The Role of Interest Rate Policy in the Generation and Propagation of Business Cycles: What Has Changed Since the '30s?

Christopher A. Sims*

Governments have two broad classes of macroeconomic impact. One has to do with the way government liabilities, including cash, interact with other traded assets in the financial system. The other has to do with government absorption and production of real resources through non-neutral taxation and provision of government goods and services like roads, schooling, and public health measures. Some evidence suggests that fluctuations in the latter class of impact are important,[1] and it can be shown theoretically that the effects could be substantial and are hard to pin down quantitatively on the basis of a priori reasoning.[2] Policy discussion and the macroeconomic literature may have overemphasized the former, financial class of impacts.

Nonetheless, this paper focuses on the financial impact. It presents empirical evidence, similar to much that has appeared previously using time series statistical modeling, that only a small portion of business cycle variation in the United States since 1948 can be attributed to fluctuations in monetary policy. Though this conclusion is not universally accepted, it is far from new. This paper therefore goes on to consider two additional possible ways of demonstrating important effects of monetary policy. It expands the usual time frame of the literature, extending its model to the interwar period, and it examines the behavior of the model with counterfactual variations in the equation describing policy behavior.

The paper presents evidence that the same methods of identifying the effects of monetary policy that have proved useful in the analysis of

*Henry Ford II Professor of Economics, Yale University.

[1] See Garcia-Mila (1987).

[2] See Baxter and King (1993).

postwar U.S. data can be applied to interwar data, where they show responses of the private sector to monetary policy shifts to have been quite similar then to what they are now. The fact that these methods prove robust in most respects across such widely varying historical circumstances provides additional support for their reliability in both periods.

The nature of private sector disturbances was different in these two periods, however, and the nature of monetary policy response to shocks also differed. During the interwar period, shocks that implied expected future price changes were not quickly met by countervailing monetary policy. Also, during the interwar period, disturbances that resulted in a flow out of bank deposits into currency were important. Such disturbances were met with interest rate increases, which might have exacerbated their effects on the banking system. Experimentation with counterfactual specifications of policy behavior suggests that in both periods, prices could have been kept more stable by a different monetary policy, but that there was only modest room for reducing cyclical fluctuations in output by modifying monetary policy.

Can we conclude that monetary policy has had little to do with the improved stability of economic activity in the postwar period? Only if we construe monetary policy narrowly, as the normal tightening and loosening of credit conditions associated with interest rate changes. Periods of financial crisis or "liquidity crunch" are treated by the modeling methods used here as surprises originating outside the policy process, but this is true only in a narrow sense. Beliefs of the public about the adequacy of bank supervisory regulation, and about the central bank's commitment to and capacity to act as lender of last resort and prevent the kind of accelerating inflation or deflation that ends in crisis, are determined by some aspects of monetary policy and institutions, although not by the month-to-month or year-to-year management of interest rate policy via open market operations.[3]

It is in this latter aspect of monetary policy, its provision of a stable base for financial markets, that it is most fundamentally entangled with fiscal policy. The paper invokes the recently articulated fiscal theory of the price level, which may provide some insight into the sources of policy difficulties in the Great Depression and in recent international banking, monetary, and fiscal crises. This line of thinking also suggests reasons for the observed greater postwar financial stability in the United States, and cautions concerning future developments in the U.S. and international monetary systems.

[3] Bernanke (1983) has argued for the importance of "non-monetary" financial mechanisms of propagation in the Great Depression. The results in this paper confirm his and, indeed, suggest less importance for interest rate and reserve policy than his discussion.

Although it is not essential to understanding this paper's empirical evidence, it may be worth recognizing here that the paper uses a somewhat different vocabulary and point of view than does much macroeconomic policy discussion. We are not dividing the influences of government into "aggregate demand" and "aggregate supply" components, as would the viewpoint of standard Keynesian hydraulics. Expectations of future monetary and fiscal policy can influence current inflationary pressures without changing current real flows of expenditures. In contrast with standard monetarist views, we are treating monetary and fiscal policy symmetrically, emphasizing the point that the price level, the ratio at which government nominal liabilities trade for real commodities, depends on the valuation of the entire portfolio of government assets. The fundamental determinants of the price level do not depend on whether reserve requirements are eliminated or whether privately issued interest-bearing money replaces currency. And of course the entire focus of interest in the paper is on the possible inadequacy of a viewpoint, like that of simple real business cycle theory, which ignores the financial impact of the government on macroeconomic fluctuations.

This "fiscal theory of the price level," or FTPL, point of view has been articulated in a growing stream of recent papers; for example, Ben-Habib, Schmidt-Grohe, and Uribe (1998); Cochrane (1988); Leeper (1991); Woodford (1994 and 1995); Sims (1994 and 1997). While some of this literature has emphasized the possibility of seeing inflation as determined primarily or entirely by fiscal policy, the theory implies that with stable fiscal policy of a certain plausible form, interest rate policy conducted through open market operations can be the main source of government-generated fluctuations in inflationary and deflationary pressures, just as it is in conventional macroeconomic theory. This paper's empirical work pursues this possibility. The distinctive FTPL point of view emerges mainly in the discussion of explanations outside the models estimated, for the behavior the models uncover.

Monetary Policy and the Business Cycle

The reason the importance of monetary policy to cyclical fluctuations remains an unsettled issue is that observed data can offer no simple resolution of it. The money stock, bank reserves, and interest rates reflect events in financial markets, which in turn are sensitive to every kind of important (and possibly also unimportant) influence on the economy. So while these variables are the main levers of monetary policy, we can reach misleading conclusions by simply plotting or regressing measures of economic activity on these "policy variables." Early monetarist empirical research largely did just that, invoking an assumption that the money stock was properly regarded as determined by policy, with response of the money stock to disturbances originating in the private sector less important than independent variation in monetary policy.[4] A plot of interest rates against output over the postwar period shows that interest rate rises preceded each recession. Some economists have taken the view that this leaves no room for doubt or subtlety: Monetary policy must have produced the recessions. But as it has become standard to use multivariate methods of time series analysis to characterize and interpret the data on interest rates, money stock, and business activity, it has become clear that simple bivariate interpretations of the data are misleading. In fact, the most likely interpretation of the data gives independent variation in monetary policy a modest role.

The literature that has reached this conclusion, concentrating mainly on postwar U.S. data, is by now extensive. It has been surveyed recently in Leeper, Sims, and Zha (1996). Rather than repeat that summary, this paper begins by encapsulating the results of the literature in a representative model. The model is constructed with an eye to allowing its extension, with minimal need to change data definitions, to the interwar period. We consider the joint behavior of six monthly time series that can be collected in more or less comparable form for both postwar and interwar periods: industrial production (IP), consumer price index (CPI), currency in circulation (Currency), currency plus demand deposits (M1), Federal Reserve discount rate (Discount), and a commodity price index (Pcomm).[5] All variables are measured in natural log units except the discount rate, which is measured in percentage points.

The use of the discount rate as the interest rate variable does not match most of the literature. Since the persuasive article of Bernanke and Blinder (1992), the most widely used interest rate in studies of monetary policy has been the federal funds rate. However, the federal funds market did not exist at the beginning of the postwar period. The discount window played a more important role at the beginning of the interwar period than it has since, and the discount rate is probably widely regarded as a lagging reflection of monetary policy in recent years. Other interest rates, in particular the 4- to 6-month commercial paper rate, are available over the full period of interest. However, spreads between private and government interest rates were more variable in the interwar period than they have been recently, and the degree to which monetary policy deliberately controlled private short rates was probably lower in

[4] Milton Friedman wrote in 1958, "Changes in the money stock are a consequence as well as an independent cause of changes in income and prices, though once they occur they will in their turn produce still further effects on income and prices. This consideration blurs the relation between money and prices but does not reverse it. For there is much evidence. . .that even during business cycles the money stock plays a largely independent role" (Friedman 1958).

[5] Some of these series required splicing of data from more than one source, so the reader is advised at some point to look at the Appendix describing the data in more detail.

the interwar period. Most of the calculations reported in this paper were carried out both with the 4- to 6-month commercial paper rate and with the discount rate. It is perhaps surprising that the results for the postwar period turn out to be qualitatively unaffected by which rate is used. The fit of the model for variables other than the interest rate is slightly better in the postwar period with the commercial paper rate, but the statistics testing the stability of the model across the postwar sample are slightly better for the version with the discount rate. In the interwar model, use of the commercial paper rate produces estimates that imply a brief, small, but statistically significant positive response of IP to a monetary contraction before the response turns negative. This no doubt reflects some inaccuracy in the identification of the model, and it leads to small anomalies in plots of results. It is for these reasons that the presentation concentrates on results with the discount rate.

The notation for the model is

$$A(L)y(t) = C + \epsilon(t), \tag{1}$$

where y is the $n \times 1$ column vector of variables in the model, A is a polynomial in the lag operator L with $n \times n$ matrix coefficients A_i on the L^i, C is a vector of constants, and ϵ is a vector of random disturbances, serially uncorrelated, uncorrelated with ys dated earlier, and with the correlation matrix the identity. This notation is a little different from that most common in the literature, in that it normalizes none of the coefficients in A_0 to one, and correspondingly normalizes the variances of the disturbances ϵ to one. Models with different A polynomials that have the same values of the reduced-form coefficient polynomial $B(L) = A_0^{-1}A(L)$ and the same value of the reduced-form residual covariance matrix $\Sigma = A_0'A_0$ imply the same distribution for the data.

The model follows the existing literature in assuming a delay of at least one month in the impact of interest rate changes on the private sector behavior that determines a block of variables including IP and CPI. The contemporaneous correlation of interest rate changes with economic activity tends to be positive; this assumption rules out the possibility that this positive correlation might arise from a positive effect of monetary contraction on business activity. The assumption is justified by the argument that the behavior of individual consumers, workers, and businessmen that determines industrial production and final goods prices does not involve continuous, sharp, finely calculated responses to market signals. This is to some extent due to technologically determined inertia, but probably more importantly to the lack of sufficient computational capacity on the part of individuals to make such continuous readjustments. Short-term fluctuations in money market rates are not an important day-to-day influence on most nonfinancial economic decisions, not because people cannot look up the federal funds rate in the newspaper or because it would be very difficult or expensive to react, but because people have too much else of greater personal importance absorbing their attention.[6]

The model differs from most previous literature, and follows Leeper, Sims, and Zha (1996) in including the money stock, and in this model also currency, in the block of variables determined within the sluggish sector. The usual money demand or liquidity preference relation is derived as an arbitrage relation connecting returns on bonds to the implicit yield on money balances. The derivation does not imply any lag in the relation. In treating currency and money this way, therefore, we are precluding a conventional money demand equation with no lags. However, the same reasoning that justifies assuming sluggishness in the reaction of IP and CPI to financial market signals implies that we should expect similar delay in the reaction of individuals and businesses to financial signals that imply they should deliberately change holdings of cash and demand deposits. Such holdings can of course react instantly to changes in flows of income and expenditure—to the same disturbances, in other words, that act on IP and CPI. Other models in the literature have produced reasonable results allowing for a money demand equation that includes a contemporaneous interest rate term. But it is difficult to justify a claim that disturbances to the aspects of private behavior that determine the money demand arbitrage relation should be unrelated to other shocks to private sector behavior. If money demand shocks are related to other shocks to private behavior, then the appearance of the interest rate in "money demand" must make it appear in all equations of the sluggish block, and this undermines identification.

An identifying restriction that is particularly important in extending the model to the interwar years is that the behavior of the Federal Reserve does not react within the month to IP or CPI. This does not mean that the Federal Reserve is assumed not to care about these variables. It simply reflects the fact that information on these variables is not available within the month. The specification does allow reaction by the Fed to these variables with a month's delay, and it allows contemporaneous reaction of the Fed to currency and M1, which the Fed monitors via its regulatory role, and to Pcomm, which reflects publicly known prices in continuously functioning auction markets.

The pattern of restrictions we have discussed can be displayed in the matrix shown here as Table 1. In this table, Xs represent unconstrained coefficients in A_0, 0s represent coefficients constrained on the basis of behavioral reasoning, as given above, and $-$s represent coefficients

[6] In Sims (1998a), I develop an argument that we should expect all reactions of individuals to external signals to behave, to a linear approximation, like relations that involve both lags (apparent inertia) and idiosyncratic random errors.

Table 1
Identifying Restrictions

Equations	Variables					
	IP	CPI	Currency	M1	Discount	Pcomm
IP	x	—	—	—	0	0
CPI	x	x	—	—	0	0
Currency	x	x	x	—	0	0
M1	x	x	x	x	0	0
Policy	0	0	x	x	x	x
Pcomm	x	x	x	x	x	x

constrained to zero as normalizations. Note that the first four equations, represented by the first four rows of the table, are distinguished only by normalizing restrictions. They do not have distinct behavioral interpretations. Only the block of four equations, representing sluggish components of private sector behavior, has an interpretation. The last row represents the reaction of commodity prices, in continuously clearing markets, to all current information.

The restricted matrix is almost, but not quite, in triangular form. Furthermore, it has only 20, not 21 free coefficients, meaning that the *A* polynomial has one less coefficient than the unrestricted reduced form model. Iterative methods are therefore required to estimate the model, but they can be executed quickly and reliably.[7]

Postwar Results

The Patterns of Response to Policy and of Policy

When this model, with the order of *A* (the number of lags) set to seven, is estimated over the full 1948:8 to 1997:10 sample period, the result implies the pattern of responses to behavioral disturbances displayed in Figure 1. Each small graph shows the pattern of response of the variable that labels its row to the disturbance that labels its column. The center line is the estimated response itself, and the upper and lower lines

[7] The estimation also uses stochastic prior information, rather than ad hoc setting to zero of insignificant coefficients, to control the bad effects of estimating so many free coefficients at once. The methods are based on ideas in Sims and Zha (1998a), although here they can be implemented entirely with "dummy observations," making the calculations simpler than those described in that article.

Figure 1
Responses to Identified Shocks, 1948:8 to 1997:10

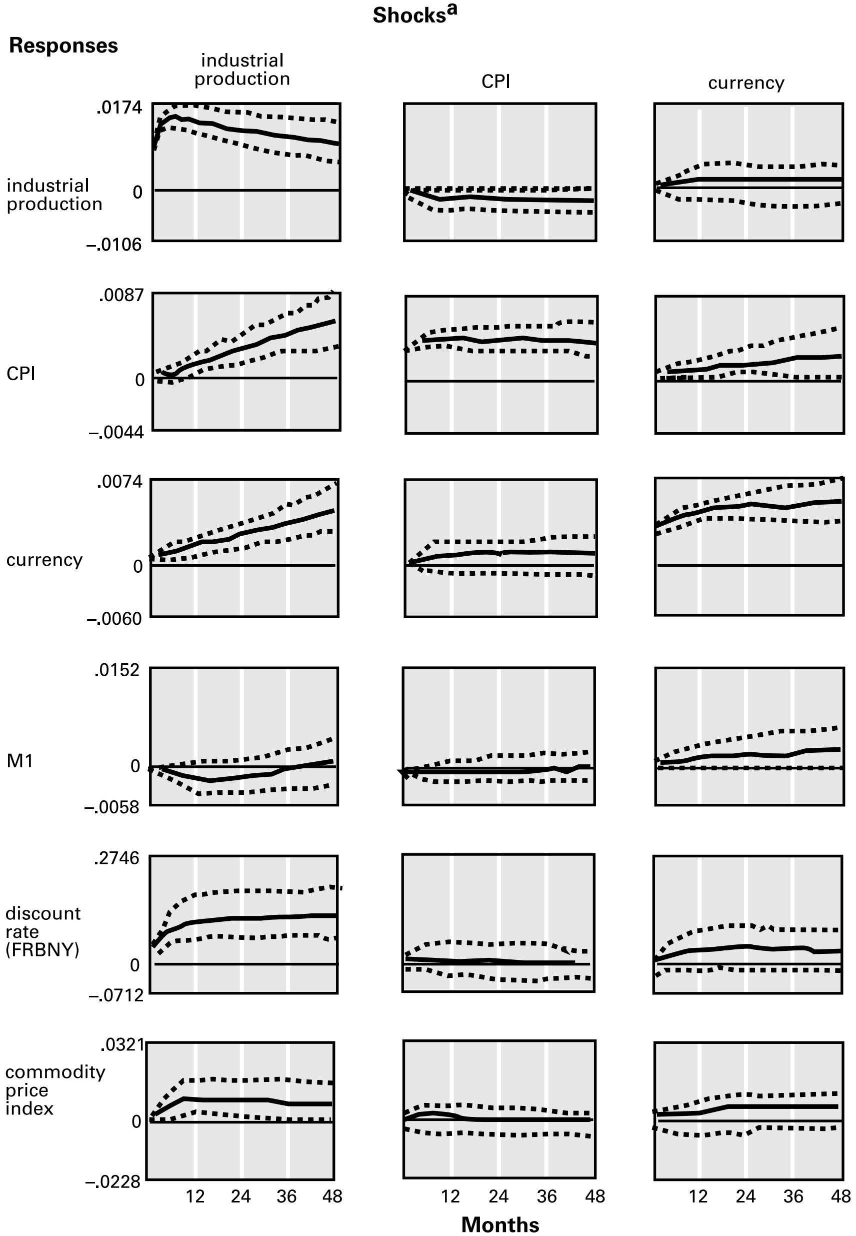
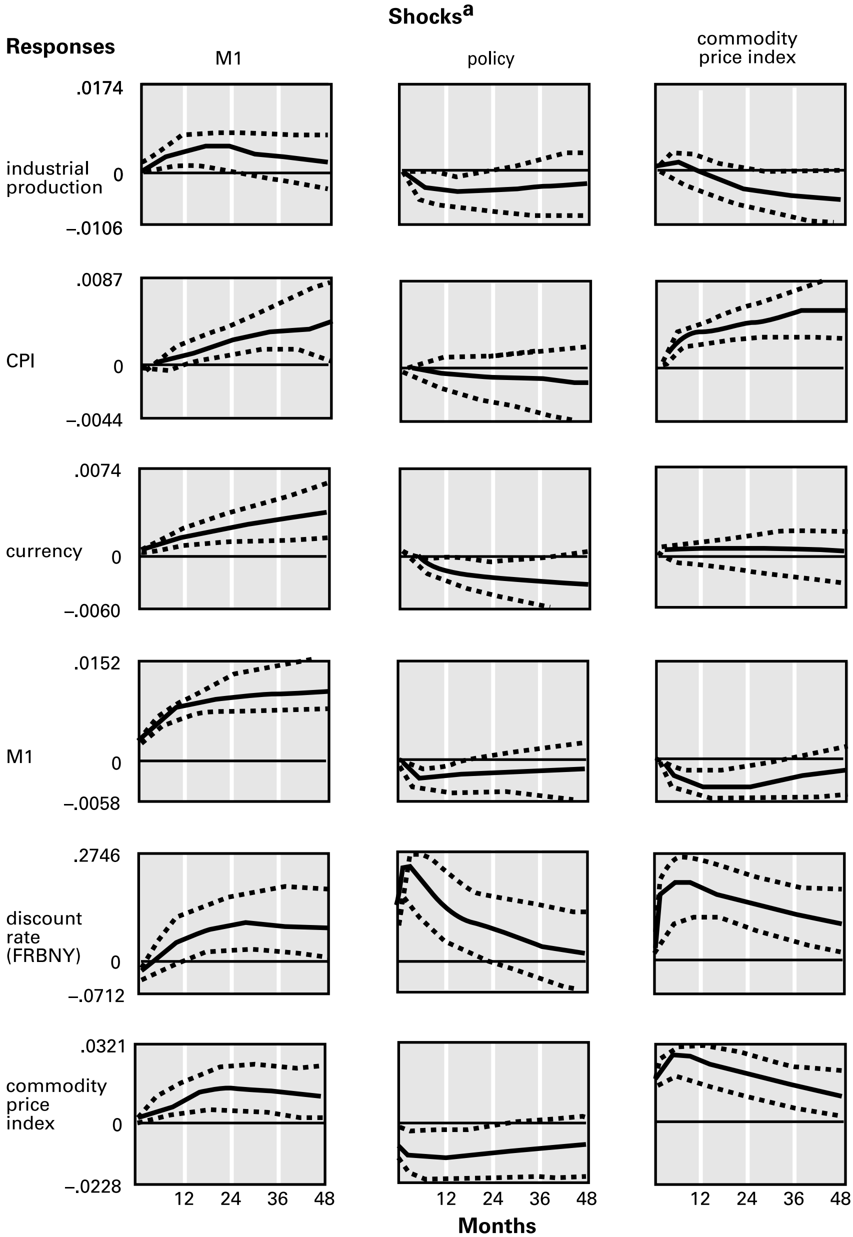


Figure 1, continued
Responses to Identified Shocks, 1948:8 to 1997:10



[a] Each shock represents a 1-standard-deviation disturbance in the corresponding equation, with the equations defined by the rows of Table 1.
Note: See the text and the Data Appendix for descriptions of the series. All variables are measured in natural log units except the discount rate, which is measured in percentage points. Upper and lower lines in each graph define 90 percent probability bands for the responses.

define a 90 percent probability band for the responses.[8] The column labeled "policy" shows the response of the rest of the economy to a typical (one-standard-deviation) disturbance in the policy equation. It displays a pattern of responses that is familiar from the previous literature. Interest rates rise and then slowly begin drifting back toward the mean. Currency and M1 both fall and remain low. Commodity prices and CPI both decline, with the decline in CPI small and delayed, while that in Pcomm is substantial and immediate. IP falls and returns very slowly toward trend. The error bands show that there is substantial uncertainty about the magnitude of the responses to policy, and in the case of the CPI response, even about the sign of it.

Looking across a single row in the figure, the relative sizes of the plotted responses show the relative importance of the sources of disturbance labeled in the columns in generating variation in the variable labeled in the row. We see from the discount rate row that policy shocks produce the largest impact on the interest rate, but that others, particularly the Pcomm shock, the IP shock, and the M1 shock, are cumulatively more important in generating interest rate variation. That is, though policy disturbances account for a substantial fraction of variation in interest rates, particularly in the short run, most variation in them is generated by systematic responses to disturbances originating outside the policy equations. Furthermore, the system implies a distinctly active response of policy to disturbances that imply inflationary pressure. The three non-policy shocks that imply interest rate increases also are the three that imply the largest increases in expected future CPI inflation and in current and expected future Pcomm levels.[9] In the case of Pcomm shocks, the rise in interest rates is sufficient to produce a decline in the money stock in the face of the inflationary pressure, and in the case of IP shocks, the interest rate rise is sufficient to hold the money stock essentially constant in the face of a rise in output and prices. The M1 shock does not show such a strong restrictive response to inflationary pressure. Interest rates rise, but only with a delay, and M1 rises substantially. This looks like what might be expected if monetary policy partially accommodated an expansionary disturbance originating elsewhere, for example, in an increased current or expected future fiscal deficit.

[8] The bands are computed as Bayesian posterior probability bands, using the approach described in Sims and Zha (1998b), except that the Monte Carlo simulations used the adaptive Metropolis-Hastings algorithm described in Sims (1998b). The bands were constructed from a 500-element subsample of 5,000 iterations of the simulation algorithm, which had an effective sample size of about 500.

[9] CPI shocks, which do not generate a strong interest rate response, account for a substantial part of variation in the level of CPI but they move the level in a single step, without implying much expected future inflation.

Stability of Behavior Over Time Within the Postwar Period

The rhetoric of monetary policy debate has certainly changed over the 1948–97 period. Attempts to model the behavior of monetary authorities over this period (including the attempt represented by this paper's model) can find statistically significant changes in behavior. The Lucas critique has conditioned many macroeconomists to think in terms of "regime shifts" as the only internally consistent way to think about improving policy, and hence to look for them statistically.[10] Why then does this paper present results from a fixed-coefficients linear model fit to the entire 1948–97 period?

Several arguments favor sticking with a fixed model for the period.

- Tests for shifts in regime based on conventional significance levels are inconsistent, in the technical econometric sense. This is not a strong argument here, since we do not actually believe in a literally fixed model. Nonetheless, the problem is symptomatic of a broader problem with conventional tests—in large samples, they will reject the hypothesis of parameter constancy even in cases where the parameter changes detected are trivially small.
- Shifts in policy rule of modest size, sustained over only a few quarters or years, may have been quite non-random from the point of view of some participants in the policy process at the time, or from the point of view of ex post statistical analysis, while still having been perceived as unpredictable randomness from the point of view of economic agents.
- As always in statistical modeling, we face a trade-off of bias versus precision. The more complex a scheme of variation in policy behavior parameters we allow for, the less precise can be our estimates of that scheme. We may be sure that a fixed model is not the absolute truth, while believing that nonetheless its bias is small enough that we would obtain worse results with a model that allowed for shifts in policy behavior.
- Using statistical criteria that explicitly gauge the trade-off of bias with precision and overcome the inconsistency problem in conventional statistical tests, we conclude that models that allow no change in parameters are preferred.

The quantitative evidence is as follows: Comparing the fit of a single model fit to 1948–97 with that of two separate models, in which all parameters, including the residual covariance matrices, are fit to the separate periods 1948:8 to 1979:6 and 1979:7 to 1997:10, twice the

[10] Macroeconomists who think this way are mistaken. See the section below, "What about the Lucas Critique?"

difference in log likelihoods (a statistic we will here call *S*) is 849.3379. The difference in numbers of free parameters is 279. Conventional statistical tests, based on asymptotic theory and using a 5 percent significance level, would certainly reject the null hypothesis of no change in parameters. The Akaike criterion, which aims at improving forecast performance but does not overcome the inconsistency of conventional tests, rejects for *S* exceeding twice the degrees of freedom, which would here be a threshold of 558. The most widely used consistent model selection criterion is the Schwarz criterion, which compares *S* to degrees of freedom times log of sample size; here it leads to a threshold of 1780, so that the fixed model is strongly favored. Another consistent criterion, which favors smaller models less strongly than Schwarz's, is the Hannan-Quinn criterion. It compares *S* to the degrees of freedom times twice log(log(sample size)) and here leads to a threshold of 1034, again strongly favoring the fixed model.[11]

That consistent model-selection criteria favor a fixed model is all the more remarkable given that the tests allow for changes in disturbance variance as well as changes in the coefficients themselves. Monetary policy from late 1979 through 1982 was announced as allowing for increased variation in interest rates, and the variance of changes in interest rates, including the discount rate, was indeed much higher in this period than in the rest of the postwar period. But this in itself does not imply a change in the shape of any of the responses plotted in Figure 1. In fact, it could be accounted for simply by increasing the variance of the disturbance to the monetary policy equation (which would imply increasing the relative size of the policy column of Figure 1 during this period, without changing its shape or that of other columns). If we allow for a change in the variance of the policy equation disturbance in this period, while otherwise holding model parameters fixed, it is likely that we would account for most of the evidence of parameter change in the data without requiring any alteration of our conclusions on the shapes of policy responses.

It might be supposed that, since the 1979–82 period was so clearly unusual, it would be better to simply omit those years in fitting the model

---

[11] For more discussion of these criteria, see, for example, Lütkepohl (1991, section 4.3). In constructing these statistics, the model was estimated in reduced form and the stochastic prior information used in constructing the estimated responses was not used. Because of the tendency of models estimated without use of stochastic prior information to be biased toward stationarity and to imply excessively accurate long-run predictions from sample initial conditions, testing for sample breaks this way is problematic. However, use of prior information would probably reduce, not increase, evidence of differences across subsamples. If data on the commercial paper rate replace data on the discount rate, the twice-log-likelihood-difference statistic becomes 969, which still gives the same conclusion by both the Schwarz and the Hannan-Quinn criteria, though it is somewhat less strongly in favor of the fixed model than are the results with the discount rate.

and to make our checks for parameter stability omitting those years as well. But these years, precisely because they showed so much variability in interest rates, provide strong evidence on the effects of monetary policy. Omitting them substantially increases the uncertainty in estimates of the model. The best procedure would be to weight the observations for the policy equation lower in this period, in proportion to the higher variance of the period, while still using all the data, but we proceed with estimates that simply use the full sample without weighting.

Interwar Results

Applying the same set of identifying restrictions to the interwar period 1919:8 to 1939:12, we find the responses displayed in Figure 2. The column corresponding to the effects of policy disturbances is qualitatively very similar to that in Figure 1. Note, though, that the scale on the output, CPI, and currency rows is more than double the scale on the corresponding rows for the postwar Figure 1. Because this period is shorter, the error bands are somewhat wider than for Figure 1.

Output shocks in the interwar period educed a much more accommodative response of monetary policy than did the smaller corresponding shocks in the postwar period. In the later period, a typical-sized output shock of about 1.5 percent generated an increase in the discount rate within a year of about 13 basis points. This was enough to keep M1 from increasing at all, and to keep the rise in commodity prices to about 1.3 percent. A corresponding shock in the interwar period raised output by 3.8 percent within the year, yet produced a rise in the discount rate of less than 5 basis points. This was reflected in M1's expanding with output, by about 1 percent, and in greater inflation, measured both by commodity prices and especially by the CPI.[12]

An especially interesting difference between the periods shows up in the currency shock column. Interwar currency shocks moved currency and M1 strongly in opposite directions, and the discount rate followed currency, not M1. Periods when people converted bank deposits to cash, corresponding to periods with positive currency shocks, reflected worries about the solvency and liquidity of the banking system. It is noteworthy that interwar monetary policy apparently accelerated the shrinkage in money by tightening—raising the discount rate—as deposits were draining out of the banking system.

To disturbances other than currency shocks, responses of the discount rate were generally smaller and more delayed in the interwar

[12] Bear in mind that this is a linear model, so it makes no distinction between increases and decreases. In the interwar period, monetary accommodation was of course often accommodation of recession and deflation, not of growth and inflation.

Figure 2
Responses to Identified Shocks, 1919:8 to 1939:12

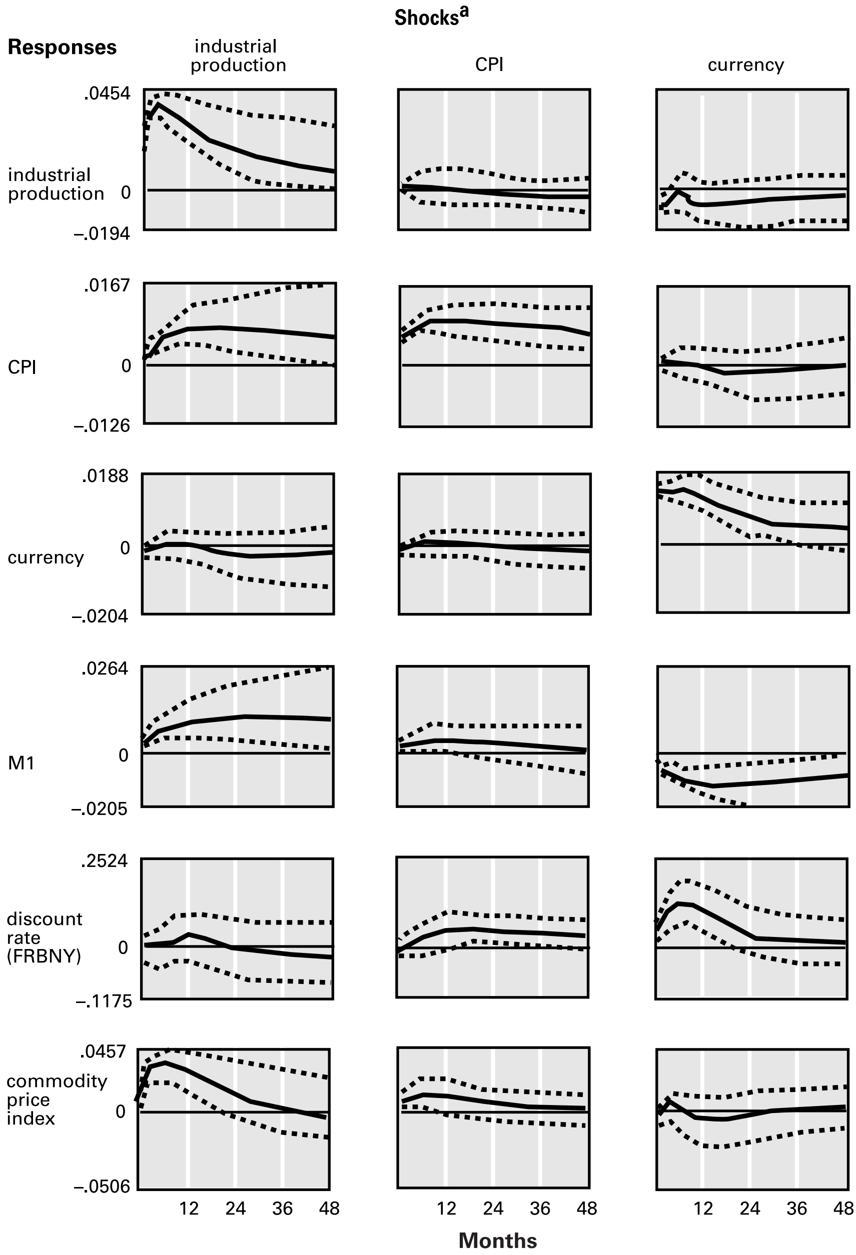
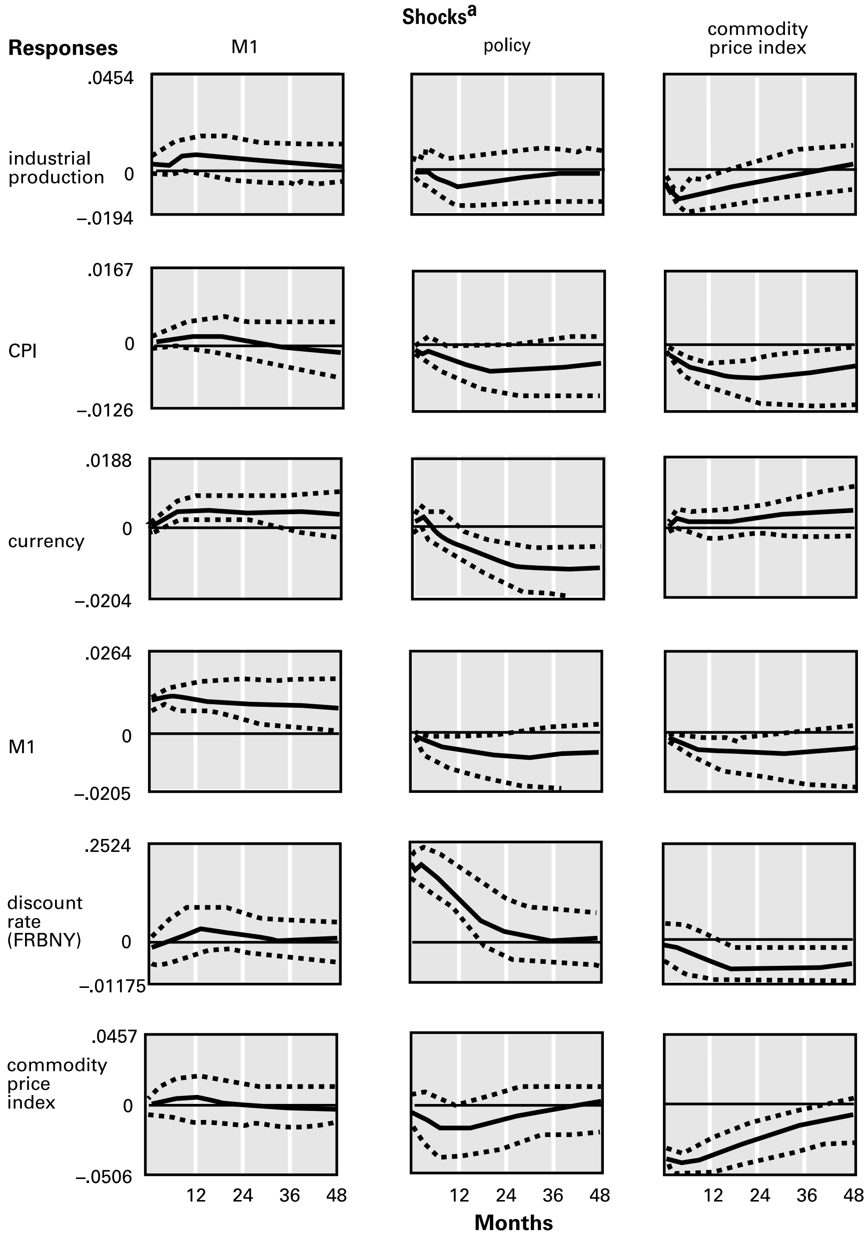


Figure 2, continued
Responses to Identified Shocks, 1919:8 to 1939:12



[a] Each shock represents a 1-standard-deviation disturbance in the corresponding equation, with the equations defined by the rows of Table 1.
Note: See the text and the Data Appendix for descriptions of the series. All variables are measured in natural log units except the discount rate, which is measured in percentage points. Upper and lower lines in each graph define 90 percent probability bands for the responses.

Table 2
48-Month Horizon Variance Decomposition, 1948–79

	IP	CPI	Currency	M1	Policy	Pcomm
IP	79%	1%	1%	5%	6%	8%
CPI	20%	21%	4%	19%	1%	35%
Currency	19%	1%	53%	14%	13%	1%
M1	1%	0%	5%	83%	3%	8%
Discount	26%	0%	3%	11%	22%	37%
Pcomm	13%	1%	1%	17%	19%	50%

Note: Numbers may not add to 100 because of rounding.

period, despite the large sizes of the shocks as measured by their effects on other variables.

The Contribution of Monetary Policy to Fluctuations

We can see directly from Figures 1 and 2 that the proportion of variability in IP in either period that is accounted for by disturbances in monetary policy is estimated as small. This follows from the fact that in the first row of the figures, all responses are much smaller in magnitude than the responses to IP shocks themselves. We can summarize what can be seen from the figures by allocating to the sources of disturbance the variance of forecast errors in all variables over the four years displayed in the figures. These allocations are summarized in Table 2 and Table 3. Each row of these tables sums to 100 percent, and shows where variation in the variable labeling the row originated during the period. Industrial production is accounted for mainly by its own disturbances in both periods. The discount rate is accounted for more by responses to variables other than policy than by policy disturbances in the postwar data, but the reverse is true in the interwar data.

Table 3
48-Month Horizon Variance Decomposition, 1919–39

	IP	CPI	Currency	M1	Policy	Pcomm
IP	83%	1%	4%	3%	3%	7%
CPI	30%	41%	0%	1%	10%	17%
Currency	3%	0%	44%	7%	43%	2%
M1	29%	1%	23%	26%	11%	9%
Discount	1%	9%	20%	2%	53%	15%
Pcomm	30%	4%	1%	1%	8%	57%

Note: Numbers may not add to 100 because of rounding.

Results like this do not of course directly imply that monetary policy is unimportant to cyclical fluctuations. They imply only that unpredictable variation in monetary policy has been unimportant. It could be true that monetary policy has been highly systematic and predictable, yet also that it could have greatly changed the pattern of fluctuations if it had taken a different course. We can use this model to gain some insight into how the economy's behavior might have differed, had monetary policy been systematically different. Indeed, we have seen that there are notable differences in the way the discount rate responded to the state of the economy in the interwar and in the postwar periods. The differences are largely in the direction that most economists would agree improves monetary policy: In the postwar period, interest rates rise more quickly and sharply in response to disturbances that predict inflationary pressure, and there is less tendency for the discount rate to rise when the public starts to substitute cash for deposits. At the same time, fluctuations have been smaller in the postwar period. Maybe the changes in the systematic behavior of monetary policy have been responsible for some of the improvement.

The modeling framework used here allows us to answer this question directly. We do so by excising the monetary policy equation of the system, the fifth row of the set of dynamic equations displayed in (1), from the model of one period, transplanting it into the model for the other period as a replacement for the original policy equation of that model, and observing how the resulting chimera behaves.[13]

Replaying the Great Depression with Postwar Monetary Policy

Consider first the outcome of sending an average of Arthur Burns, Paul Volcker, and the like back in time, to manage the Federal Reserve System in the '20s and '30s. The impulse responses of the grafted system are displayed in Figure 3, alongside the originally estimated responses for the 1919–39 period.

Changing the policy equation has a noticeable, if not large, effect. CPI and M1 respond less to IP shocks and to commodity price shocks with the postwar policy, while currency responds more. However, the effect on IP's responses to shocks is very small. IP shocks have a slightly less persistent effect on IP with the postwar policy. Perhaps surprisingly, the postwar policy behavior raises interest rates following an interwar currency shock, just as did the actual interwar policy. The increase in

[13] In doing this, we are subject to the "Lucas critique." The reflex reaction of many economists that this makes such exercises internally contradictory or misleading is mistaken. We take up this point at more length below. In the meantime, the reader is urged to proceed to see how interesting the results are before assessing whether they must be dismissed on doctrinal grounds.

Figure 3
Responses: 1919 to 1939 Model, Actual and Counterfactual

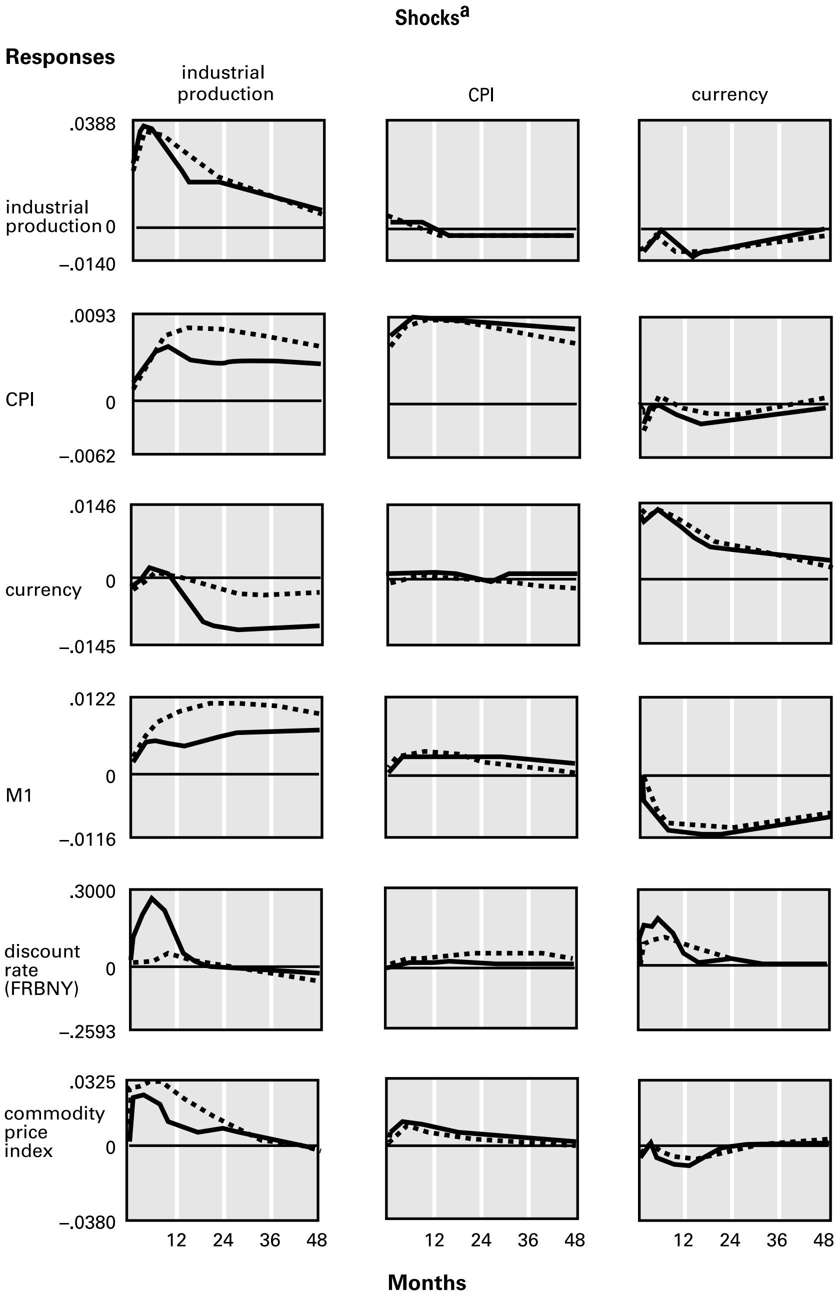
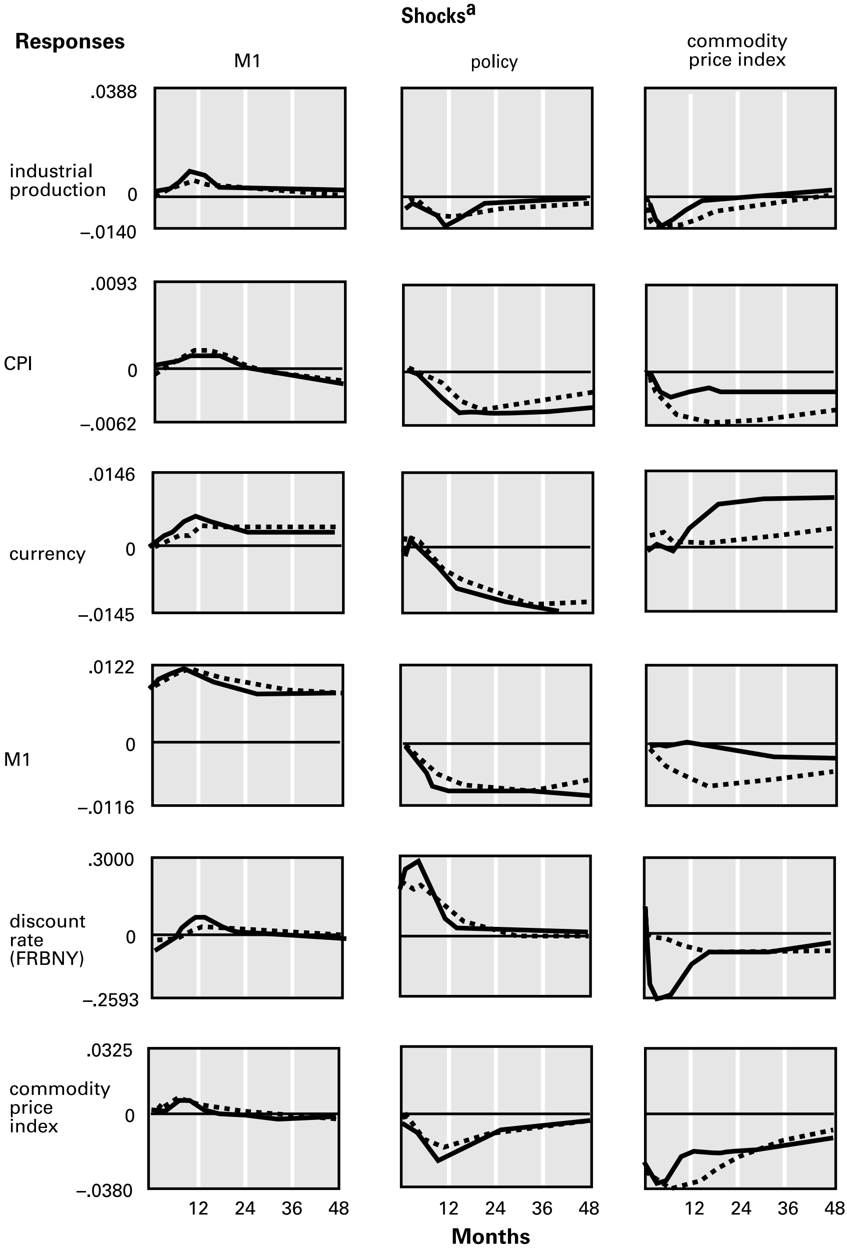
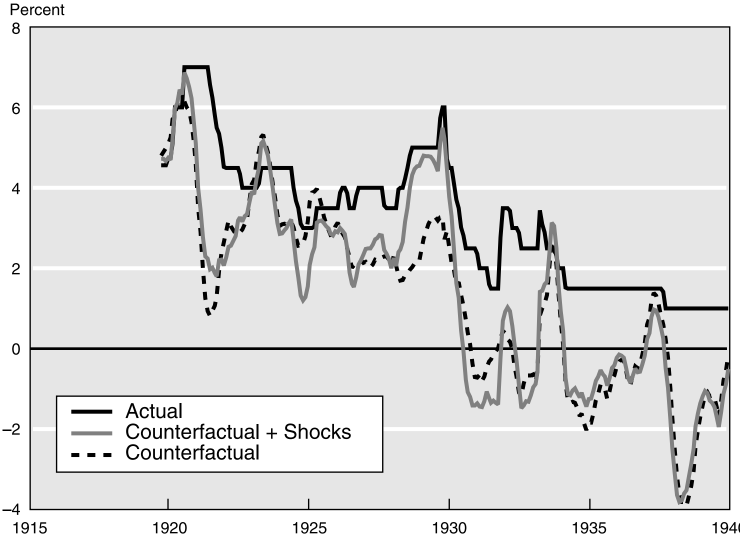


Figure 3, continued
Responses: 1919 to 1939 Model, Actual and Counterfactual



[a] Each shock represents a 1-standard-deviation disturbance in the corresponding equation, with the equations defined by the rows of Table 1.
Note: The solid lines use the 1948-97 policy reaction function in the 1919-39 model, while the dotted lines match Figure 2, the original estimated responses for the 1919-39 model.

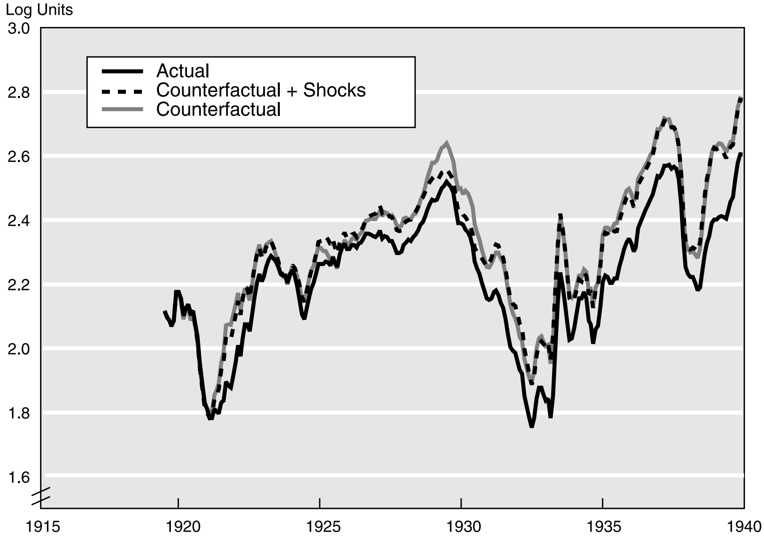
Figure 4
Interwar Discount Rate, Actual and Counterfactual



discount rate following this shock is less persistent than it was in the actual interwar data, but this does little to dampen the outflow of deposits as currency increases.

What would have been the historical outcome if these responses had characterized actual interwar monetary policy? We can answer that question by feeding the actual historical initial conditions and shocks through our 1919–39 "chimerical VAR." Because the variables in the system are in some cases indexes whose base years do not match across the two periods, the constant term in the policy equation requires adjustment, and there is no unique best way to choose the adjustment. The results we present choose the constant so that when current and lagged values of all variables are set at their means over the 1919:1–7 initial conditions period, the policy equation has a zero residual. This leads to simulations in which, as in Figure 4, the discount rate becomes negative after 1930. By choosing a somewhat higher constant term, the counterfactual discount rate can be kept positive. We present the results with the discount rate going negative because with the higher constant term, and thus tighter monetary policy, the differences between actual and counterfactual IP paths are smaller. Since the differences are remarkably small even when the non-negativity bound is ignored, we show these results to underline the model's implications for the limitations of monetary policy in counteracting the forces that generated the Great

Figure 5
Interwar Industrial Production, Actual and Counterfactual

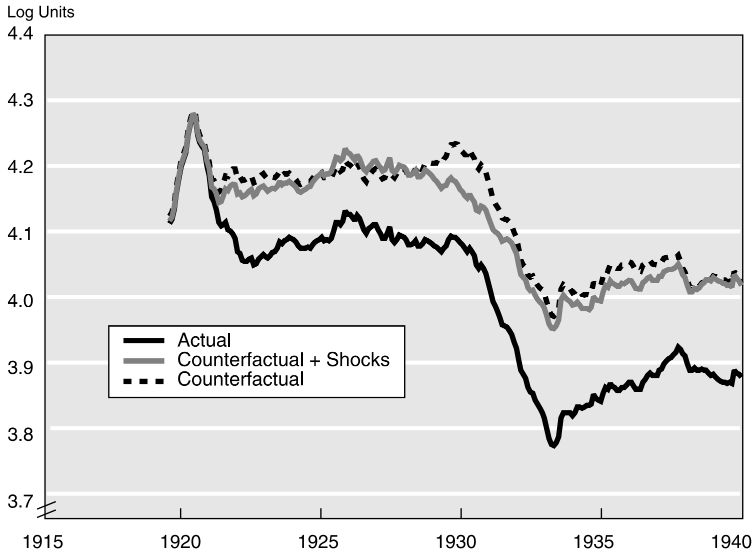


Depression. Each of the Figures 4 through 9 shows three lines—actual data, simulated data using the postwar policy behavior function and no disturbances, and simulated data using the postwar policy behavior function with the disturbances from the original 1919–39 policy behavior function.

With postwar policy, the discount rate would have dropped sharply during the 1920–21 recession, and the model implies that this would have somewhat accelerated the recovery of production and sharply curtailed the associated decline in the price level and the money stock. The discount rate would have dropped more sharply during 1929 and 1930 at the onset of the Depression, according to the simulation that includes policy disturbances, and by about the same amount as the actual discount rate decline according to the simulation without policy disturbances. The simulations imply, adjusted for the fact that interest rates cannot in fact be made negative, that discount rates would have been at approximately zero throughout the 1930–39 period. Note, though, that the rise in rates in September 1931, associated with Britain's departure from the gold standard, is partially reproduced in the results without policy shocks. The rise is not so great, and starts earlier, but it is still there.

Figure 5 shows that the (infeasibly) greater ease of the simulated monetary policy is implied to have increased the level of output at the end of 1939 by about 18 percent compared to the actual outcome, adding

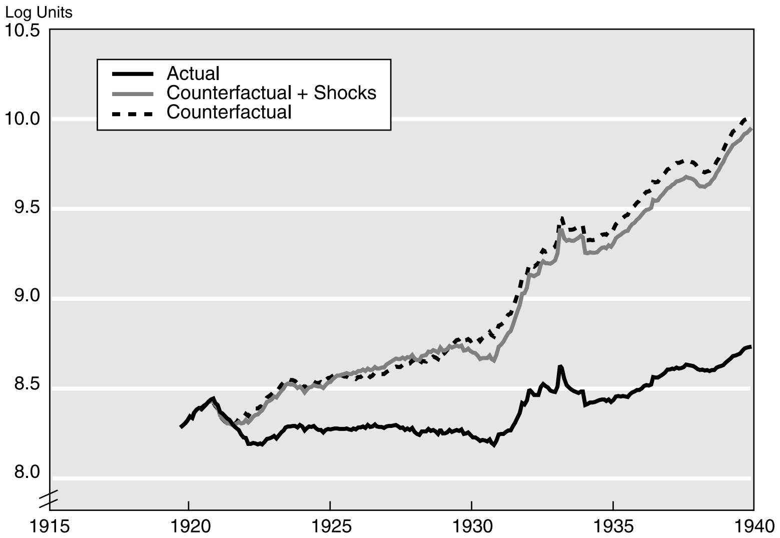
Figure 6
Interwar CPI, Actual and Counterfactual



about 1.2 percent per year to the mean growth rate over the 1924–39 period. However, it should be borne in mind that the statistical accuracy of the model deteriorates at long horizons. Thus, this effect on the long-term growth rate is very uncertain, with a zero effect quite possibly within a reasonable error band. When we consider the effects of the postwar policy on the cyclical movements within the period, we see very modest changes in the path of IP. The drop in IP from 1929 to 1933 is completely unaffected by the altered monetary policy. Recovery from 1933 to 1937, the renewed recession thereafter, and the recovery again through 1939, all reappear in roughly the same form and magnitude despite the altered monetary policy.

The postwar policy would have cut short the 1920–21 deflation, and it would have moderated the decline in CPI between 1929 and 1933, as can be seen from Figure 6. In the 1929–33 period the CPI decline would have been about 20 to 25 percent, instead of 30 percent. Figure 9 (below) shows that the 1920–21 decline in commodity prices would, like that in the CPI, have been cut short by postwar monetary policy. But after that period, the postwar monetary policy makes little difference to the time path of interwar commodity prices. Currency and money supply growth would have been substantially greater, as can be seen from Figure 7 and Figure 8, but the cyclical pattern of the movements in these two simulated series remains close to that of the series' actual paths.

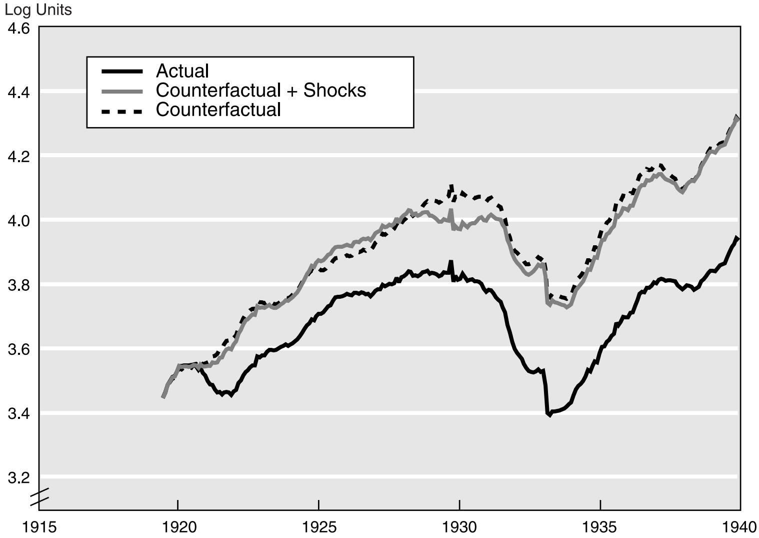
Figure 7
Interwar Currency, Actual and Counterfactual



The results taken together imply that postwar policy reactions would have reproduced much of the cyclical pattern in interest rates and money stock that actually occurred. Postwar policy reactions might well have led to a less restrictive monetary policy on average over the period (as in our simulations), but greater policy ease would have had only modest effects on the path of prices and even more modest effects on the path of output, despite substantial effects on the long-term growth rates of money and currency.

These results, it must be remembered, treat all disturbances that arise from crises of confidence in the banking system or speculative pressure on gold reserves as non-policy disturbances. Bernanke (1983) has pointed out that bankruptcy and bank failure seem to have played a role in the propagation of the Great Depression beyond what can be accounted for by their effects on the money stock. The calculations here suggest that movements in interest rates and the quantity of money in themselves may have been rather unimportant, but they leave Bernanke's arguments in full force. In fact, it might well be argued that if monetary policy had succeeded in expanding currency and deposits as rapidly as is assumed in this paper's counterfactual simulation of the interwar period, at least some of the bank failures of the '30s might have been avoided. Large-scale bankruptcies and bank failures do not occur in ordinary times, so to a linear model they appear as external disturbances, but they might in fact have been dampened by a persistent commitment to monetary ease.

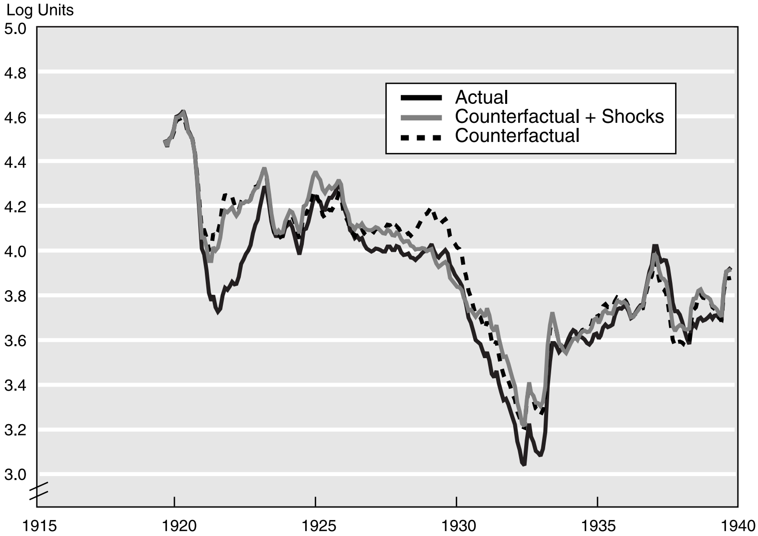
Figure 8
Interwar M1, Actual and Counterfactual



But would a policy of ease of the sort simulated here have been feasible? And would it have been monetary policy? The simulations show that to inflate the growth of money would have required pushing the discount rate down to about zero. Furthermore, it would have required convincing banks to expand. When interest rates on the securities it buys in open market operations have reached zero, a central bank's open market operations cease having any effect on the private sector's overall portfolio: They simply replace one non-interest-bearing government liability with another. Banks were holding large amounts of reserves at this time. It seems unlikely that they would have made much of a distinction between holding non-interest-bearing deposits with the Federal Reserve System and holding non-interest-bearing government securities.

To affect bank behavior, the Federal Reserve would have had to open the discount window, and to do so systematically. That is, it would have had to offer to discount bank loans at an attractive rate and to do so in a way that would attract banks to the discount window on a large scale. It is true today that discounting of bank assets by government agencies, when carried out on a case-by-case basis and subject to a determination of "need," cannot attract large-scale use by banks because it becomes a signal of financial distress. This was true also, and probably to an even greater extent because of the widespread concern about bank solvency,

Figure 9
Interwar Commodity Prices, Actual and Counterfactual



during the Great Depression.[14] We have seen that in fact the tendency was to increase the discount rate in the face of disturbances that tended to increase currency and shrink deposits. This behavior, I would argue, is not a simple mistake, but arises naturally when the central bank is reluctant to or legally forbidden to take on essentially fiscal commitments. Open market operations in short-term government securities denominated in dollars have no appreciable effects on the risk characteristics of the central bank's portfolio. Acquisition of rediscounted private sector loans at a time when the economy is declining and concern about bankruptcy is widespread is in this respect quite different, and was certainly understood to be different at the time of the Great Depression. At least potentially, it presents a substantial risk of losses. To undertake such risk without undermining confidence in the central bank itself, the central bank must have fiscal backing. That is, it must be understood that, were there to be substantial losses on the private assets being acquired, the central bank would be kept solvent by government budgetary action.[15]

[14] See Friedman and Schwartz (1963, p. 325), for example.

[15] The recent international monetary crises have brought this point sharply into relief in some cases. For example, in the 1994 peso collapse in Mexico, the central bank discounted a large quantity of bank debt that proved to be bad. In 1998, there is a political struggle over

That in a deflationary crisis the line between monetary and fiscal policy blurs is not an accident, but a reflection of a general principle. Starting with Leeper (1991), the literature on the fiscal theory of the price level has brought out the interdependence of monetary and fiscal policy regimes in guaranteeing a unique price level. One combination of regimes, labeled "active money, passive fiscal" by Leeper and "active money, Ricardian fiscal" by Woodford, involves a commitment by the monetary authority to raise nominal interest rates by enough to raise real interest rates when inflation rises, accompanied by a commitment by the fiscal authority to increase primary surpluses via taxation or expenditure reduction by more than enough to cover the increased interest expense implied by the rise in nominal rates. In such a pairing of regimes, the price level is determined by monetary policy, in the sense that stochastic shocks to the monetary policy rule have a direct impact on prices, while stochastic shocks to the fiscal rule have no effect on prices. It seems that this kind of pairing of regimes characterizes most advanced economies most of the time.

However, as Ben-Habib, Schmidt-Grohe, and Uribe (1998) have recently emphasized, this pairing of regimes does not deliver global uniqueness of the price level. The commitment by monetary authorities to raise rates when inflation advances must be matched by a corresponding commitment to lower them when inflation recedes, and to lower them further when inflation is replaced by deflation. So long as one component of the government debt is non-interest-bearing currency, it will not be possible to make nominal interest rates negative. But this means that if events force the monetary authority, following its "active" rule, into near-zero-interest-rate territory, it must eventually lose its ability to move rates in the same direction as inflation and by enough to lower real rates as inflation declines. The passive or Ricardian fiscal policy that couples with an active monetary policy to deliver a determinate price level becomes a source of indeterminacy in circumstances where the monetary authority has lost the ability to respond strongly to changes in inflation with changes in interest rates. Determinacy of the price level when monetary policy is forced to leave the nominal rate fixed requires a fiscal commitment to keep the real primary surplus insensitive to changes in the real value of outstanding government debt. If all interest rates, including long rates, fell to zero, this would mean no more than that the budget surplus should not increase with deflation. But long rates are

---

the fiscal measures needed to cover this transaction, and the delay in resolving it is causing continued difficulties for the banking system. This seems to have been an instance where the central bank acted on the assumption that it had fiscal backing, the fiscal backing has since come into doubt, and the result is that the original effect of increasing confidence in the banking system is being partially unraveled. (See *Business Week*, June 22, 1998, p. 62.)

likely to remain positive even if short rates are driven near to zero.[16] The required fiscal commitment then is that the conventional deficit should increase with deflation by more than enough to offset any rise in the real value of interest expenditures due to deflation. Putting the matter more broadly, in a deflationary crisis the problem is that government liabilities in general are too attractive relative to private sources of wealth. Countering the deflation requires policy action that decreases the expected return on government liabilities. Budget deficits, or reduced surpluses, if perceived as a permanent change in fiscal policy, can accomplish this. Open market operations in government securities cannot.

A related exercise was undertaken by McCallum (1990). He concludes that a monetary base rule could have largely eliminated the Great Depression. The difference in results comes from several sources. He deliberately refrains from modeling prices and real output separately, concentrating entirely on whether nominal GNP could have been kept stable. The model estimated in this paper implies stronger influence of monetary policy on prices than on output for the interwar period. McCallum also uses a model with simple dynamics and strong a priori restrictions. Most important, his model includes no recognition of the fact that monetary policy reacts to the state of the economy, and that this should affect the interpretation of estimated regression equations.

Replaying Postwar History with Interwar Monetary Policy

The interwar period involved such large cyclical disturbances that the relatively modest effect of changing the monetary policy rule on the implied outcomes for that period may not be representative of the effect of changing policy rules in more stable periods. It is therefore interesting to reverse the experiment of the previous section, replacing postwar monetary policy with interwar policy in the postwar model.

Figure 10 shows the effect of the change on responses to disturbance. The change in the way the discount rate responds to non-policy disturbance is substantial. IP, M1, and Pcomm disturbances, all of which imply future inflation, produce interest rate responses of the same sign with the interwar function as with the postwar reaction function, and after several years the responses achieve similar magnitudes, but the postwar responses are much quicker. This difference has noticeable effects on the responses of commodity prices to the same shocks, with commodity prices responding less under the postwar policy. However, IP and CPI

[16] Yields on 12-year government bonds averaged 3.6 percent in 1929 and did not fall below 2 percent from then through 1939. See Board of Governors of the Federal Reserve System (1943, Table 130).

Figure 10
Responses to Identified Shocks, Postwar, Actual and Counterfactual

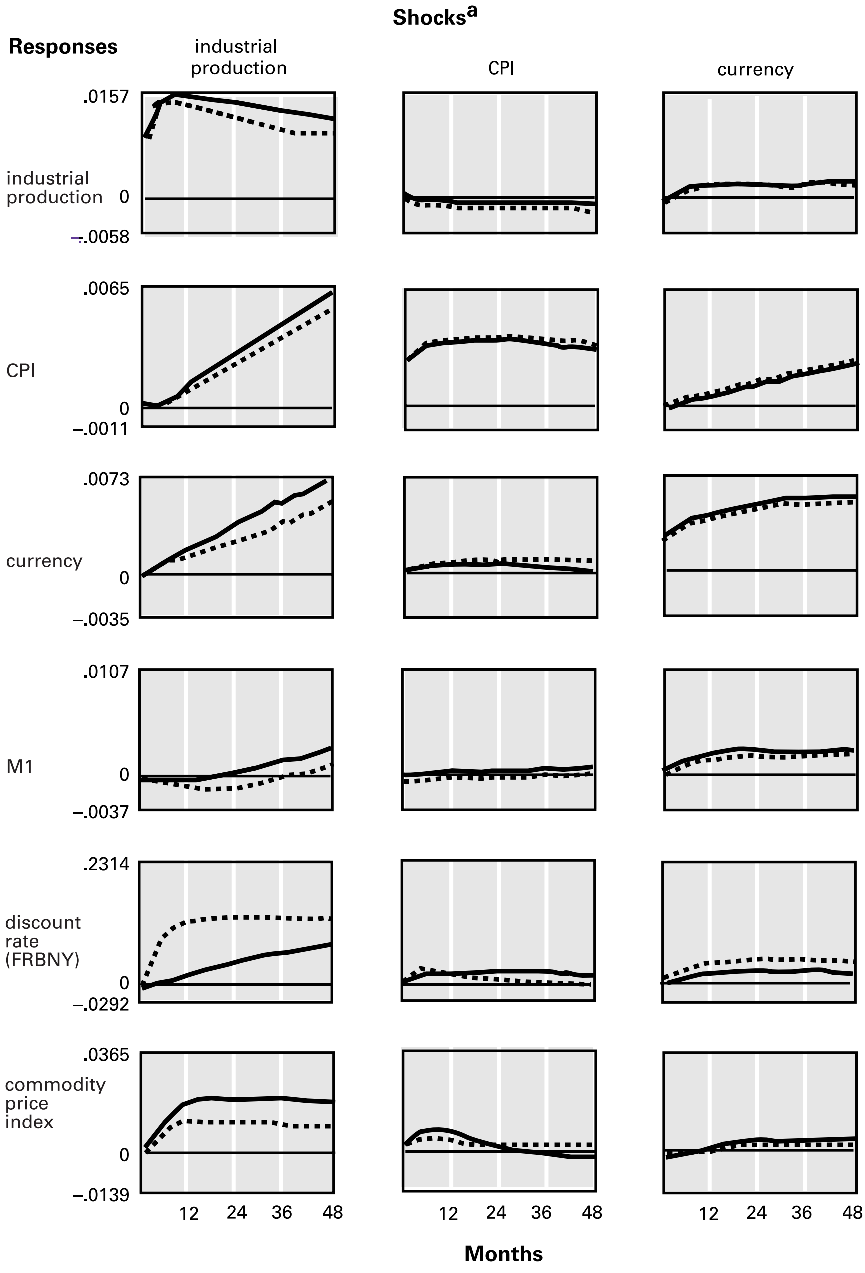
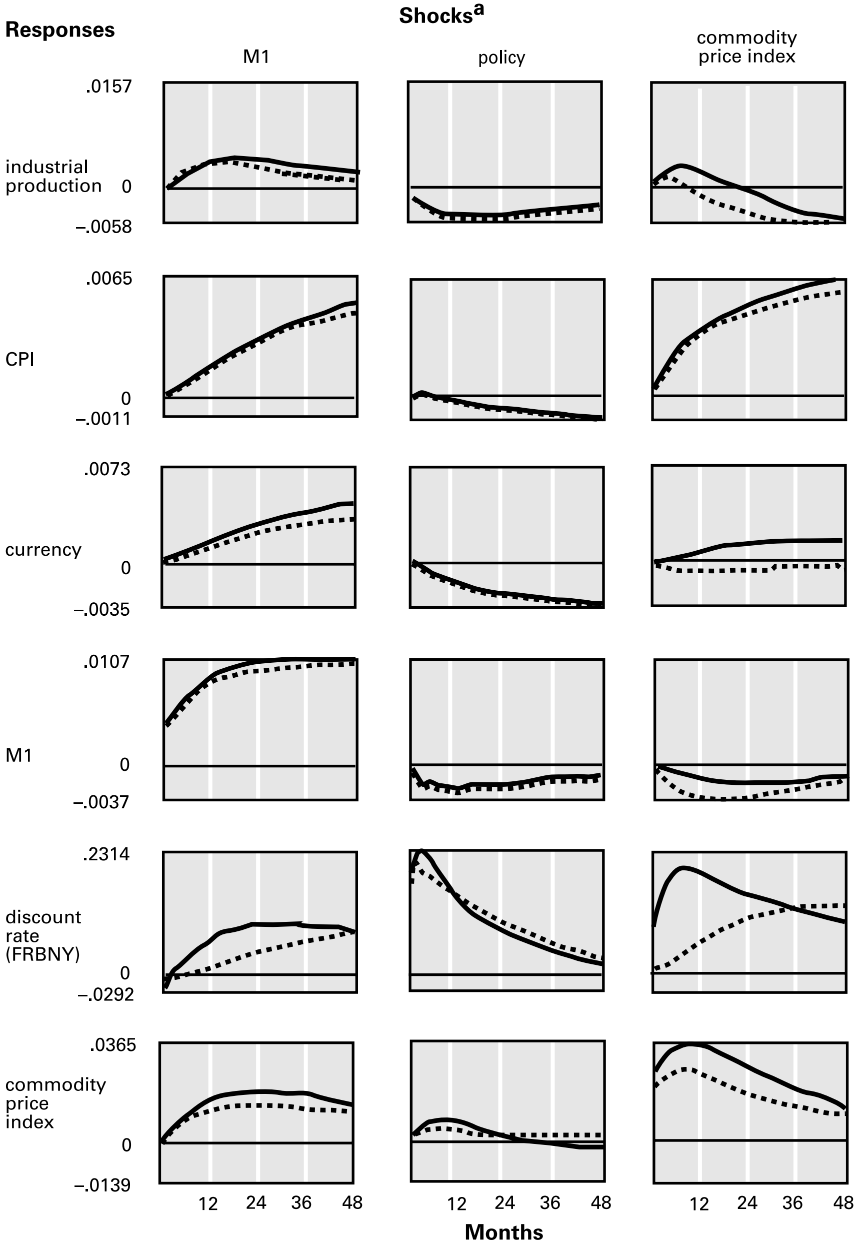
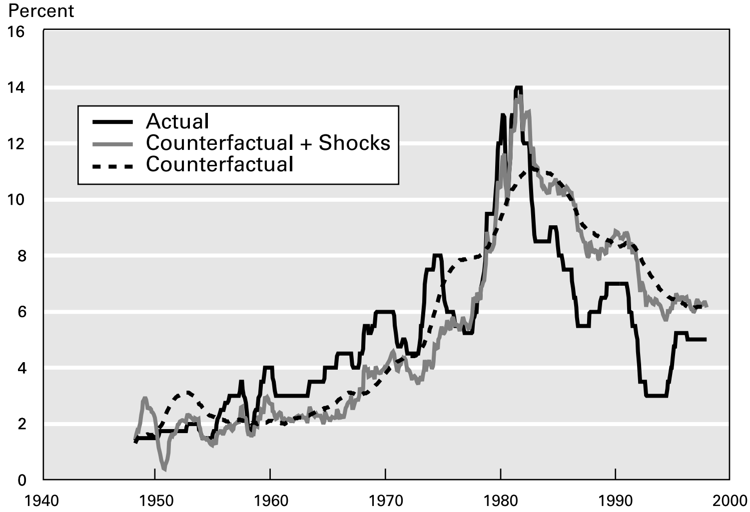


Figure 10, continued
Responses to Identified Shocks, Postwar, Actual and Counterfactual



[a] Each shock represents a 1-standard-deviation disturbance in the corresponding equation, with the equations defined by the rows of Table 1.
Note: The solid lines use the 1919-39 policy reaction function in the 1948-97 model, while the dotted lines match Figure 1, the original estimated responses for the 1948-97 period.

Figure 11
Postwar Discount Rate, Actual and Counterfactual



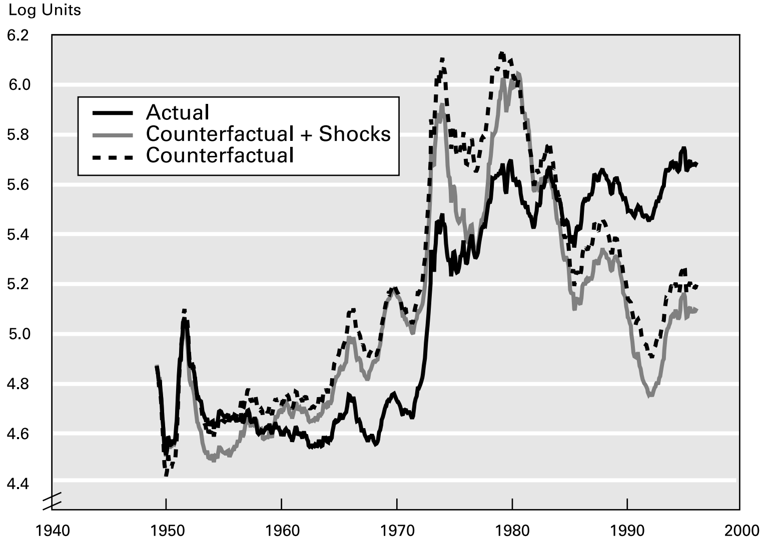
respond in much the same way with either policy rule. There is an effect, with CPI inflation and IP responses less under the postwar policy, but the effect is quite small.

If we rerun postwar history with the interwar reaction function, we find in Figure 11, as would be expected from the impulse responses, notable differences in the history of the discount rate. The counterfactual discount rate is lower in the ′60s and the first part of the ′70s than the actual rate, then rises faster than the actual discount rate. The simulation without policy shocks has the rate rising earlier in the ′70s than the actual path, but then not rising quite as high in the early ′80s. When policy shocks are added, the rise of rates from the late ′70s to the early ′80s is reproduced almost exactly, in timing and magnitude. The interwar policy rule keeps rates high notably longer than did the actual path of policy.

In Figure 12 we see that the earlier rise of rates in the ′70s in the no-policy-shock simulation produces a sharper temporary reversal of commodity price inflation, so that by the early ′80s commodity prices are on almost the same track in the no-policy-shock path as in the policy-shock counterfactual path, despite the less pronounced peak in rates under the former path.

Figures 13 and 14 show, perhaps surprisingly given the small differences in responses to shocks in Figure 10, that the difference in

Figure 12
Postwar Commodity Prices, Actual and Counterfactual

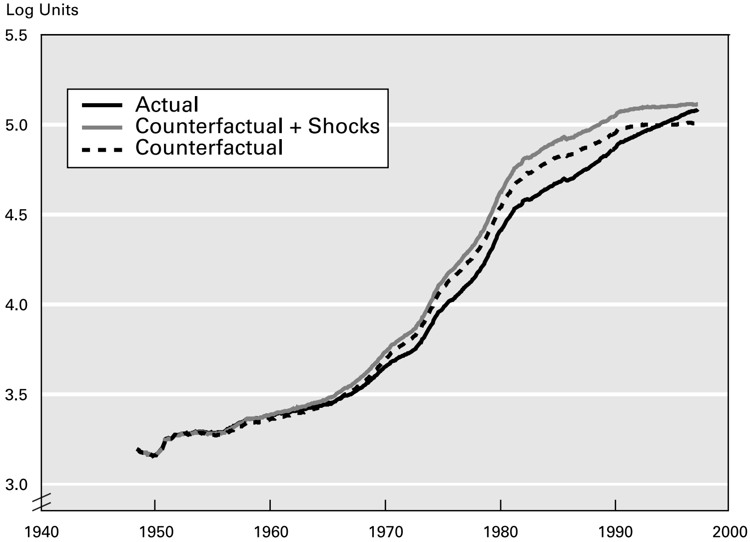


policy has noticeable effects on the time paths of CPI inflation and IP. The low interest rates through the early ’70s under the interwar policy produce greater CPI inflation, and this is accompanied by higher output growth. The higher inflation eventually requires interest rates just as high under the interwar as under the postwar policy, however, and as these bring inflation down, they also slow output growth. The recession of the early ’80s is larger under the interwar policy, and the growth rate of IP remains generally lower under the interwar policy until the early ’90s.

There is some plausibility to this analysis of how outcomes might have differed with a monetary policy that, like the interwar policy, responded less promptly to inflationary and deflationary pressure, but the statistical caveats mentioned earlier bear repeating here. The effects on CPI and IP are visible on a time scale of five or 10 years for the most part. This is why they are more visible on the plots of simulated history than they are on the impulse response graphs, which cover only four years. But responses at longer time horizons are less reliably estimated, so the differences found, while interesting, may be statistically unreliable.

At business cycle frequencies, IP fluctuations are very similar for all three lines plotted in Figure 14. It seems likely that the NBER business cycle chronologies would have looked quite similar with any of these paths. Putting the matter another way, the size and timing of the postwar

Figure 13
Postwar CPI, Actual and Counterfactual



U.S. recessions had little to do with either shocks to monetary policy or its systematic component.

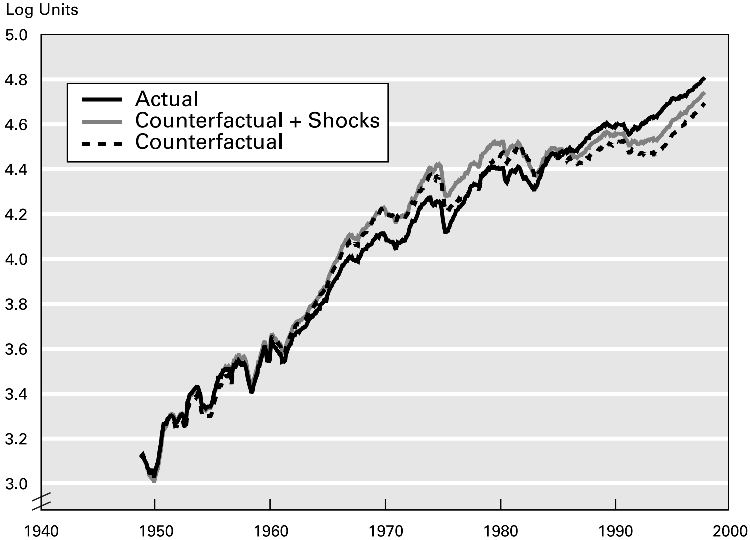
It also seems clear from the simulations that postwar monetary policy is not as much different from interwar policy as might have been imagined. Estimates of policy responses to inflationary and banking system pressures obtained from data on the ′20s and ′30s reproduce the qualitative features of postwar monetary policy responses. They also trace the history of interest rate rises during the accelerating inflation of the ′70s much as they occurred in fact.

What about the Lucas Critique?[17]

The analytical framework of this paper is one in which all policy actions, hypothetical or historical, are regarded as realizations of random variables. The task of econometric model identification is that of constructing a model that contains a component describing how the conditional distribution of economic outcomes varies as the random variables

[17] The first part of this section reviews long-standing philosophical disputes on which I have stated my views many times before. It is only because my views on these issues seem still to be controversial in some quarters, and perhaps incompletely understood, that I review them here.

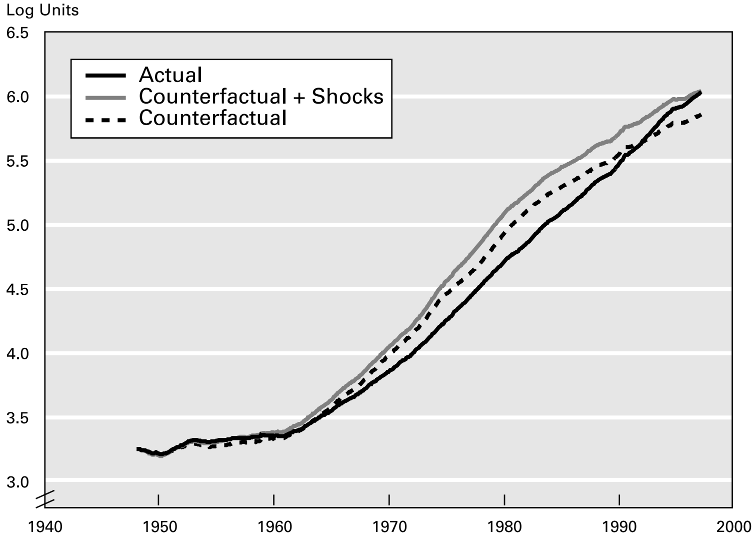
Figure 14
Postwar Industrial Production, Actual and Counterfactual



characterizing policy take on different possible values. Our modeling approach does this, and it is therefore legitimate to use it to discuss counterfactual history or to project the future of the economy under various policy choices as a guide to policy formulation. There is no other approach to policy evaluation that recognizes the existence of uncertainty and that is internally consistent.

The Lucas critique of econometric policy evaluation can be formulated in a variety of ways. At its most straightforward, it points out that in a stochastic model that explicitly models the dynamics of expectations formation, evaluating changes in policy rule as if they could be made permanently, while leaving expectations formation dynamics unchanged, is a mistake. This version of the critique clearly does not apply to this paper's analysis, as the models being used contain no explicit expectations-formation dynamics. Another version of the critique makes it a warning about the potential importance of a particular type of nonlinearity. Every applied economist understands that the linear (or otherwise mathematically simple) models we use are approximations valid over a certain range. The conventional version of this point is that it is dangerous to extrapolate results from a linear regression to independent variable values much larger or smaller than those actually observed in the sample. Lucas's analysis made clear that in dynamic macroeconomic models the absolute size of changes in random variables being conditioned on in

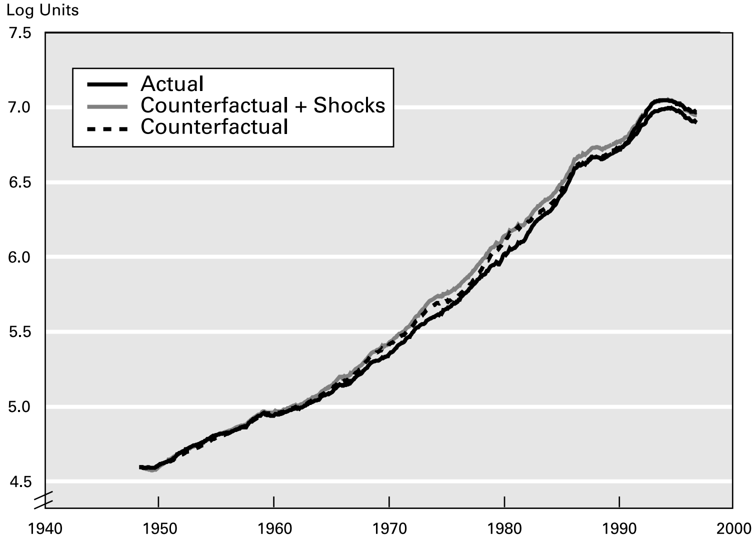
Figure 15
Postwar Currency, Actual and Counterfactual



making projections is not the only worry. Sequences of values for conditioning random variables that are historically unprecedented in their serial correlation properties—like persistently high or low money growth rates or interest rates—might make models run astray even when they are not outside the range of historical experience in absolute size. This version of the critique does apply to this paper's analysis, and we need to consider it.

A third version of the critique makes it into a philosophical puzzle akin to Zeno's paradox. Policy properly understood, from this viewpoint, is the policy rule. Since without changing the rule we will not change the stochastic process describing the economy, no intervention that leaves the rule intact produces any real change. Hence discussion of policy by economists should be limited to discussion of changes in policy rule. As a corollary, changes in policy will always have to be accompanied by an analysis of how the change in rule affects private behavior via expectations formation. But once we recognize that the parameters of the rule can change, and that a rational public is aware that they can change, then we must also recognize that the particular values of the parameters of the rule that are chosen are realizations of random variables, for which the public, assuming rational behavior, knows the true probability distribution. We are then back at square one; changes in the parameters of the

Figure 16
Postwar M1, Actual and Counterfactual



rule itself are mere realizations of random variables, generating no real change in the probability distribution of the economy.[18]

The fallacy in this third version is its assumption that change in policy that does not change the probability distribution of economic outcomes is trivial. Two economies whose probability distributions are the same may have very different actual realized histories. If the probability model is non-stationary or nearly so, as are most economic models, they may even have different histories when averaged over time.

Our attention then focuses on version 2 above. Are we conditioning on variations in policy so great that it is implausible that the public would view them as realizations of a fixed probability law for policy behavior? If we had found drastically different behavior of the economy as we switched policy rules, this would be a strong caveat to the results. But we found differences that were for the most part quite modest. Of course, if actual policy followed either of the no-policy-shock rules, the public would quickly discover the perfectly fitting regression equation that

[18] A clear exposition of this viewpoint, bringing out its nihilistic implications for the possibility of internally consistent policy evaluation, is in Sargent (1984). That paper also contains an articulation of another position, even more nihilistic (that policymakers are always behaving optimally), that Sargent incorrectly (but apologetically) attributes to me. My own views on this are articulated at more length in Sims (1987).

determines policy reactions and build it into their expectations. This would lead to much more certainty about monetary policy than there is in fact. In this sense, our simulation of these rules is unrealistic, as it ignores the reduction of uncertainty about monetary policy that they would entail. But clearly we are thinking of these simulations as representative of similar rules that still contain error terms. We display them only to give some insight into how much of historical policy behavior is attributed to the historical pattern of realized random policy disturbances.

Also, we have already made the point that an important nonlinearity is probably lurking in the interwar results that could be seen as a version of the Lucas critique idea: A policy that succeeded in expanding bank deposits as rapidly as our counterfactual interwar policy would probably have had to entail increasing confidence in bank liquidity and solvency. It might well therefore have eliminated or reduced some of the financial crisis shocks that the model treats as unrelated to monetary policy.

But on the whole, it appears that these considerations are only one of many reasons to be somewhat cautious about these results, not a reason for ignoring them. The postwar simulations do involve persistent differences from historical patterns in rates of monetary expansion and price inflation. If the historical pattern had shown extremely stable inflation around a fixed mean, this would be strong reason for concern. Historical dynamics might then have reflected a public that has a strong tendency to forecast rapid mean-reversion in inflation. But historical postwar U.S. experience shows a complicated pattern of near-non-stationary drift in inflation rates. Actual rational expectations-formation therefore must have involved recognition that the inflation rate can drift, and our simulated counterfactual patterns of drift are not far outside the range of actual experience.

The identifying assumptions we have used in deriving our model are certainly legitimately subject to dispute, and altering those assumptions might alter results. These are much stronger reasons for questioning the results than the Lucas critique, which is after all just one particular line of attack on a model's identifying assumptions. In this case, it seems that other identifying assumptions would provide a better place to start.

Conclusion

The assigned topic of this paper was the role of government as a source of business cycles. We began by limiting attention to the role of budgetary and monetary policy in generating business cycles. We have developed a way of looking at historical data that allows us to consider both whether erratic variation in monetary policy has been an important source of fluctuations and whether systematic patterns of response of monetary policy to the private sector have been important in shaping business cycle fluctuations. The conclusion of our analysis is that even during the Great Depression, the role of interest rate policy in generating or propagating cycles was modest. The systematic component of monetary policy has been remarkably stable, not only within the postwar period, but between the interwar and postwar periods. Changes in the systematic component of monetary policy of the magnitude seen between these two periods would not have greatly changed historical business cycle chronologies, though they would probably have changed the postwar history of inflation. And random fluctuations in monetary policy also do not have effects large enough to substantially alter the economy's business cycle chronology.

Analysis of the limitations of monetary policy during the '30s, as interest rates approached a zero lower bound, and consideration of the importance of disturbances related to financial crises, suggest routes by which government actions outside the bounds of normal interest rate policy could have had substantial effects, not modeled in this approach.

The overall conclusion might be that the aim of good monetary policy should be to make monetary policy unimportant to the business cycle, and that postwar U.S. monetary policy has largely succeeded in this respect.

Data Appendix

I. Interwar

Except for IP, the series are from the National Bureau of Economic Research (NBER) macro history database, which is accessible at

www.nber.org/databases/macrohistory/data/04/.

• IP: Federal Reserve code B50001

Industrial Production, total index, seasonally adjusted, from the Federal Reserve Board. Accessible at http://www.bog.frb.fed.us/releases/G17/iphist/ip1ahist.sa

• CPI: NBER series 04128

Consumer Price Index, All Items, U.S. Bureau of Labor Statistics
Units: 1957–1959 = 100
Seasonal adjustment: None
Source: BLS Release, "Consumer Price Index—U.S.: All Items, 1913–1960," Series A.
Notes: Prior to 1953, this series was called the "index of cost of living." Data have been converted to the average 1957–59 base by BLS. Prior to September 1940, only fuel and food components were monthly; all other components were priced at intervals of 3, 4, and 6 months. (See *Survey of Current Business,* May 1941; also *Monthly Labor Review*, August 1940, and BLS *Bulletin* nos. 699 (1941) and 966 (1949) for detailed information.) The early segment of this series represents monthly interpolations by the U.S. Department of Commerce.

• Currency: NBER series 14125

Currency Held by the Public, Seasonally Adjusted
Units: millions of dollars
Seasonal adjustment: Seasonally adjusted by source
Source: Friedman and Schwartz, *Monetary Statistics of the United States* (NBER 1970), Table 27, Column 3, pp. 402–15.
Notes: Data represent vault cash of all banks subtracted from currency in circulation outside the Treasury and Federal Reserve Banks. Data are for the Wednesday nearest the end of the month.

• M1: NBER series 14144

Money Stock, Commercial Banks plus Currency Held by the Public, Seasonally Adjusted
Units: billions of dollars
Seasonal Adjustment: Seasonally adjusted by NBER
Source: Data are computed by NBER from the sum of series 14125 (currency held by the public) and series 14145 (demand deposits adjusted and time deposits all commercial banks). See Friedman and Schwartz, *Monetary Statistics of the United States* (NBER 1970).
Notes: Data are for the Wednesday nearest the end of the month.

• Discount Rate: NBER series 13009

Discount Rates, Federal Reserve Bank of New York
Units: Percent
Seasonal Adjustment: None
Source: Federal Reserve Board, data for 1914–1921: "Discount Rates of Federal Reserve Banks, 1914–1921," 1922. Data for 1922–1969: *Annual Reports* for 1931–1942; *Federal Reserve Bulletin*, successive issues.
Notes: Data are computed by NBER by taking simple averages of rates for commercial, agricultural, and livestock paper, and weighting them by the number of days each rate was in force. Data are for all classes and maturities of discount.

• Commodity Prices: NBER series 04202

Units: 1947–1949 = 100
Seasonal adjustment: None
Source: Ruth P. Mack, "Inflation and Quasi-Elective Changes in Costs," *The Review of Economics and Statistics*, August 1959.
Notes: Series discontinued after January 1957.

II. Postwar
All series except M1 (in part) were drawn from Citibase.

• IP: Citibase series name IP.
Industrial Production: total index (1992=100, SA)

• CPI: Citibase series name PUNEW
CPI-U: all items (82–84=100, SA)

• Currency: Citibase series name FMSCU.
Money Stock: currency held by the public (bil$,SA)

• M1: Citibase series name FM1, spliced together with the NBER historical M1 series cited above. The Citibase M1 series starts in 1959:1. The earlier data were scaled to match the modern series in 1959:1. Citibase title: Money Stock: M1 (currency, travelers checks, demand deposits, other checkable deposits) (bil$,SA)

• Discount Rate: Citibase series name FYGD.
Discount Rate, Federal Reserve Bank of New York (% per annum)

• Commodity Prices: Citibase series name PSCCOM.
Spot Market Price Index: BLS & CRB: all commodities (1967=100, NSA)

References

Baxter, M. and R.G. King. 1993. "Fiscal Policy in General Equilibrium." *The American Economic Review*, 83 (June), pp. 315–34.
Ben-Habib, Jess, Stephanie Schmidt-Grohe, and Martin Uribe. 1998. "Monetary Policy and Multiple Equilibria." New York University discussion paper available at *http://www.econ.nyu.edu/user/benhabib/research.htm*.
Bernanke, Ben. 1983. "Nonmonetary Effects of the Financial Crisis in the Propagation of the Great Depression." *The American Economic Review*, 73, pp. 257–76.
Bernanke, Ben and Alan Blinder. 1992 "The Federal Funds Rate and the Channels of Monetary Transmission." *The American Economic Review*, 82, pp. 901–21.
Board of Governors of the Federal Reserve System. 1943. *Banking and Monetary Statistics, 1914–1941*. Washington, DC.
Cochrane, John H. 1988. "A Cashless View of U.S. Inflation." Presented in March at the NBER Macroeconomics Annual Conference.
Friedman, Milton. 1958. "The Supply of Money and Changes in Prices and Output." In *The Relationship of Prices to Economic Stability and Growth,* 85th Congress, 2nd Session, Joint Economic Committee Print. Washington DC: Government Printing Office. Reprinted in Friedman 1969, pp. 171–87.
______. 1969. *The Optimum Quantity of Money and Other Essays*. Chicago: Aldine Publishing Company.
Friedman, Milton and Anna Schwartz. 1963. *A Monetary History of the United States 1867–1960.* Princeton, NJ: Princeton University Press.
Garcia-Mila, Teresa. 1987. *Government Purchases and Real Output: Empirical Evidence and an Equilibrium Model with Government Capital.* University of Minnesota Ph.D. thesis.
Leeper, Eric M. 1991. "Equilibria under 'Active' and 'Passive' Monetary and Fiscal Policies." *Journal of Monetary Economics*, 27 (February), pp. 129–47.
Leeper, Eric M., C.A. Sims, and Tao Zha. 1996. "What Does Monetary Policy Do?" *Brookings Papers on Economic Activity*, 1996:2, pp. 1–63.
Lütkepohl, Helmut. 1991. *Introduction to Multivariate Time Series Analysis.* New York: Springer-Verlag.
McCallum, Bennett T. 1990. "Could a Monetary Base Rule Have Prevented the Great Depression?" *Journal of Monetary Economics*, 26(1), August, pp. 3–26.
Sargent, Thomas J. 1984. "Autoregressions, Expectations, and Advice." *The American Economic Review Papers and Proceedings,* 74 (May), pp. 408–15.
Sims, Christopher A. 1987. "A Rational Expectations Framework for Short-Run Policy

Analysis." In *New Approaches to Monetary Economics*, W. Barnett and K. Singleton, eds., pp. 293–310. Cambridge University Press. Also available at *http://www.econ.yale.edu/~sims*.

______. 1994. "A Simple Model for Study of the Determination of the Price Level and the Interaction of Monetary and Fiscal Policy." *Economic Theory*, 4, pp. 381–99.

______. 1997. "Fiscal Foundations of Price Stability in Open Economies." Presented at the July 1997 Far Eastern meetings of the Econometric Society. Available at *http://www.econ.yale.edu/~sims*.

______. 1998a. "Stickiness." Processed, Department of Economics, Yale University.

______. 1998b. "Adaptive Metropolis-Hastings Sampling." Processed, Yale University.

Sims, Christopher A. and Tao Zha. 1998a. "Bayesian Methods for Dynamic Multivariate Models." *International Economic Review,* forthcoming.

______. 1998b. "Error Bands for Impulse Responses." *Econometrica*, forthcoming.

Woodford, Michael. 1994. "Monetary Policy and Price Level Determinacy in a Cash-in-Advance Economy." *Economic Theory,* 4(3), pp. 345–80.

______. 1995. "Price Level Determinacy without Control of a Monetary Aggregate." NBER Working Paper No. 5204.