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COULD A MONETARY BASE RULE HAVE PREVENTED THE GREAT DEPRESSION?

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ABSTRACT

This paper continues an ongoing investigation of the properties of a specific, quantitative, and operational rule for the conduct of monetary policy, a rule that specifies settings of the monetary base that are designed to keep nominal GNP growing smoothly at a noninflationary rate. Whereas previous studies have examined the rule's performance in the context of United States experience since World War II, the present paper is concerned with the period 1923-1941. Counterfactual historical simulations are conducted with the rule and a small model of nominal GNP determination, estimated with U.S. quarterly data for 1922-1941. Residuals from the estimated relationships serve as estimates of the behavioral shocks that occurred and accordingly are fed into the simulation process quarter by quarter. The simulation results indicate that nominal GNP would have been kept reasonably close to a steady 3 percent growth path over 1923-1941 if the rule had been in effect, in which case it is highly unlikely that real output and employment could have collapsed as they did during the 1930s.

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I. Introduction

In previous papers [1] I have described some properties of a specific quantitative policy rule that adjusts the monetary base each quarter so as to keep nominal GNP--or some alternative measure of total nominal spending--close to a prespecified target path that grows smoothly at a noninflationary rate. Simulation studies with a variety of small econometric models have indicated that the rule would have been effective, in keeping nominal GNP close to the target path, in the United States over the postwar period 1954-1985 despite the drastic regulatory and technological changes that buffeted the financial and payments industries. In these studies the rule exhibits a substantial degree of robustness to model specification, a property that is highly attractive since there continues to exist substantial disagreement among macroeconomists concerning the dynamic relationship of nominal and real variables or, in other words, the mechanism by which monetary policy affects real variables.

Of course these papers have not established that the <u>best</u> target for monetary policy would be a smooth path for nominal spending; it is conceivable that macroeconomic objectives would be more fully met by maintaining cyclical stability of some other nominal variable such as the price level or a different weighted average of the price level and real output.[2] But it seems highly probable that keeping nominal GNP close to a smooth growth path rising at (say) three percent per year would result in good, if not optimal, performance. Specifically, a steady three percent growth rate for nominal GNP would keep the average inflation rate close to zero over extended periods of time and should suffice to prevent the occurrence of severe recessions.

This last suggestion leads quite naturally to the topic of the unfortunate U.S. experience of 1929-1940, typically known as the Great

Depression. More specifically, it gives rise to the almost inevitable question: Would the policy rule under discussion have succeeded in preventing the occurrence of the Great Depression? An investigation of that issue is the topic of the present paper.

It should be said at the outset that the object will not be to learn whether steady three percent growth in nominal GNP would have kept real GNP and employment from their catastrophic historical declines; that proposition will be taken for granted. The issue to be studied, rather, is whether the extreme decline in nominal GNP that actually occurred over 1929-1933 would have been prevented if monetary policy had been conducted according to the base rule under discussion. For the years of the depression that seems the more questionable hypothesis, since the period witnessed enormous changes in base velocity--the ratio of nominal GNP to the base--brought about by exceptionally sharp movements in the currency to deposit ratio desired by money holders and the reserve to deposit ratio chosen by banks.[3]

In the present paper this issue will be studied by means of counterfactual simulations pertaining to the years 1923-41. In these simulations the path of the monetary base is determined by the policy rule under study with the consequent path of nominal GNP then generated by a small model estimated with quarterly data for the years 1922-1941.[4] Residuals from the estimated relationships serve as estimates of the behavioral shocks that actually occurred and accordingly are fed into the simulation process quarter by quarter. The study's strategy is thus similar to that employed in my previous papers pertaining to the postwar era, except that robustness of the rule's performance with respect to alternative models is not explored nearly as thoroughly.

The paper's outline is as follows. In Section II, some facts concerning 1922-41 are reviewed to indicate the nature of the problems faced by the monetary base rule in attempting to cope with the nominal GNP collapse of the early years of the Great Depression. In addition, one of the model's key relationships is estimated. Then Section III develops specifications and reports estimates for the remaining equations of the econometric model that will be used together with the policy rule in simulations. The counterfactual policy simulation results are described in Section IV for the basic version of the model and some results for a few alternative specifications are summarized in Section V. Brief concluding comments appear in Section VI and data series are presented in an appendix.

II. Overview

It will be useful to begin by outlining the dimensions of the problem that our policy rule will be required to overcome if it is to provide successful stabilization in simulations over the period 1923-1941. Let x_t denote the logarithm of nominal GNP for quarter t, with the latter measured in billions of dollars expressed at an annual rate.[5] Then the actual historical record is as shown in Figure 1, where x_t is plotted against time. Also shown is a smooth target path (denoted x_t^*) with a constant growth rate of three percent per year--an increase of 0.00739 for the log of GNP in each quarter--drawn through the actual x_t value for the fourth quarter of 1922. (In this figure, and those that follow, x_t values are designated as LX and x_t^* values as TAR.) The sharp fall in x_t between 1929.4 and 1933.1 reflects values of 4.61 = log 100.92 and 3.91 = log 49.78 for those two dates, which imply an average drop of 5.3 percent <u>per quarter</u> over that span of three and one-fourth years. Furthermore, despite its rapid climb during 1933-1936, the level of x_t remains far below the three percent target path continuously until late 1941.

The policy rule under consideration would have attempted to keep x_t close to the x_t^* target path by means of quarterly adjustments in the growth rate of the monetary base, a policy instrument that can be accurately controlled by the Federal Reserve.[6] Let b_t denote the log of the base for quarter t. Then the rule can be written as

$$(1)\quad \Delta b_t = 0.00739 - (1/16)\,(x_{t-1} - b_{t-1} - x_{t-17} + b_{t-17}) + \lambda\,(x^*_{t-1} - x_{t-1})$$

where λ is a positive feedback coefficient. On the right-hand side of (1) the first term is simply a three percent annual growth rate expressed in quarterly logarithmic units, while the second term subtracts the average

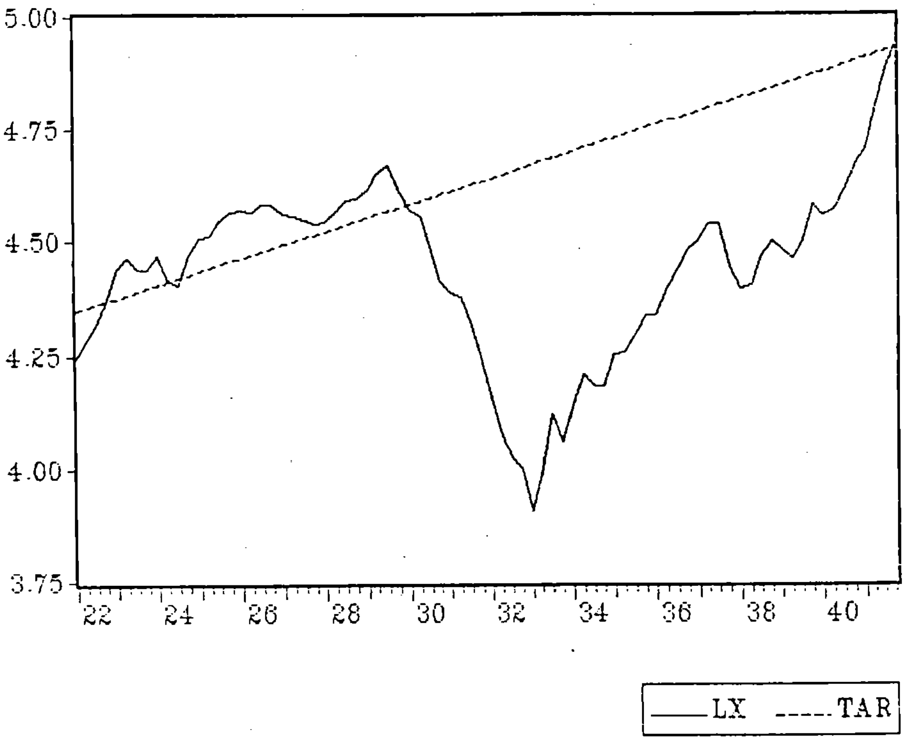


Figure 1

growth of base velocity over the previous four years and the third adds an automatic feedback adjustment in response to cyclical departures of (nominal) GNP from its target path. In simulations pertaining to the 1954-85 experience of the United States, values of the policy coefficient λ in the range 0.10 - 0.25 have yielded good results in a variety of vector autoregression systems as well as three behavioral models designed to represent leading alternative theories of the business cycle mechanism.[7] Stronger feedback responses, with $\lambda = 0.50$, are even more effective in some of the simulations but tend to generate dynamic instability in others. On the basis of these previous studies, therefore, the range 0.10 - 0.25 seems most attractive.

For present purposes, the crucial difference between the postwar and interwar periods pertains to the relationship between GNP and the monetary base. For the postwar years 1954-1985, straightforward estimation results indicate a strong effect of base growth on nominal GNP growth, as exemplified by the following least-squares relationship:

$$\text{(2)}\quad \Delta x_t = \underset{(.0019)}{0.0078} + \underset{(.083)}{0.198}\ \Delta x_{t-1} + \underset{(.125)}{0.549}\ \Delta b_{t-1} + e_{2t}$$

$$R^2 = 0.248 \qquad SE = 0.010 \qquad DW = 2.04$$

Here the impact of base growth is both sizable and prompt; the estimated coefficients remain much the same if Δb_t is used in place of Δb_{t-1}. Also, the inclusion of additional lagged values of Δx_t and/or Δb_t does not substantially alter this relationship, nor does the inclusion of other variables such as real GNP growth and/or the Treasury bill rate.

For the interwar years 1922-1941, by contrast, estimation of the same specification as in (2) gives rise to the following results:[8]

$$\Delta x_t = 0.0022 + 0.403\ \Delta x_{t-1} + 0.184\ \Delta b_{t-1} + e_{3t} \qquad (3)$$

$$(.0059) \qquad (.104) \qquad (.203)$$

$$R^2 = 0.175 \qquad SE = 0.044 \qquad DW = 1.99$$

Here Δb_{t-1} enters insignificantly--the coefficient's magnitude is exceeded by its standard error--and the estimated effect turns negative if Δb_t is used in place of Δb_{t-1}. Furthermore, if four lagged values of both Δx_t and Δb_t are utilized, those for Δb_t fail to provide incremental explanatory power, the chi-square test statistic for the hypothesis of zero effect being 8.6 as compared with a 0.05 critical value of 9.5.

These contrasting findings should come as no surprise to monetary economists, since it is well known that dramatic shifts occurred during the 1930s in the currency/deposit and reserves/deposit ratios, here denoted COD and ROD. The extent and sharpness of these shifts are indicated by the time plots presented in Figure 2.[9] Since a change in either of these ratios will bring about a change in the money stock to base ratio, if the other does not change in an offsetting manner, the GNP to base relationship will tend to shift if the GNP to money stock relationship is unchanged.

The foregoing line of argument suggests that a critical issue is whether there was a reasonably stable (i.e., unchanging) relationship between the money stock and GNP during the interwar period. A small amount of experimentation revealed that Δx_t was quite strongly related to Δm_{t-1}, where m_t is the log of the M1 money stock. Three lagged Δx values were found to possess a bit of explanatory power and so were included in an estimated relationship for 1922.1 - 1941.4:

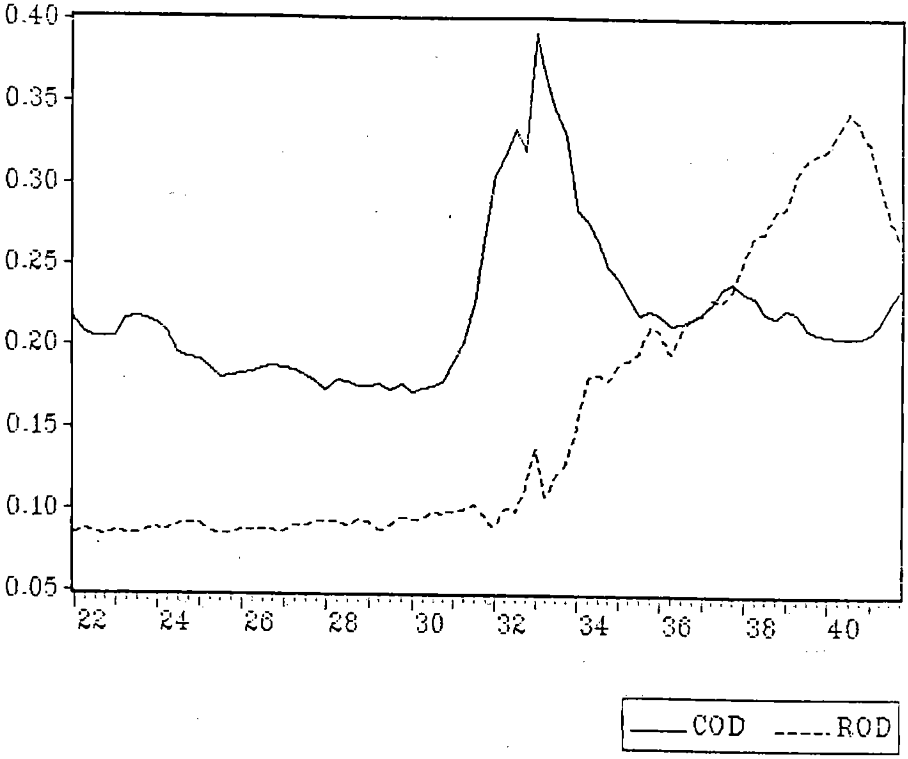

0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
22
24
26
28
30
32
34
36
38
40
COD
ROD

Figure 2

$$\Delta x_t = -\underset{(.0045)}{0.0016} + \underset{(.113)}{0.241}\,\Delta x_{t-1} - \underset{(.106)}{0.240}\,\Delta x_{t-2} + \underset{(.108)}{0.291}\,\Delta x_{t-3} + \underset{(.228)}{0.796}\,\Delta m_{t-1} + e_{4t} \tag{4}$$

$$R^2 = 0.413 \qquad SE = 0.037 \qquad DW = 1.96$$

Examination of the latter's residuals e_{4t} reveals, however, large positive values for the two middle quarters of 1933. These are, of course, the first two quarters following the re-opening of the nation's banks after the banking holiday of March 6-15. In addition they include most of the famous "hundred days" during which President Roosevelt initiated his new administration's intense efforts to halt the great contraction and begin an upturn. As the extent of these efforts, the nature of the steps taken, and the public's response were all rather extraordinary, it seems entirely appropriate to include a dummy variable for each of these two quarters, 1933.2 and 1933.3.[10] Defining d_t as a variable that takes on the value 1.0 for 1933.2, and equals zero otherwise, the estimated relationship then becomes

$$\Delta x_t = -\underset{(.0037)}{0.0082} + \underset{(.098)}{0.174}\,\Delta x_{t-1} - \underset{(.090)}{0.163}\,\Delta x_{t-2} + \underset{(.087)}{0.287}\,\Delta x_{t-3} + \underset{(.188)}{1.079}\,\Delta m_{t-1} + \underset{(.031)}{0.171}\,d_t + \underset{(.033)}{0.123}\,d_{t-1} + e_{5t} \tag{5}$$

$$R^2 = 0.633 \qquad SE = 0.030 \qquad DW = 1.93$$

The explanatory power of this relationship is significantly greater, as the dummy variable and its lagged value enter with t-statistics of 5.4 and 3.7, respectively. Furthermore, the resulting specification is one for which a Chow test does not call for rejection of the hypothesis of parameter constancy across the two subperiods 1922.1-1933.1 and 1933.2-1941.4.[11] Consequently, this specification will be retained as part of the basic model to be used in the simulation studies of Section IV.

III. Relationship of Money Stock to Monetary Base

Another element needed for our basic model is a relationship between the monetary base, which is the instrument variable regulated by policy rule (1), and the money stock (again operationally represented by the M1 measure). The first task of this section, accordingly, is to develop a model explaining $m_t - b_t$, the log of the ratio of M1 to the base. Given this objective, one could proceed either to model separately the behavior of the currency to deposit ratio and the reserves to deposit ratio, using these two relationships and an identity to determine the implied values of $m_t - b_t$, or to model movements in $m_t - b_t$ directly. In the present study the latter approach has been adopted, largely for the sake of simplicity but also because preliminary investigations suggested that there would be little benefit from following the more detailed approach.

In considering the behavior of $m_t - b_t$ over the interwar period, three likely determinants spring to mind almost immediately. The first of these is the public's attitude toward the safety of its bank deposits, which was crucially involved (as both cause and effect) in the banking panics of 1931 - 1933. Second is the level of reserve requirements, which was increased sharply in 1936 and 1937. And third is the level of nominal interest rates, which fell to exceedingly low values for the period 1933-1941 (and after). Quantitative measures of the last two variables can be obtained in a straightforward manner,[12] but to represent the public's attitude or confidence some type of proxy must be devised. The strategy adopted in this study is to utilize a measure reflecting the magnitude of bank failures. As a raw measure of the latter, the ratio of deposits in suspended banks to deposits of all banks can readily be calculated.[13] Let the log of this ratio for quarter t be denoted sod_t. Then it might be hypothesized that $m_t - b_t$ would be related to sod_t in some distributed-lag fashion. Empirically it transpires that the strongest relationship (among simple specifications) is between $\Delta m_t - \Delta b_t$ and sod_t, which is equivalent to a relationship between $m_t - b_t$ and the cumulated sum of sod_t magnitudes. This relationship will be taken to prevail only through 1933.1, however, with zero effect assumed for later periods as a result of the altered situation after the banking holiday and the creation (in 1934.1) of the Federal Deposit Insurance Corporation.

Least squares estimates of several specifications, in each of which $\Delta m_t - \Delta b_t$ is the dependent variable, are reported in Table 1. There it will be seen that the interest rate measure, ΔR_t, does not enter significantly but that d_t, the previously-mentioned dummy variable for 1933.2, does. Also, the overall explanatory power is greater when the sod_t variable is included only for the period up through 1933.1 as conjectured above. In sum, the preferred relationship is as follows:

$$(6) \quad \Delta m_t - \Delta b_t = 0.0049 - 0.134\ \Delta rr_t$$
$$- 0.0133\ sod_t + 0.0730\ d_t + 0.197\ (\Delta m_{t-1} - \Delta b_{t-1}) + e_{6t}$$

This equation, in which rr_t is the log of the required reserve ratio, will be used as part of the basic model.

It could perhaps be argued that the bank-failures variable sod_t should simply be set at the value zero for the entire simulation period, the idea being that bank failures would not have been an important determinant of $m_t - b_t$ if policy rule (1) had been in effect. That position will <u>not</u> be taken, however, in this study. Instead, we will initially conduct our policy simulations in a manner that permits bank failures to occur and affect $m_t - b_t$ over the period prior to 1933.2. Thus an additional relationship will be required, one whose purpose is to explain quarter-to-quarter movements in the

Table 1

Alternative Regressions with $\Delta m_t - \Delta b_t$ as Dependent Variable

Sample Period: 1922.1 - 1941.4

Coeff. (std. error) Attached to:	Case 1	Case 2	Case 3	Case 4
Constant	-0.0031	-0.0009	0.0064	0.0049
	(.0030)	(.0030)	(.0031)	(.0029)
Δrr_t	-0.109	-0.167	-0.143	-0.134
	(.068)	(.067)	(.061)	(.056)
sod_t[1]		-0.0088	-0.0151	-0.0133
		(.0019)	(.0025)	(.0024)
Δsod_t	-0.0132			
	(.0033)			
ΔR_t	0.0200	0.0054	0.0052	
	(.021)	(.020)	(.019)	
d_t				0.0730
				(.024)
$\Delta m_{t-1} - \Delta b_{t-1}$	0.305	0.062	0.047	0.197
	(.106)	(.106)	(0.089)	(.104)
Statistics				
R^2	0.230	0.270	0.373	0.439
SE	0.025	0.024	0.022	0.021
DW	2.29	1.92	1.78	1.95

[1] In cases 3 and 4, sod_t equals zero for 1933.2 - 1941.4.

bank failure variable, sod_t. In specifying this equation, standard economic theory is not very helpful, but it seems highly plausible that the unusually high sod_t values during 1931-33 would be partially explicable by the poor business conditions that were prevailing. Accordingly, the following relationship was estimated and will be adopted for inclusion in our basic model:

$$(7) \quad sod_t = \underset{(.193)}{0.481} - \underset{(.745)}{2.210}\,(x_{t-1} - x^*_{t-1}) + \underset{(.159)}{0.559}\,sod_{t-1} + e_{7t}$$

$$R^2 = 0.612 \qquad SE = 0.741 \qquad DW = 1.69$$

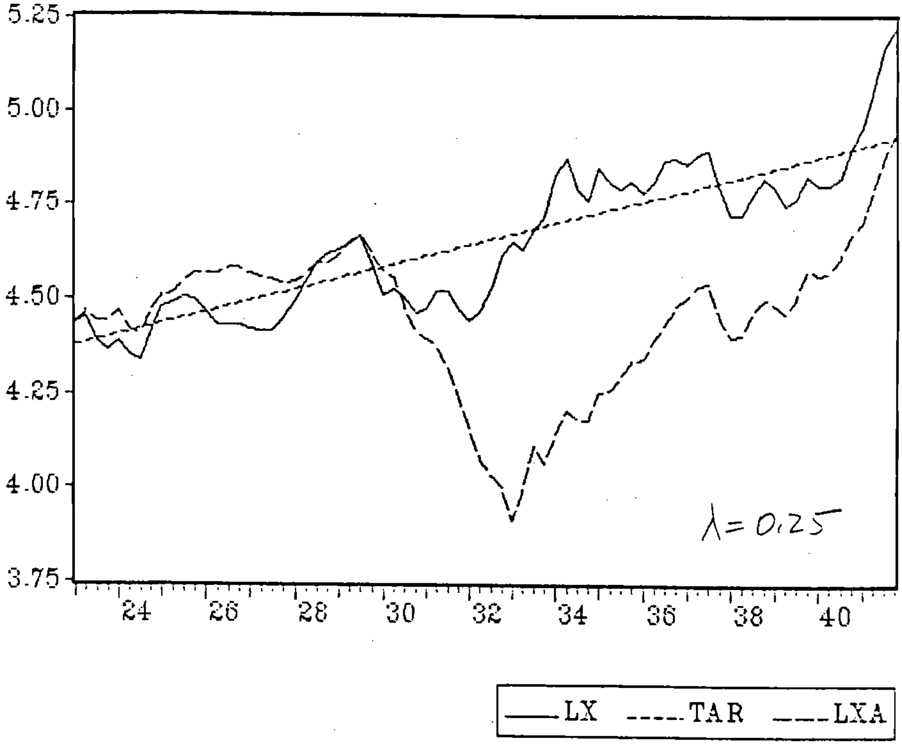
Here the business-conditions variable $x_{t-1} - x^*_{t-1}$ has the anticipated negative impact: when x_t is low, bank failures in t+1 tend to be high.[14] In (7) the estimation period is 1922.1 - 1933.1, since one would not expect the same relationship to be relevant after the institutional changes that took place in the last three quarters of 1933.

A second way of proceeding, which should also be of interest, would involve the counterfactual assumption that these institutional changes did not take place. If the policy rule had prevented the depression, that is, it might have also forestalled the creation of the FDIC. In this case, bank failures would presumably have continued to occur as in the 1922-1932 period and to have affected $m_t - b_t$ as in that period. To represent this possibility, simulations would be conducted with (7) remaining intact throughout 1923-1941 and with no change on the sod_t coefficient in (6). More detail concerning this second simulation strategy will be provided in Section IV.

IV. Basic Model Simulation Results

The foregoing sections have specified a system that includes the policy rule (1) and a simple model of nominal GNP determination consisting of the three equations (5), (6), and (7).[15] In the policy simulations to be reported, these four equations are used to generate counterfactual time paths over the period 1923.1 - 1941.4 for the four variables b_t, m_t, sod_t, and x_t. More precisely, the simulations are conducted with actual historical values of all variables as of 1922.4 used as initial conditions and with residuals (for 1923.1 - 1941.4) from equations (5), (6), and (7) fed into the system each period as estimates of the behavioral shocks that occurred. The reserve requirement variable is held constant throughout the simulations, implying $\Delta rr_t = 0$, as a natural complement to the policy rule (1), while the dummy variable d_t is of course set equal to zero for all periods. Also, in the first set sod_t is set equal to zero for periods after 1933.1.[16]

The exercise just described has been conducted with five alternatives values of the feedback coefficient λ in rule (1). Consider first the results with $\lambda = 0.25$, which is the value emphasized in my first presentation of the rule (McCallum, 1987). The simulated time path is plotted (as LX) in Figure 3, together with the target path x_t^* and also the actual historical path of x_t (denoted LXA). It is immediately apparent from this figure that the simulated behavior of nominal GNP is vastly superior to the actual outcome in terms of its proximity to the "smooth and noninflationary" target path. The root-mean-square error (RMSE) value reported in Table 2 is 0.0922, as compared with the actual historical value of 0.3269. Furthermore, the mean value of $x_t^* - x_t$ is only 0.0052 for the simulated series, whereas the actual mean was 0.2095. Indeed, it seems almost inconceivable that real output and employment could have suffered declines anything like those actually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λ= 0.25
LX
TAR
LXA

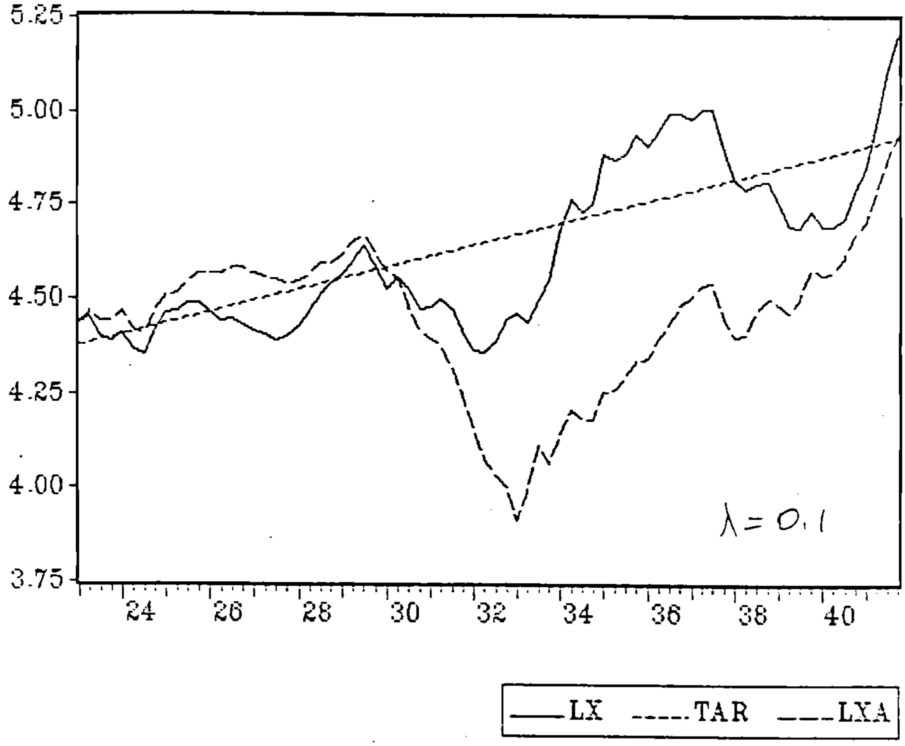
Figure 3

experienced if nominal GNP had followed the simulated path.

Simulated time paths for x_t when the policy coefficient λ is equal to 0.1 and 0.5 are shown in Figures 4 and 5, respectively. From there it is clear that performance is better with stronger feedback ($\lambda = 0.5$) and poorer with weaker feedback ($\lambda = 0.1$), a finding corroborated by the RMSE figures in Table 2. It is certainly possible to provide too much feedback, however, as Figure 6 indicates. In the case depicted there, a λ setting of 1.0 leads to explosive oscillations. Figure 7, finally, indicates that in the absence of feedback (i.e., with $\lambda = 0.0$), nominal GNP would have behaved almost as badly as it did in actuality.

The policy rule works, in the cases with $0.1 < \lambda < 0.5$, by generating rapid growth of base money beginning in 1930, shortly after the downturn in x_t. This shows up clearly in Figure 8, for $\lambda = 0.25$, where the simulated time path for the log of base money (there denoted LH) is compared with the actual historical path (denoted LHA). Analogous paths for M1, both simulated and actual, are shown in Figure 9. The major fall in M1 that actually occurred between 1929 and 1933 is avoided, despite shocks and a substantial volume of bank failures during 1930 - 32.[17]

A notable feature of the simulated x_t path in Figures 3 - 5 is the sharp rise above the target path during 1941. One might guess that this occurs as a result of positive e_{5t} residuals--shock estimates--from equation (5), with those reflecting the influence of sharp increases during 1941 in the level of government purchases (whose magnitude for the year was \$25.0 billion, almost double the \$14.2 billion value of 1940).[18] Such effects do not show up clearly in the data, however: the 1941 values of e_{5t} are positive but not unusually large and neither Δg_t nor Δg_{t-1} (with g_t = log of government purchases) adds significant explanatory power to (5).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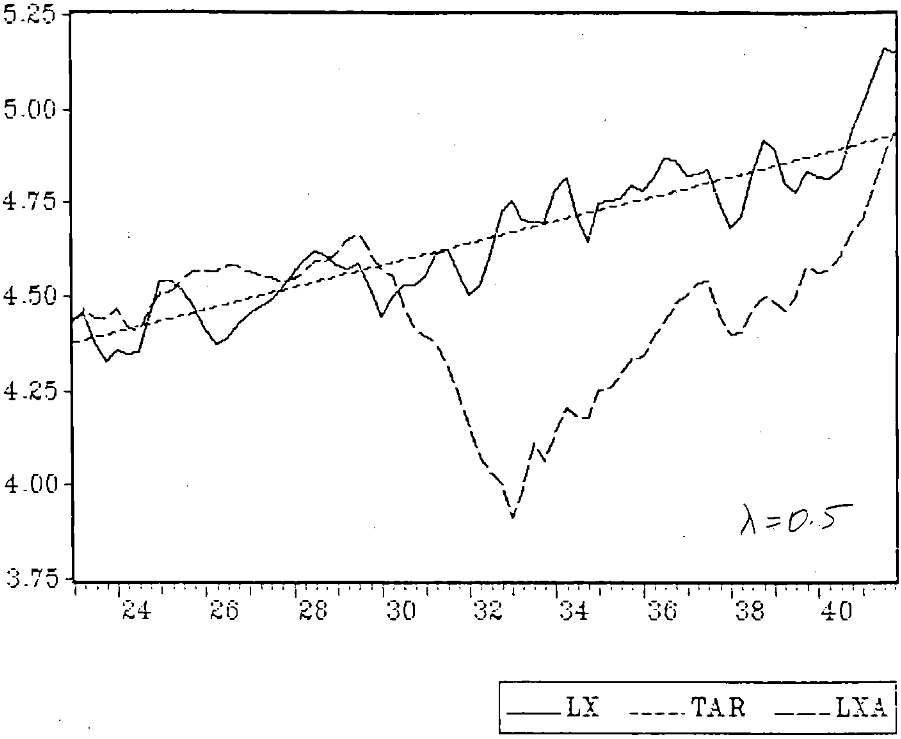
λ = 0.1
LX
TAR
LXA

Figure 4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40
λ=0.5
LX
TAR
LXA

Figure 5

Table 2

Properties of Actual and Simulated Time

Paths of Nominal GNP, 1923.1 - 1941.4

	Mean $x_t^*-x_t$	Maximum $x_t^*-x_t$	Root Mean Square $x_t^*-x_t$
Actual Historical	0.2095	0.765	0.3269
Simulated, Rule (1)			
λ = 0.00	0.1811	0.7301	0.2880
λ = 0.10	0.0263	0.2905	0.1342
λ = 0.25	0.0052	0.1996	0.0922
λ = 0.50	-0.0016	0.1378	0.0769
λ = 1.00	0.0260	2.0622	0.6668

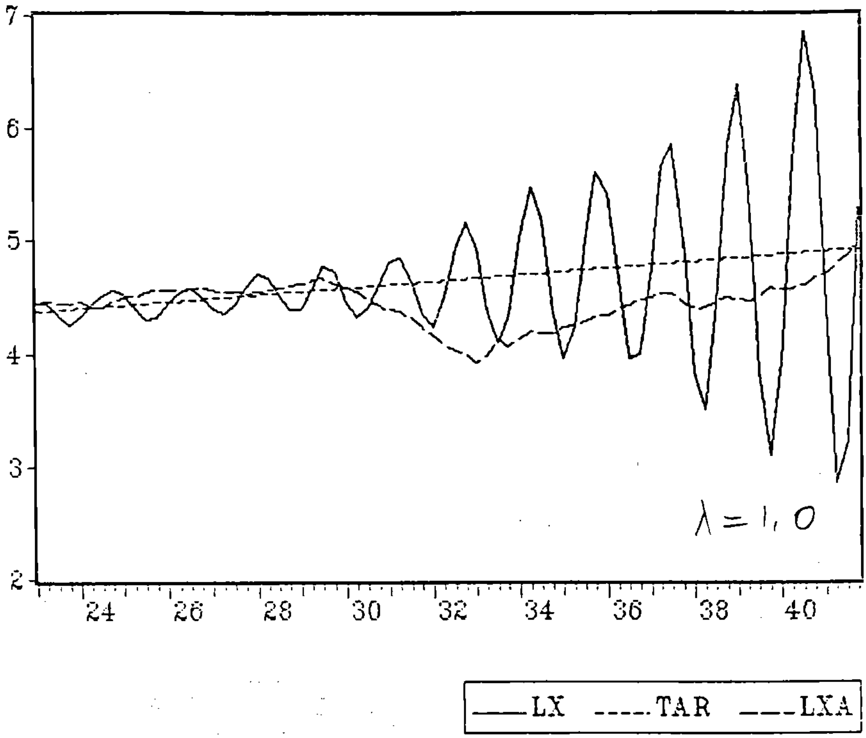

Figure 6

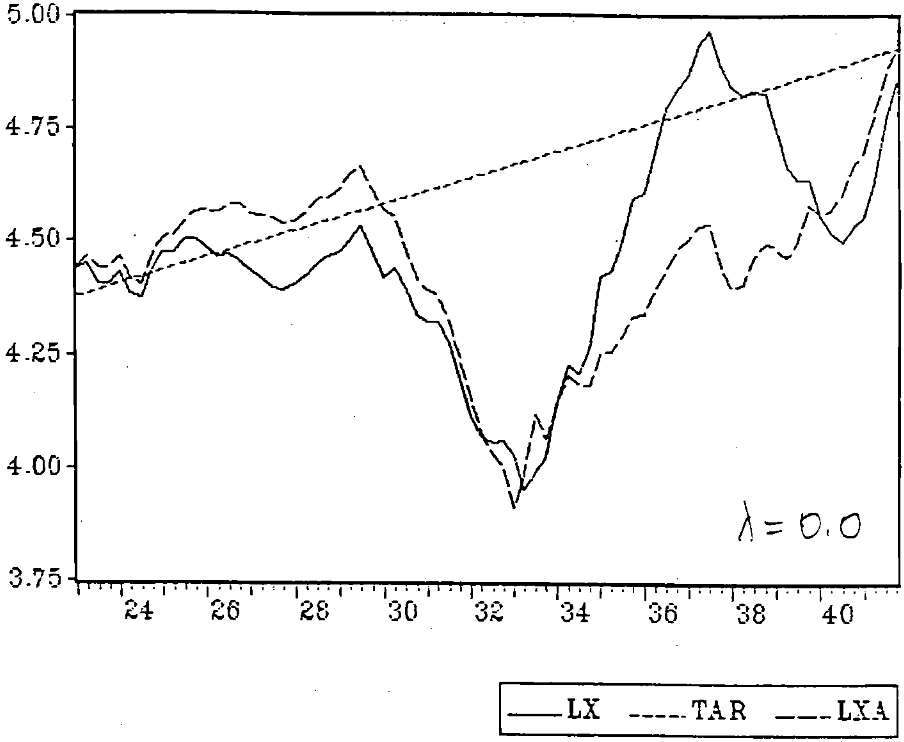

Figure 7

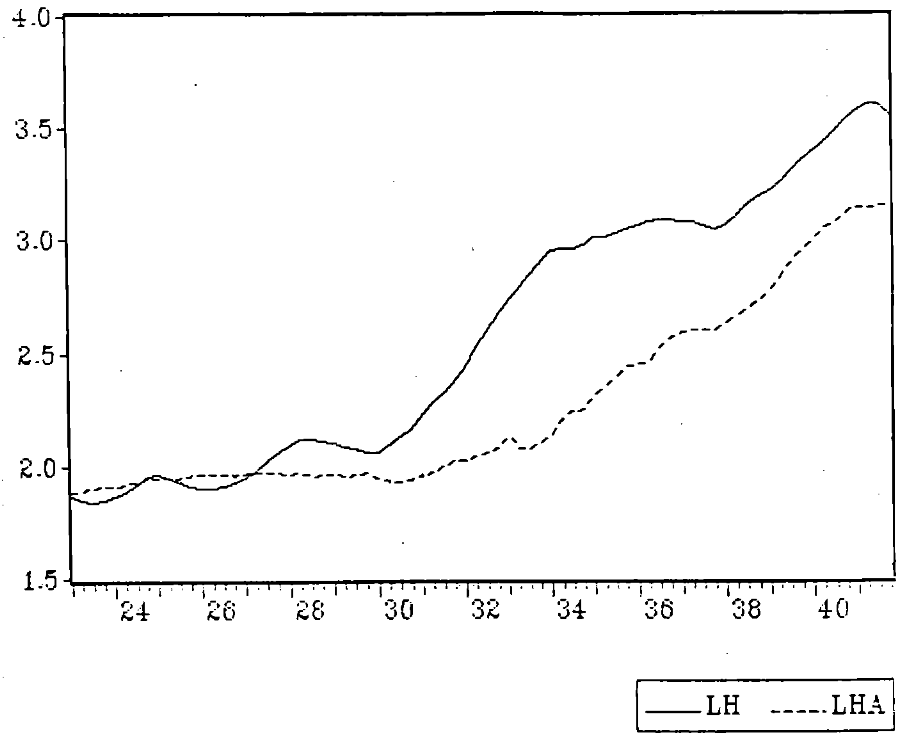

Figure 8

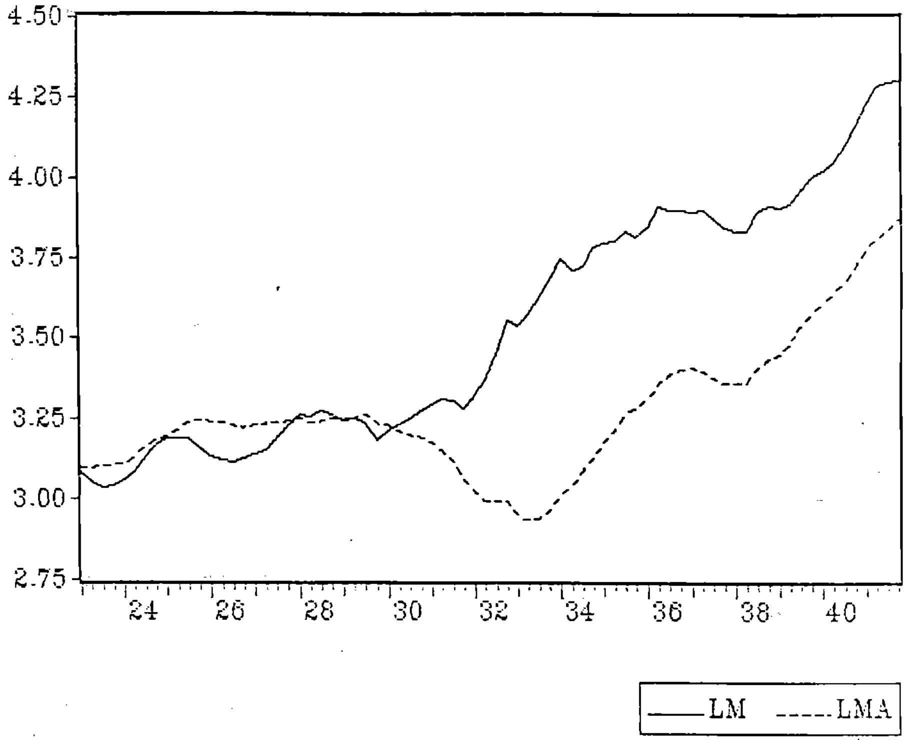

Figure 9

All of the foregoing results implicitly incorporate the assumption that the FDIC was established and other banking regulations altered, with a major effect on the generation of bank failures, at the end of 1933. As mentioned in Section III, it should also be of interest to consider simulations in which the implicit assumption is instead that no institutional change of this type takes place. For this alternative scenario, simulations are conducted as before except that equation (7) remains intact through the entire simulation period and the effective coefficient on sod_t in (6) is not changed after 1933.1. In this case residuals from (7) are unavailable for the period 1933.2-1941.4, so shock estimates have to be generated in some other fashion. One possibility would be to draw values randomly from a normal distribution with mean zero and standard deviation 0.741. The procedure adopted, however, was to draw shock estimates randomly from a finite distribution consisting of the 44 measured e_{7t} residuals for 1922.1-1932.4.[19]

Numerical results for this alternative institutional scenario are reported in Table 3. There it will be seen that most of the error measures are larger than in Table 2, but to a minor extent. Basically, for intermediate λ values (0.1, 0.25, 0.5) the simulated paths are much like those obtained in the previous set of experiments. This similarity is exemplified by Figure 10, pertaining to the case with $\lambda = 0.25$, which may usefully be compared with Figure 3.

Table 3

Properties of Actual and Simulated Time

Paths of Nominal GNP, 1923.1 - 1941.4

(Alternative Institutional Scenario)

	Mean $x^*_t - x_t$	Maximum $x^*_t - x_t$	Root Mean Square $x^*_t - x_t$
Actual Historical	0.2095	0.765	0.3269
Simulated, Rule (1)			
λ = 0.00	0.5051	1.1005	0.6584
λ = 0.10	0.0383	0.2905	0.1672
λ = 0.25	0.0204	0.2086	0.1021
λ = 0.50	0.0052	0.1378	0.0769
λ = 1.00	0.0145	1.0319	0.4159

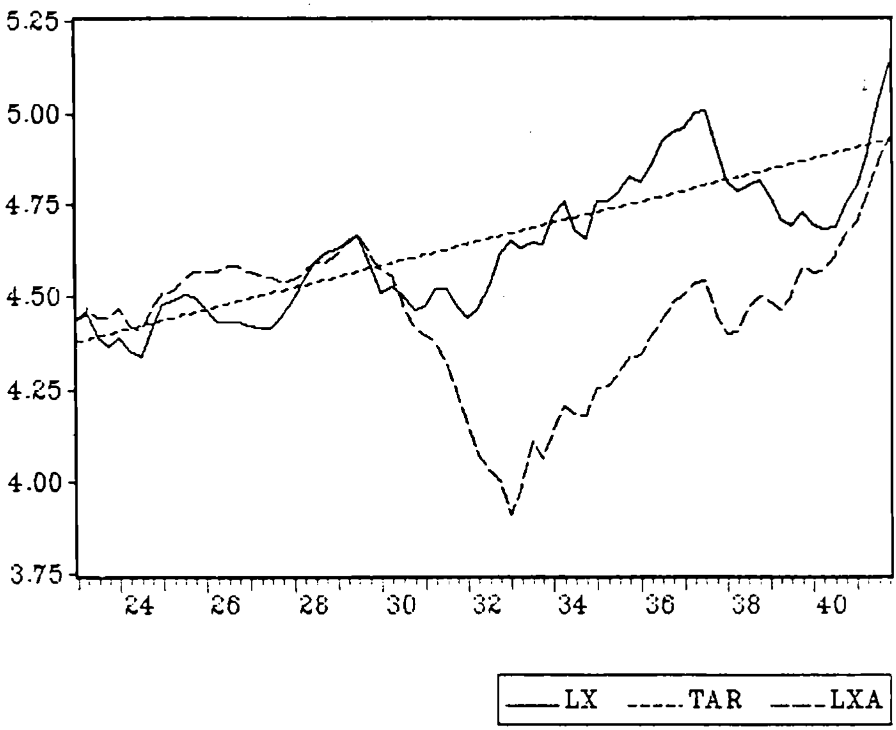

Figure 10

V. Alternative Specifications

In addition to the results obtained with the basic model of equations (5)-(7), others have been developed with two alternative specifications. These alternatives are designed to explore the effect of (a) including more lagged terms in equations (5)-(7) and (b) dropping the 1933.2 dummy variable d_t from the system. In both cases, the institutional scenario without creation of the FDIC is adopted--that is, equations (6) and (7) are kept intact throughout the simulation period.

It is of importance to experiment with additional lagged regressors in equations (5)-(7) so as to ascertain whether the results reported above are an artifact of the practice of including only those terms that have significant explanatory power. That practice has the potential of shortening the model's various distributed-lag response times, thereby making feedback stabilization appear unrealistically effective. To guard against that possibility, equations (5) and (6) were re-estimated with four lagged terms included for all explanatory variables except the dummy d_t. Thus the revised version of (5) includes Δx_{t-j} and Δm_{t-j} for $j = 1,2,3,4$ together with d_t and d_{t-1}, while the revised version of (6) includes Δrr_{t-j}, sod_{t-j}, and $\Delta m_{t-j} - \Delta b_{t-j}$ (for $j = 1,2,3,4$) plus d_t. Note that current values of Δrr_t and sod_t are excluded in the latter, a change that should tend to make stabilization more difficult. Also in this experiment equation (7) was estimated with sod_{t-j} and Δx_{t-j} ($j = 1,2,3,4$) as regressors, Δx_{t-j} replacing $x_{t-1} - x^*_{t-1}$ as another check against our basic specification.

With the model revised in this manner, the simulation results with $\lambda = 0.25$ in the policy rule (1) give rise to statistics for the target error $x^*_t - x_t$ that are quite close in value to those on the third line (for $\lambda = 0.25$) of Table 3. In particular, the calculated mean value for $x^*_t - x_t$ is 0.0148, the maximum is 0.2289, and the RMSE is 0.1005. The simulated time path, moreover, is too similar to that of Figure 10 to warrant its inclusion.

The effect of dropping d_t and d_{t-1} from (5) and d_t from (6)--in addition to the previous changes--is more substantial as the three $x_t^* - x_t$ statistics become 0.0061, 0.2931, and 0.1379, respectively. Thus while the mean target error is again close to zero, the maximum and RMSE values are somewhat higher. From the plotted time path, shown in Figure 11, we can see that x_t falls farther below x_t^* during early 1932 than in Figure 10. But the most undesirable aspect of nominal GNP performance is the sharp "overshoot" that occurs during 1933 and early 1934, with x_t values well in excess of x_t^*. This result occurs, apparently, because the large positive residuals for 1933.2 and 1933.3 in the revised equation (5) arrive after the upturn of late 1932 has already occurred and while monetary growth is very rapid.

Consequently, it cannot be claimed that the role of the d_t dummy is innocuous. With the exclusion of d_t, policy rule (1) keeps nominal GNP from falling as far below the x_t^* target as it did in actuality, but does not yield a very attractive path. But while it is important to recognize that the influence of d_t is not trivial, it is also important not to leap to the false conclusion that the existence of a substantial influence renders policy rule (1) unattractive. For if the historical surge in GNP that took place in 1933.2 - 1933.3 was in fact attributable to the unusual policy actions of the new Roosevelt administration, as argued above, then the inclusion of d_t in equations (5) and (6) is entirely appropriate. And in this case the more satisfactory x_t path of Figure 3 or Figure 10 indicates what rule (1) with $\lambda = 0.25$ would have produced, according to our estimates.

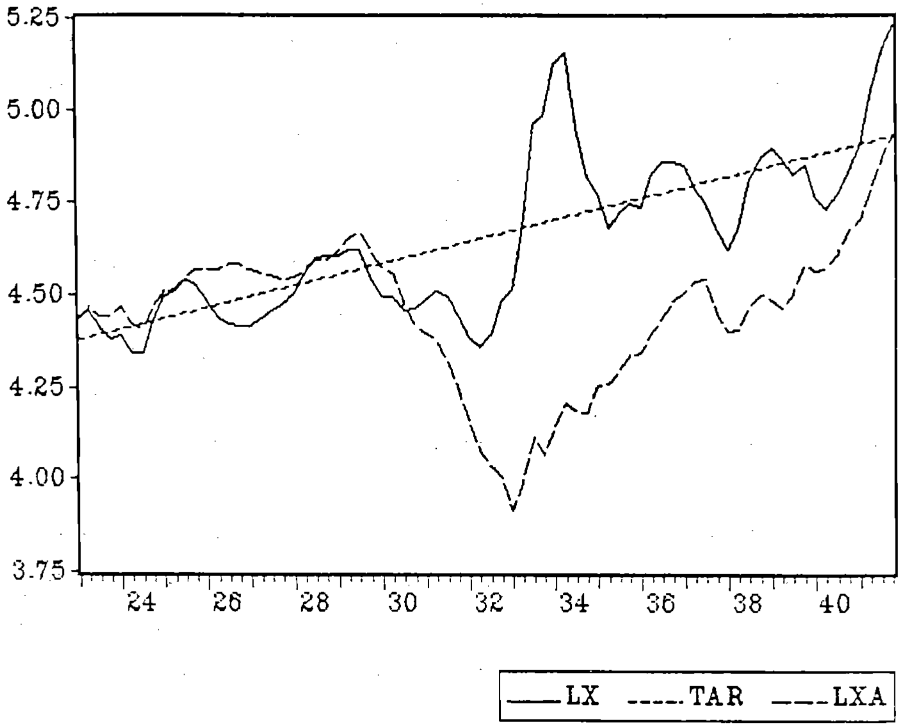

Figure 11

VI. Concluding Remarks

Perhaps the most questionable aspect of the foregoing analysis is the absence of any equilibrium-approach justification for equations (5) and (6) of the basic model. Because of this absence, some proponents of the equilibrium approach might suggest that the simulations are open to Lucas-critique objections, especially as the base rule considered implies policy behavior quite different from that actually experienced.

It is important that this type of objection be taken seriously but also that it not be applied indiscriminately. Lucas's critique (1976) is best thought of not as a methodological imperative, but as a reminder of the need to use policy-invariant relations in simulation studies and especially as a provider of important examples in which policy invariance could not reasonably be presumed. Explicit maximization analysis can be helpful in the design of models intended to possess approximate policy invariance, to a reasonable extent, but is neither necessary nor sufficient.

A major difficulty in the construction of an invariant model for monetary policy analysis is the profession's lack of understanding, in qualitative terms as well as quantitative, of the connection between monetary and real variables. As I have argued previously, "flexible price models appear to be inconsistent with the behavior of actual economies, while existing sticky-price models do not conform to the dictates of the equilibrium approach and so are open to the Lucas critique" (McCallum, 1988b, p. 466). I have also argued, however, that "because of the crucial role of unexpected components or surprises in the wage-price or Phillips curve sector of [macroeconomic] models, it is that sector that would appear to be especially susceptible to Lucas's critique. Relations among variables all of one type, either nominal or real, would tend to be less likely to experience major shifts in response to policy changes" (1988b, p. 463).[20]

For the foregoing reason, the present study has emphasized relations among nominal variables, without attempting to develop an explanation of quarterly movements of aggregates such as real GNP or employment. In my investigation of the postwar period, an additional line of defense against Lucas-critique dangers is provided by the robustness of the rule's effectiveness to alternative model specifications, most involving real variables and some that represent leading competing theories of Phillips-type effects of nominal on real variables. Thus it would clearly be desirable to investigate more throughly the robustness of the reported simulation results in a similar manner. Consequently, the present results cannot be viewed as definitive in nature. But they provide a framework for further investigation and, at the present stage, clearly indicate the plausibility of the proposition that a monetary base rule could have prevented the Great Depression. Whatever the nature of the connection between monetary and real variables might be, it is difficult to imagine that output and employment would have collapsed, as they actually did in the 1930s, if nominal GNP had been induced to follow a path similar to that of Figure 3.

Appendix

The data series used in the present study are tabulated below for the period 1918.1 - 1941.4. The series and their sources are as follows.

GNP; nominal gross national product, billions of dollars. Source: Balke and Gordon (1986, Table 2).

HPM; monetary base (high-powered money), billions of dollars. Source: Friedman and Schwartz (1963, Table B-3). Average of monthly figures.

M1; money stock, M1 concept, billions of dollars. Source: Balke and Gordon (1986, Table 2). This series was compiled by Benjamin M. Friedman by averaging the Friedman and Schwartz (1963) monthly figures and applying an adjustment designed to make the values more compatible with current M1 data (as of 1983).

CURRQ; currency in circulation (i.e., held by non-bank public), billions of dollars. Source: Friedman and Schwartz (1963, Table A-1). Average of monthly figures.

RRR; reserve requirement ratio for demand deposits in city reserve banks. Source: Banking and Monetary Statistics, p. 400.

SUS; Deposits of banks suspended, millions of dollars. Source: Federal Reserve Bulletin, September 1937, p. 909.

R; Commercial Paper Rate, percentage per annum. Source: Balke and Gordon (1986, Table 2).

obs	GNP	HPM	M1	CURRQ	RRR	SUS	R
1918.1	67.24000	5.678000	17.87000	3.227000	0.100000	4.000000	5.900000
1918.2	75.37000	5.880000	17.97000	3.443333	0.100000	4.000000	6.080000
1918.3	81.82000	6.206000	18.77000	3.871000	0.100000	4.000000	6.110000
1918.4	81.81000	6.548000	19.65000	4.097667	0.100000	4.000000	6.000000
1919.1	77.97000	6.450000	20.18000	3.953333	0.100000	5.300000	5.290000
1919.2	81.42000	6.550000	20.90000	3.928667	0.100000	5.300000	5.340000
1919.3	87.29000	6.633000	21.81000	3.974333	0.100000	5.300000	5.380000
1919.4	90.43000	6.847000	22.72000	4.129000	0.100000	5.300000	5.460000
1920.1	95.98000	7.034000	23.22000	4.286667	0.100000	14.20000	6.420000
1920.2	95.95000	7.204000	23.23000	4.431667	0.100000	14.20000	7.380000
1920.3	93.84000	7.284000	23.05000	4.566000	0.100000	14.20000	8.130000
1920.4	80.40000	7.228000	22.54000	4.559333	0.100000	14.20000	8.090000
1921.1	69.78000	6.865000	21.57000	4.271667	0.100000	60.00000	7.710000
1921.2	68.56000	6.637000	20.72000	4.112000	0.100000	35.00000	7.090000
1921.3	69.35000	6.411000	20.29000	3.943333	0.100000	22.00000	6.170000
1921.4	70.37000	6.241000	20.22000	3.761333	0.100000	55.00000	5.500000
1922.1	69.65000	6.151000	20.36000	3.620000	0.100000	41.00000	4.880000
1922.2	72.44000	6.268000	21.08000	3.619000	0.100000	18.00000	4.420000
1922.3	75.49000	6.302000	21.49000	3.660667	0.100000	10.00000	4.130000
1922.4	79.07000	6.413000	22.01000	3.748334	0.100000	22.00000	4.670000
1923.1	84.71000	6.567000	22.21000	3.792333	0.100000	26.00000	4.750000
1923.2	87.17000	6.656000	22.21000	3.946000	0.100000	27.00000	5.130000
1923.3	84.68000	6.717000	22.31000	3.993333	0.100000	37.00000	5.210000
1923.4	84.93000	6.763000	22.38000	3.987333	0.100000	60.00000	5.170000
1924.1	87.30000	6.758000	22.38000	3.943333	0.100000	86.00000	4.820000
1924.2	82.86000	6.827000	22.96000	3.968000	0.100000	54.00000	4.420000
1924.3	82.00000	6.906000	23.74000	3.889667	0.100000	29.00000	3.290000
1924.4	87.35000	7.006000	24.20000	3.915667	0.100000	41.00000	3.340000
1925.1	91.08000	6.996000	24.47000	3.936333	0.100000	53.00000	3.750000
1925.2	91.27000	6.973000	24.99000	3.927667	0.100000	41.00000	3.920000
1925.3	94.41000	7.024000	25.64000	3.922667	0.100000	18.00000	4.040000
1925.4	96.44000	7.090000	25.64000	3.941000	0.100000	56.00000	4.380000
1926.1	96.60000	7.121000	25.58000	3.964667	0.100000	35.00000	4.340000
1926.2	96.15000	7.140000	25.52000	3.988000	0.100000	57.00000	4.130000
1926.3	97.93000	7.150000	25.33000	3.995000	0.100000	68.00000	4.340000
1926.4	97.98000	7.081000	25.11000	3.971333	0.100000	100.0000	4.540000
1927.1	95.94000	7.129000	25.36000	3.998333	0.100000	90.00000	4.170000
1927.2	95.44000	7.215000	25.45000	3.982000	0.100000	36.00000	4.170000
1927.3	94.77000	7.186000	25.54000	3.937333	0.100000	39.00000	4.080000
1927.4	93.88000	7.158000	25.63000	3.871333	0.100000	34.00000	4.000000
1928.1	94.31000	7.129000	25.85000	3.832667	0.100000	47.00000	4.040000
1928.2	96.18000	7.173000	25.49000	3.892667	0.100000	27.00000	4.540000
1928.3	99.01000	7.076000	25.62000	3.884667	0.100000	22.00000	5.380000
1928.4	99.16000	7.115000	25.80000	3.855333	0.100000	46.00000	5.420000
1929.1	101.0300	7.149000	25.74000	3.859667	0.100000	52.00000	5.590000
1929.2	105.0200	7.056000	25.85000	3.886667	0.100000	51.00000	6.000000
1929.3	106.7200	7.118000	26.16000	3.876000	0.100000	77.00000	6.130000
1929.4	100.9200	7.158000	25.40000	3.828000	0.100000	51.00000	5.670000
1930.1	96.53000	6.981000	25.39000	3.739000	0.100000	82.00000	4.630000
1930.2	95.25000	6.907000	24.79000	3.681667	0.100000	109.0000	3.710000

obs	GNP	HPM	M1	CURRQ	RSR	SUS	R
1930.3	88.35000	6.902000	24.56000	3.669000	0.100000	74.00000	3.080000
1930.4	82.77000	6.959000	24.35000	3.692334	0.100000	572.0000	2.920000
1931.1	80.66000	7.106000	23.94000	3.834000	0.100000	144.0000	2.670000
1931.2	79.74000	7.183000	23.30000	3.929667	0.100000	275.0000	2.210000
1931.3	74.99000	7.398000	22.53000	4.174667	0.100000	454.0000	2.000000
1931.4	69.09000	7.583000	21.35000	4.548000	0.100000	817.0000	3.670000
1932.1	63.94000	7.593000	20.56000	4.821000	0.100000	281.0000	3.800000
1932.2	58.83000	7.714000	19.95000	4.818667	0.100000	199.0000	3.130000
1932.3	56.08000	7.858000	19.92000	4.992333	0.100000	91.00000	2.290000
1932.4	54.57000	7.967000	19.99000	4.845000	0.100000	135.0000	1.710000
1933.1	49.78000	8.498000	19.01000	5.358666	0.100000	3472.000	1.920000
1933.2	54.13000	7.978000	18.86000	5.056667	0.100000	74.00000	2.210000
1933.3	61.55000	7.920000	18.92000	4.855333	0.100000	36.00000	1.500000
1933.4	58.11000	8.194000	19.46000	4.828667	0.100000	15.00000	1.290000
1934.1	62.88000	8.452000	20.34000	4.518000	0.100000	33.00000	1.380000
1934.2	67.22000	9.171000	21.03000	4.568667	0.100000	2.000000	0.960000
1934.3	65.50000	9.438000	22.01000	4.621333	0.100000	1.000000	0.880000
1934.4	65.49000	9.468000	23.00000	4.593333	0.100000	1.000000	0.880000
1935.1	70.36000	10.10600	24.03000	4.678333	0.100000	3.500000	0.790000
1935.2	70.62000	10.49900	25.07000	4.710333	0.100000	3.500000	0.750000
1935.3	73.43000	10.87000	26.29000	4.748000	0.100000	3.500000	0.750000
1935.4	76.58000	11.46300	26.71000	4.864000	0.100000	3.500000	0.750000
1936.1	76.81000	11.69700	27.52000	4.974000	0.100000	7.000000	0.750000
1936.2	81.14000	11.70500	28.96000	5.095000	0.100000	7.000000	0.750000
1936.3	84.71000	12.53200	29.55000	5.241667	0.125000	7.000000	0.750000
1936.4	88.49000	13.12600	30.11000	5.386667	0.150000	7.000000	0.750000
1937.1	90.60000	13.33700	30.30000	5.479667	0.158300	8.500000	0.750000
1937.2	93.75000	13.50600	29.93000	5.511334	0.191700	8.500000	1.000000
1937.3	93.94000	13.45200	29.28000	5.590334	0.200000	8.500000	1.000000
1937.4	85.30000	13.47900	28.76000	5.562000	0.200000	8.500000	1.000000
1938.1	81.08000	13.87000	28.84000	5.465334	0.200000	15.10000	0.960000
1938.2	81.96000	14.35700	28.93000	5.437334	0.179200	15.10000	0.880000
1938.3	87.03000	14.80100	30.24000	5.479667	0.175000	15.10000	0.730000
1938.4	90.13000	15.44400	31.02000	5.577667	0.175000	15.10000	0.670000
1939.1	88.59000	16.06500	31.48000	5.746000	0.175000	40.00000	0.560000
1939.2	86.76000	17.10900	32.59000	5.916667	0.175000	40.00000	0.560000
1939.3	90.37000	18.28500	34.65000	6.063000	0.175000	40.00000	0.600000
1939.4	98.15000	19.12400	35.81000	6.194667	0.175000	40.00000	0.630000
1940.1	95.49000	20.04700	36.84000	6.354667	0.175000	35.70000	0.560000
1940.2	96.82000	21.20200	38.15000	6.521333	0.175000	35.70000	0.560000
1940.3	100.9200	21.87900	39.49000	6.751000	0.175000	35.70000	0.560000
1940.4	106.9200	22.78600	41.57000	7.104333	0.175000	35.70000	0.560000
1941.1	110.6500	23.21000	43.79000	7.555666	0.175000	4.700000	0.560000
1941.2	120.3500	23.12400	45.18000	7.990666	0.175000	4.700000	0.560000
1941.3	131.4000	23.38600	46.35000	8.569667	0.175000	4.700000	0.500000
1941.4	138.9000	23.53600	47.97000	9.170667	0.191700	4.700000	0.520000

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Footnotes

[1]The principal items are McCallum (1987, 1988a, 1989).

[2]A target scheme that weights real fluctuations more heavily than price level movements has been discussed by Hall (1984) while a price level target has been advocated by Barro (1985), Clark (1988), and Haraf (1986). A partial investigation of the feasibility of the latter is reported in McCallum (1989).

[3]Indeed, this question was emphasized in the discussion following the original conference presentation of McCallum (1988a), most explicitly in comments by Robert J. Hodrick and Robert E. Lucas, Jr.

[4]The simulation period begins with 1923.1, rather than 1922.1, because initial conditions with the latter would suggest a gradual introduction of the rule, as discussed in McCallum (1988a, pp.195-8). The slightly longer period is used for estimation to provide more observations.

[5]The quarterly values were developed by Robert J. Gordon by interpolations of the Chow-Lin (1971) type with industrial production as reported by Persons (1931) used as the interpolating variable. Since the latter figures are seasonally adjusted (Persons, 1931, p.131), so too are Gordon's GNP figures. They are presented in Balke and Gordon (1986). Quite recently, Romer (1988) has constructed a revised series of annual GNP estimates for 1909-1928 that could be used to develop new quarterly values for the early part of our sample. But since the main discrepanies (in relation to the Commerce Department values) occur for years prior to 1922, that exercise has not been conducted.

[6] It might be argued that the Fed could not accurately control the base with the institutions of the 1930s. That issue is beside the point; the controllability of the base under today's conditions is what is relevant to issue of the desirability of the proposed policy rule. In the present paper the subject is whether that rule would have been effective, if it had been in force during the 1920s and 1930s. Such a regime is, of course, an alternative to the Gold Standard.

[7] These theories are the real business cycle theory of Kydland and Prescott (1982), the monetary misperceptions theory of Lucas (1972) and Barro (1981), and a more Keynesian theory with sluggish price adjustments and an expectations-augmented Phillips mechanism as embodied the MPS model [recently described by Brayton and Mauskopf (1987)]. For more detail, the reader is referred to McCallum (1988a).

[8] Here the monetary base figures are quarterly averages of the high-powered money stock values compiled by Friedman and Schwartz (1963, Table B-3).

[9] Here deposits are measured as M1 minus currency in circulation, with M1 statistics being those calculated by Benjamin Friedman and reported by Balke and Gordon (1986), while currency values are those of Friedman and Schwartz (1963, Table A-1). Reserves are calculated as base money minus currency in circulation.

[10] It should be emphasized that the d_t dummy variable pertains only to the upturn in business, not the preceding decline. Since no other dummies are introduced below, it is not the case that they are being used to "explain" the depression. They represent only the brief impact effect of the early actions of the Roosevelt administration.

[11] The calculated value of the standard F statistic is only 1.1, as compared with a 0.05 critical value of 2.2.

[12] In the results reported below, the interest rate utilized is the 4-6 month prime commercial paper rate as reported by Balke and Gordon (1986). For reserve requirements, the variable utilized is the legally required ratio of reserves to demand deposits for reserve city banks. For quarters during which the ratio changed, weighted averages of the initial and final figures were utilized. The resulting series can be summarized as follows: 0.100 for 1922.1 - 1936.2; 0.125 for 1936.3; 0.150 for 1936.4; 0.1583 for 1937.1; 0.1917 for 1937.2; 0.200 for 1937.3 - 1938.1; 0.1792 for 1938.2; 0.175 for 1938.3 - 1941.3; and 0.1917 for 1941.4.

[13] The quarterly data on suspensions come from the September 1937 issue of the <u>Federal Reserve Bulletin</u>.

[14] It would perhaps be better to include a <u>real</u> measure of cyclical conditions instead of the nominal GNP measure $x_{t-1} - x^*_{t-1}$. That has not been done because our model is designed to explain movements in nominal variables only.

[15] In terms of posited relationships and basic structure, this model is rather similar to a five equation system employed by Anderson and Butkiewicz (1980). Specificational details are different, however, and the present model determines the currency-to-deposit ratio implicitly rather than explicitly. One qualitative difference is that the present model does not rely upon any measure (treated as exogenous) of "autonomous" expenditures.

[16] This is not to be interpreted as a claim that no bank failures would have occurred during 1933.2 - 1941.4 under our rule, but only as a way of eliminating the effect of sod_t from equation (5).

[17]The simulated volume of suspensions over deposits averages 0.0096 over 1930.1 - 1932.4 as compared with the actual historical figure of 0.0151.

[18]The difference was due primarily to a jump in federal defense expenditures from $2.3 to $13.8 billion.

[19]Exclusion of the residual for 1933.1 seems warranted, given the uniqueness of the Banking Holiday episode.

[20]This tendency can be illustrated in the context of the most well-developed of Lucas's own models, that of "Expectations and the Neutrality of Money" (1972), for convenience log-linearized as in McCallum (1984). The latter's version with autoregressive money growth rates features the money supply rule $\Delta m_t = \rho\Delta m_{t-1} + \varepsilon_t$, in which ρ is the basic policy parameter. (Here m_t is the log of the money stock and ε_t a white noise policy shock.) The results on p.142 of McCallum (1984) enable one to determine that the log of per-capita real output y_t obeys the following relation in this model: $y_t = b_0 + [b_1(1-\beta)/(1+a_1)]\ [\Delta m_t - \rho\Delta m_{t-1}]$. Thus the relationship between output and money growth rates depends sensitively on the policy parameter ρ. By contrast, the log of nominal output--i.e., $x_t = y_t + p_t$ with p_t the log of the price level--is in this model given as $x_t = b_0 - a_0 + m_t + [(1-\beta)(b_1-a_1)/(1+a_1)]\ [\Delta m_t-\rho\Delta m_{t-1}]$. Again ρ enters (unless $b_1 = a_1$), but now in a comparatively unimportant way--the behavior of x_t is primarily dependent upon m_t and only secondarily (if at all) on the term $\Delta m_t - \rho\Delta m_{t-1}$.