the price level, the unemployment rate and the interest rate to the monetary base.[9]

5. Conclusion

The purpose of this paper has been to reconsider the Shughart and Tollison (S—T) argument that the Fed has pursued expansionary monetary policy in an effort to enlarge its amenities as reflected in total system employment and to test whether the Fed acted to accommodate Treasury borrowing. To confirm their hypothesis, causation must run from system employment (SYSEMP) to the monetary base (B) and SYSEMP must be positive and significantly related to the base. The evidence from the bivariate causality tests shows that causality runs from total system employment, the debt, and all other independent variables in the extended public choice model to the monetary base, but there is no evidence of feedback for any of the relationships analyzed. The results from the multivariate tests, however, indicate the presence of bidirectional causality between B and SYSEMP which indicates that SYSEMP is endogenous rather than exogenous. In addition the multivariate tests indicate that there is causality from the three independent variables added to the S—T model (the price level (P), unemployment (U) and the level of federal debt (D)) to the base. Furthermore, the extended public choice model consistently shows a positive and statistically significant effect on the base from Treasury borrowing, while there is no such effect from system employment. Thus, there is strong evidence to support the Buchanan and Wagner hypothesis that the Fed responded to the constraint of reducing the cost of Treasury debt but no evidence that the Fed systematically acted to enlarge its amenities by increasing its employment.

Notes

1.   Supply-side theories of Federal Reserve behavior also have been advanced by Toma (1982) and Mounts, Sowell and Lindley (1985).
2.   Strong (1984) is critical of the inclusion of time in the S—T model and the interpretation of the causality tests by Shughart and Tollison.
3.   For example, see Nelson and Kang (1981, 1984) and Nelson and Plosser (1982).
4.   Toma (1982: 167) assumes that taxpayers hold the Fed accountable for the inflation rate.
5.   Joines (1985) argues that the monetary base is not related to non-war government deficits. Levy (1981), Allen and Smith (1983), Allen (1986), and Allen and McCrickard (1988) provide evidence that the Federal Reserve accommodated deficits in the post-Accord period.
6.   The data for the debt are June observations on the U.S. Government gross debt from the following publications of the Federal Reserve Board of Governors: *Banking and Monetary Statistics, 1914-41* (Table 146), *Banking and Monetary Statistics, 1941-70* (Table 13.2), *Annual Statistical Digest, 1971-75* (Table 35), *Annual Statistical Digest, 1974-78* (Table 29) and various issues of the *Federal Reserve Bulletin.* The data for U and P are from Gordon (1984, Table B-1). The other data is reported by Shughart and Tollison.
7.   The SYSEMP, coefficient also is insignificant when S—T's model, equation (1), or the first-difference of equation (1) is estimated for the 1917-81 period.
8.   We substituted the gross debt for either the log of the Cox and Hirschhorn (1983, Table 5) market value of the total marketable treasury debt (June or December observation) for the 1943-1980 period or the log of the Seater's (1981, MVSUM from Table 1) market value of all marketable issues of Treasury debt for the 1920-75 period in the first-difference version
of equation (3). In each case the SYSEMP coefficient remains statistically insignificant and the debt coefficient becomes insignificant. Such a result is consistent with the public choice view that the Federal Reserve is constrained to reduce the cost of new Treasury borrowing regardless of the change in the value of the outstanding Treasury or government debt.
9. The multivariate tests do not indicate the presence of causality between the base and the currency-deposit ratio or between the base and real income.

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