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MONETARY POLICY RULES AND FINANCIAL STABILITY

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ABSTRACT

This paper investigates empirically the possibility that a central bank could adhere to a macro-oriented monetary policy rule while also providing lender-of-last-resort services to the financial system. The method considered involves smoothing week-to-week movements of an interest rate instrument so as to achieve quarterly-average intermediate targets for the monetary base, with these specified so as to keep aggregate nominal spending growing steadily at a noninflationary rate. Simulations utilizing weekly U.S. data are conducted with a system consisting of a policy rule for the federal funds rate--one designed to hit monetary base targets obtained from a quarterly macroeconomic rule--and an empirically-based model of the response of base growth to funds rate movements. Results for the periods 1974-1979 (Sept.) and 1988-1991 suggest that such a procedure could succeed in reconciling macroeconomic goals with the provision of lender-of-last-resort services.

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I. Introduction

The subject matter of this session is the relationship between the two ultimate goals recognized by most central banks, namely, macroeconomic stability and financial-system stability.[1] This is an extremely broad topic and one that could be approached by various distinct methods of analysis--evolutionary/historical, welfare theoretic, institutional, etc. But given my own experience relative to others on the program, it seems most appropriate for me to narrow the scope of the assignment by focusing primarily on one limited but extremely important set of issues.

These issues, which are closely interrelated, concern macro-oriented rules for monetary policy and the central bank's role as a lender of last resort. Are macro-oriented rules--such as those advocated by McCallum (1988, 1993), Meltzer (1987), or Taylor (1988, 1993)--inappropriate because of their neglect of financial market conditions? If so, might these rules be modified so as to overcome that neglect? What are the implications concerning lender-of-last-resort responsibilities? Does acceptance of these responsibilities require the operation of a discount window? Or could they be satisfied, as suggested by Goodfriend and King (1988), by means of open market operations that involve smoothing of interest rates?

As here formulated, the answers to these questions depend to a large extent upon the accuracy with which it is possible for the central bank to hit intermediate quarterly targets for the monetary base by means of an interest rate instrument while practicing smoothing--i.e., while avoiding large week-to-week changes in the interest rate. Consequently, a substantial portion of the paper is devoted to an attempt to measure this accuracy empirically. As the econometric methods utilized are rather rudimentary, our results must be regarded as exploratory, rather than definitive, in nature. But estimation of a fully structural model is inhibited by data limitations and identification problems, so our first-pass analysis may be difficult to improve upon substantially. In any event, it will provide a starting point for further consideration of the issue.

Organizationally, the analysis begins in Section II with an overview discussion of the broad topic of this session, a discussion which serves to justify our attention on the narrower set of issues described above. Section III is then devoted to a background review of some results relating to monetary policy rules, formulated at the quarterly frequency, in which the monetary base is treated as a policy instrument. Section IV develops a framework for the study of a system in which quarterly-average base values are viewed as targets to be achieved by manipulation at the weekly frequency of an interest rate instrument. Basic simulation results pertaining to this system are given in Section V while Section VI takes up some alternative formulations. Finally, Section VII contains a brief recapitulation.

II. Monetary Policy Rules for the Lender of Last Resort?

Before focusing our attention as described above it will be useful to justify that strategy by reference to the broader topic assigned for this session: the relationship between the goals of macroeconomic and financial stability. The tension between these goals has recently been expressed by Folkerts-Landau and Garber (1992), writing about the design of the European Central Bank, in terms of the aphorism, "A bank or a monetary policy rule?" More generally, many economists have expressed doubts as to the compatibility of a strict monetary policy rule--or in any case one featuring a monetary base instrument--with central bank acceptance of lender-of-last-resort (LLR) responsibilities.[2] The achievement of a base path as dictated by the rule would conflict, according to this position, with the need to supply liquidity at times of crisis in accordance with the central bank's role as a LLR.

Recent discussions of alternative viewpoints pertaining to the LLR role--see e.g., Bordo (1990), Humphrey (1992), and Summers (1991)--have identified four main positions. These are (i) the classical Thornton-Bagehot doctrine, (ii) a "modern-pragmatic" position that calls for more lenient management of the discount window, (iii) the so-called "free banking" contention that no public LLR is needed, and (iv) a "monetarist" scheme, developed primarily by Goodfriend and King (1988), that calls for LLR actions via open-market operations rather than the discount window.[3]

As most readers will know, the classical doctrine developed by Thornton (1802) and Bagehot (1873) calls for the LLR to lend aggressively at times of crisis,[4] to any solvent institution providing good collateral, but at a penalty rate (a concept discussed below). This policy should, moreover, be publicly known to prevail. A major objective is to support illiquid but solvent institutions, thereby providing protection for the banking system rather than for individual banks.[5] Actual practice of the Federal Reserve in recent years has deviated from the Thornton-Bagehot prescription in a number of ways (Garcia and Plautz, 1988). Thus the Fed lends only to depository institutions, rather than to any sound institution, and at rates that represent subsidies to the borrowers. It has not spelled out its policies publicly and has apparently been willing occasionally to lend to insolvent banks. Summers (1991) expresses support for this more lenient mode of behavior, expressing the opinion that LLR policy "is probably an area where James Tobin's insight that 'it takes a heap of Harberger triangles to fill an Okun gap' is relevant.... This at least is the modern pragmatic view that has worked so far" (p. 153). To the present author, it is surprising that a prominent writer would take such a sanguine view of U.S. policy in this area.[6] Perhaps Summers' argument rests on a presumption that the massive late-1980s expenditures by the FDIC represented only transfers, not lost output. I would suggest, by contrast, that the construction of a useless and unoccupied shopping center does not constitute output. In any event, the desirability of the modern pragmatic view has implicitly been the topic of an enormous volume of analysis.[7] It should be more useful for this paper's attention to be addressed to other viewpoints.

Proposals of the "free banking" type have, despite the efforts of White (1984), Selgin (1987), Glasner (1989), and Dowd (1989), received little support among monetary economists in general. Different writers on the subject have expressed different criticisms of the proposals. Laidler (1992, p. 192), for example, has suggested that "the very nature of banking precludes its being simultaneously unregulated and competitive [because of economies of scale in reserve holding], and that arguments against the regulation of banking based on the assumption of competition are therefore inconsistent." Summers (1991, p.147) follows Goodhart (1987), in emphasizing that "the true asset value of the bank's (non-marketed) loans is always subject to uncertainty though their nominal value is fixed" [the latter occurring because of the informational advantage of borrowers over even the lending bank] and that "under these conditions, it will benefit both bank and depositor to denominate deposit liabilities also in fixed nominal terms" (Goodhart, 1987, pp. 86-87). But "the combination ... of the nominal convertibility guarantee, together with the uncertainty about the true value of bank assets, leads to the possibility of runs on individual banks and systemic crises" (1987, p. 87) thereby requiring the assistance of a LLR. Humphrey, finally, argues that "occasional shocks such as the threat of war or the failure of a large firm may trigger moneyholders' desire to switch from inside to outside money" (1992, p. 573) which can only be supplied under a fiat-money system by a central bank or LLR. These criticisms have been disputed by the proponents of free banking but, as stated above, most analysts remain unconvinced.

My own view is that there is an especially glaring weakness in the case for free banking that has not been emphasized by its critics. That weakness involves the basic argument of free-banking proponents that competition will induce profit-seeking bank firms to issue liabilities (bank notes and deposits) that maintain their purchasing power over time because they are redeemable in commodities or bundles that are designed to have reasonably constant value, relative to a comprehensive consumption bundle. But it seems highly uncertain that individual banking firms would in fact choose to offer that type of liability under today's conditions. The free banking literature is largely written in a manner that appears to suggest that historical evidence supports the questionable proposition under discussion, but that suggestion is (I believe) unwarranted. For the principal historical examples occurred during the era of commodity money standards, during which banks were legally required to keep their bank notes redeemable in the standard commodity (e.g., gold or silver coin).[8] But the situation is, of course, crucially different in today's era of fiat money.

The fourth position mentioned above, that of Goodfriend and King (1988), would retain central banks and their role as a LLR, but would have LLR activities conducted by means of open market actions. In particular, discount window lending would be eliminated and with it the need for most--if not all--of the central bank's regulatory and supervisory activities. The main point of the Goodfriend-King argument is that the job of the LLR is to prevent systemic breakdown, not to protect individual banks. But systemic crises involve sharply increased demands for high-powered money, which can be satisfied by open-market purchases without discount window loans.[9] Indeed, such purchases will be triggered automatically in a regime with interest rate smoothing, since sharply increased demands for high-powered money would result in sharply higher interest rates if no central bank response were forthcoming.

A number of objections to the Goodfriend-King analysis have been put forth. Meltzer (1988), for example, has suggested that it would be preferable to retain the discount window but for lending to take place only at a penalty rate. "Even a small penalty...would ensure that the lender of last resort would do no lending except in a severe banking crisis when (or if) markets do not function" (1988, p. 445). Furthermore, Meltzer believes that regulation and supervision would not be required for such loans. And his "reason for insisting on retaining the lender-of-last-resort function is to avoid catastrophes like that of 1931-1933 when the [Fed] refused to lend. Having penalty-rate loans [available] as an option means that banks have access to base money even if the central bank repeats its major error of the 1930s" (1988, p. 446).

In evaluating this suggestion, it is important to consider what is meant by a "penalty rate." It must presumably not be a rate in excess of the current market rate because the latter is the rate at which borrowers can obtain funds. What Meltzer has in mind, I believe, is a rate that is somewhat above recent market rates. An example for the United States might be the previous week's average for the Federal Funds rate plus 2 percentage points (annualized).

Under this interpretation it becomes clear that the Meltzer and Goodfriend-King position are, though different, highly compatible. For interest rate smoothing, as prescribed by the latter, would presumably never permit the Funds rate to rise to a level as much as 2 percentage points (for example) above the previous week's average. At some lower value--its exact position depending on the precise smoothing rule adopted--the Fed would begin to supply base money in virtually unlimited quantities. So the penalty rate would never materialize. Alternatively, Meltzer's proposal would keep the discount window open, with a penalty rate, and eliminate the practice of interest rate smoothing. But market rate changes from week to week would then be limited by the penalty margin.

Cagan's (1988, p. 256) main objection to the Goodfriend-King proposal is that interest rate pegging leads to dynamic instability.[10] His argument does not adequately distinguish between interest rate pegging and the use of an interest rate instrument, however, the latter being the relevant practice. And the analysis in McCallum (1981, 1986) suggests that there is in fact no instability or indeterminacy problem in this case if expectations are formed rationally, provided that the central bank's policy rule for setting the interest rate instrument reflects some concern for some nominal magnitude--i.e., possesses a "nominal anchor."[11]

Summers (1991) objects to the Goodfriend-King position rather strongly, presenting three arguments. One of these involves a "reasonably clear lesson from the [October 1987] crash period. It would not have been sufficient for the Fed to keep the money stock growing steadily.... Their successful action involved rapid money growth" (1991, p. 149). But this point is irrelevant, since the Goodfriend-King prescription does not call for the Fed to keep money growth steady. A more relevant claim of Summers' goes as follows: "The crucial point here is that driving down the federal funds rate is not likely to be sufficient to stop prophesies that predict the failure of banks or securities firms from proving to be self-fulfilling. A more ambitious set of lender-of-last resort policies would seem to be necessary" (1991, p. 150). But Summers's "demonstration" in this case is based neither on experience nor theoretical reasoning, but on a totally imaginary "scenario" that he created out of thin air and used in several places in this paper. There is very little reason, consequently, to give any weight to this second claim.

The only substantial argument put forth by Summers, then, is that "because of the relationship-specific capital each has accumulated, reserves at one bank are an imperfect substitute for reserves at another. Maintaining a given aggregate level of lending is not sufficient to avoid the losses associated with a financial disturbance" (1991, p. 149). But this argument again seems to miss its target. The object of LLR policy is not to "avoid losses" but to prevent systemic failure. And "maintaining an aggregate level of lending" is an inaccurate characterization of the policy under discussion.

My conclusion from this review is that convincing refutations of the Goodfriend-King position have not yet been presented. Accordingly, that position warrants further consideration, since it offers a possible way for a central bank to provide LLR insurance against financial system breakdown while generating little moral hazard and avoiding the need for an extensive regulatory and supervisory role.[12]

There is, however, an important gap in the argument of Goodfriend and King that remains to be filled. In particular, their analysis relies upon the existence of interest rate smoothing but does not provide any evidence that such smoothing can be practiced without undermining longer-run attention to nominal macroeconomic goals such as the avoidance of inflation. The analysis in McCallum (1981) provides theoretical support for the notion that an appropriate behavioral rule might be feasible. But there remains a need for a constructive example, with some empirical foundation, of a policy rule for manipulation of an interest rate instrument that combines smoothing behavior--and its automatic LLR services--with a longer term trajectory that achieves the objective of macroeconomic stability. An attempt to provide such a rule will be presented in Section IV, but first some matters concerning macro-oriented rules require discussion.

III. Policy Rules for Macroeconomic Stability

In previous studies I have explored the properties in terms of macroeconomic stabilization--the avoidance of inflation and sharp cyclical fluctuations--of a specific, concrete, and operational rule for the conduct of monetary policy. (See McCallum 1988, 1990a, 1990b, 1993.) The objective of the rule is to generate a time path for nominal aggregate spending that grows smoothly at a non-inflationary rate, with nominal GNP being the spending measure used in existing studies. The indication of these studies, implemented for the economies of the United States and Japan, is that the rule would perform quite well from a macroeconomic perspective. It would, that is, result in a nominal GNP growth paths that are less inflationary and smoother than those that have prevailed historically.

An objection that has been raised by some critics of the rule is that it relies upon the monetary base as an instrument variable. Actual central banks strongly prefer, of course, to focus their day-to-day operations on short-term interest rates, such as the Federal Funds rate in the United States or the overnight call rate in Japan. This preference arises from a belief that day-to-day and week-to-week interest rate volatility would be greatly increased if attempts were made to keep the monetary base (or any other reserve aggregate) in strict conformity with the values specified by the policy rule in question.

But since the rule pertains to quarterly-average values of the base, there exists the conceptual possibility of achieving these values to a fairly high degree of accuracy while using an interest rate variable as the control instrument on a daily or weekly basis. And obviously this possibility is closely related to the Goodfriend-King method for providing LLR services, which we discussed in the previous section. It is conceivable, in other words, that an interest rate rule could be devised that would provide smoothing behavior and yet also achieve monetary base targets--now intermediate targets--dictated by a macroeconomic policy rule such as the one investigated in my previous studies. If the design of such a rule could be achieved, it would then serve the double purpose of (i) completing the case for the Goodfriend-King scheme for the LLR function and also (ii) modifying the case for the macroeconomic policy rule given in McCallum (1993) so as to rely upon operating procedures more like those employed by the Fed, the Bank of Japan, and other actual central banks.

In Sections IV-VI, accordingly, a rule for weekly adjustments of the Federal Funds rate will be proposed and investigated using U.S. data. That rule will be designed to hit weekly targets for the monetary base that will yield quarter-average values for the base that are dictated by the quarterly macroeconomic rule used in McCallum (1993). The remainder of this section will be devoted to an explanation of that rule, some results concerning its performance in simulations of the U.S. economy, and the generation of intermediate target values for the monetary base that will be used to generate weekly targets for the exercise in Sections IV-VI.[13]

The rule used in my previous U.S. studies may be written as in equation (1), where x_t and b_t denote quarter-average values of the log of nominal GNP and the log of the monetary base:

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

Here λ is a positive policy parameter and x^*_t is the target value of x_t. In my earlier studies for the United States the x^*_t values were taken to increase each quarter by 0.00739, i.e., to reflect constant growth of nominal GNP at a rate of 3 percent per year. This value was chosen to give a time path of realized x_t values that would grow at approximately the rate of long-term annual growth of <u>real</u> GNP, since that would yield an average inflation rate of approximately zero. The purpose of the three terms on the rule's right-hand side are as follows. First, the 0.00739 constant term is a 3 percent growth rate expressed in quarterly logarithmic units. Next, the second term subtracts a magnitude equal to the average growth rate of base velocity over the previous four years. The purpose of that term is to provide a correction for long-lasting changes in velocity stemming from regulatory and technological change. A four year average is used to avoid incorporation of cyclical movements in velocity. Cyclical influences, finally, are accounted for by the third term, which calls for a stimulative increase in the base growth rate Δb_t when the previous quarter's value of nominal GNP was below its target value.

To determine whether the macroeconomic policy rule (1) could in fact keep nominal GNP close to a steady target growth path, given the existence of random shocks of various types, the researcher needs to conduct simulations that include such shocks in a system consisting of the rule and an econometric model that depicts the response of x_t to the rule-generated values of b_t.[14] The fundamental difficulty is that there is no agreed-upon model--in part because the macroeconomics profession has not developed a satisfactory model of the short run dynamic behavior of aggregate supply that governs the response of real variables to monetary policy actions.[15] Because of that problem, my preferred method of investigation has been to determine whether policy rule (1) will perform reasonably well in a variety of different models. Thus my 1988 study of the U.S. economy included simulations with two single-equation atheoretic specifications, several vector autoregression (VAR) systems, and three models that were intended to be structural (i.e., policy invariant). These latter models are quite small in scale but are designed to represent three leading theories of business cycle dynamics--the "real business cycle" (RBC) theory of Kydland and Prescott, the "monetary misperceptions" theory of Lucas and Barro, and a more

Keynesian theory (PC) patterned on the Phillips curve and price-adjustment specifications of the Fed's quarterly MPS model.

Principal results for the U.S. economy, in counterfactual simulations pertaining to the period 1954.1-1985.4, are summarized in Table 1. The entries in this table are root-mean-square errors (RMSE)--i.e., deviations from the target path--in simulations with systems including rule (1) and the five models indicated.[16] In each case the simulation begins with initial conditions prevailing at the start of 1954 and continues with shocks fed into the system each quarter, these shocks being estimated as residuals from the equations estimated in the various models. It will be seen that for λ values in the range of 0.1 to above 0.25, the RMSE values are about 0.02 (that is, 2 percent) with all five models.[17] Thus performance is satisfactory in all of these cases, and distinctly superior to that with $\lambda = 0$. Higher values of λ give rise to the possibility of dynamic instrument instability, which occurs with $\lambda = 0.5$ in the VAR system (and with $\lambda = 1.0$ in the other four systems). But with moderate values of λ, the rule succeeds in generating paths of x_t that are noninflationary and, in addition, somewhat smoother than those that have obtained historically. A plot of x_t and the constant rising target path of x_t^* for the PC model and $\lambda = 0.25$ is shown in Figure 1.[18]

Recently I have come to believe that a strong case can be made for expressing the GNP target in terms of growth rates, rather than levels corresponding to a single predetermined growth path. The main reason is that, since real shocks that affect the economy's natural-rate output level are highly persistent, it may be undesirable to quickly drive x_t back to the predetermined x_t^* path after shocks have arrived. Instead, it would seem preferable to treat past shocks as bygones, which could be accomplished by adopting $x_t^{**} = x_{t-1} + 0.00739$, rather than $x_t^* = x_{t-1}^* + 0.00739$, as the target value for period t. This sort of rebased growth-rate target has been favored

Table 1

Basic Results for U.S. Economy, 1954-1985

RMSE Values with Five Models

Model	Value of λ in Rule (1): 0.00	0.10	0.25	0.50
Single Equation	0.0488	0.0249	0.0197	0.0162
4-Variable VAR	0.0479	0.0216	0.0220	0.1656
Real business cycle	0.0281	0.0200	0.0160	0.0132
Monetary misperceptions	0.0238	0.0194	0.0161	0.0137
Phillips curve	0.0311	0.0236	0.0191	0.0174

Table 2

Additional Results for U.S. Economy, 1954-1985

Results with x_t^{**} Target Value and $\lambda = 0.25$

Model	RMSE relative to x_t^{**}	RMSE relative to x_t^{**}	RMSE relative to x_t^{*}	Standard deviation of Δb_t	Standard deviation of Δb_t using x_t^{*} target
Single Equation	.0102	.0104	.0244	.0041	.0063
4-Variable VAR	.0104	.0105	.0218	.0039	.0069
Real business cycle	.0105	.0109	.0197	.0043	.0054
Monetary misperception	.0110	.0116	.0184	.0039	.0051
Phillips curve	.0104	.0103	.0234	.0048	.0066

by several economists, including Feldstein and Stock (1993).[19] And the suggestion of using rebased growth rate targets merits serious consideration for two additional reasons. These are that instrument variability should be reduced for any given value of λ and that it should accordingly be possible to use larger λ values, implying stronger feedback, without inducing instrument instability.

Consequently, in my study of the Japanese economy (McCallum, 1993), I conducted several simulations using a modified version of rule (1) that substitutes x_t^{**} for x_t^{*}. These simulations produced encouraging results. They suggest, however, that an even more attractive rule would be one that uses a weighted average of x_t^{*} and x_{tt}^{**} as the target variable. Such a target would seem to provide most of the benefits of x_t^{**} without eliminating entirely the tendency to drive x_t back to a fixed path. A large portion of the Japanese study was, therefore, conducted with a target of this type. The weights chosen were 0.2 and 0.8 for x_t^{*} and x_t^{**} so the target variable utilized was $x_t^{*a} = 0.2\ x_t^{*} + 0.8\ x_t^{**}$. The resulting simulations indicated that RMSE values relative to the x_t^{**} path suffered very little deterioration while performance relative to the x_t^{*} path was substantially enhanced, relative to the case with x_t^{**} targets.

Let us then consider performance with our five models of the U.S. economy when x_t^{*a} is used as the target variable. Summary results for the simulation period 1954-1985 and $\lambda = 0.25$ are reported in Table 2. There it will be seen that RMSE values relative to the x_t^{*a} target are only about 0.01 and that RMSE values relative to the x_t^{*} path are not too far from those in Table 1. Furthermore, the variability of the Δb_t instrument is reduced considerably relative to its magnitude in the simulations of Table 1, in which x_t^{*} is the target.

In addition, for three of the models RMSE values have been obtained for an updated estimation and simulation period that extends through 1991.4. This updating is of interest and importance because of recent shifts in base demand and because the evidence of Hess, Small, and Brayton (1993) suggests that the performance of rule (1) with the x_t^* target has deteriorated in recent years. The models utilized are the basic single-equation version (because of its simplicity), the VAR system (which because of lags is perhaps the most difficult to stabilize), and the Phillips curve model (which is empirically the most satisfactory of the structural specifications). Summary results with λ values of 0.25 and 0.50 are reported in Table 3, with a plot of the Phillips curve case (λ = 0.5) shown in Figure 2. As can readily be seen, performance relative to the steady x_t^* path deteriorates noticeably, relative to Table 2, with λ = 0.25. The higher value of λ yields smaller RMSE values, however, as conjectured above. Most importantly, we see that performance relative to the utilized target, x_t^{*a}, is almost as good as with the shorter sample period. And since the argument above suggests that the x_t^{*a} targets are the most appropriate of those considered, the Table 3 results are quite encouraging.

We are now finally in a position to proceed with the main business of this section from the perspective of the present paper. That business is to generate quarterly time paths for the monetary base that conform to the macroeconomic policy rule (1), in order to determine whether a funds rate instrument can be used at the weekly frequency to achieve these base values at the quarterly frequency. For that purpose, let us adopt the time path of Δb_t implied by the 1954.1 - 1991.4 simulation with λ = 0.50 in the Phillips curve model. This model has been chosen as the one that is perhaps the most similar to models used by policy makers while the higher λ value has been chosen since it is the more demanding from the perspective of our upcoming

Table 3

Updated Results for U.S. Economy, 1954-1991

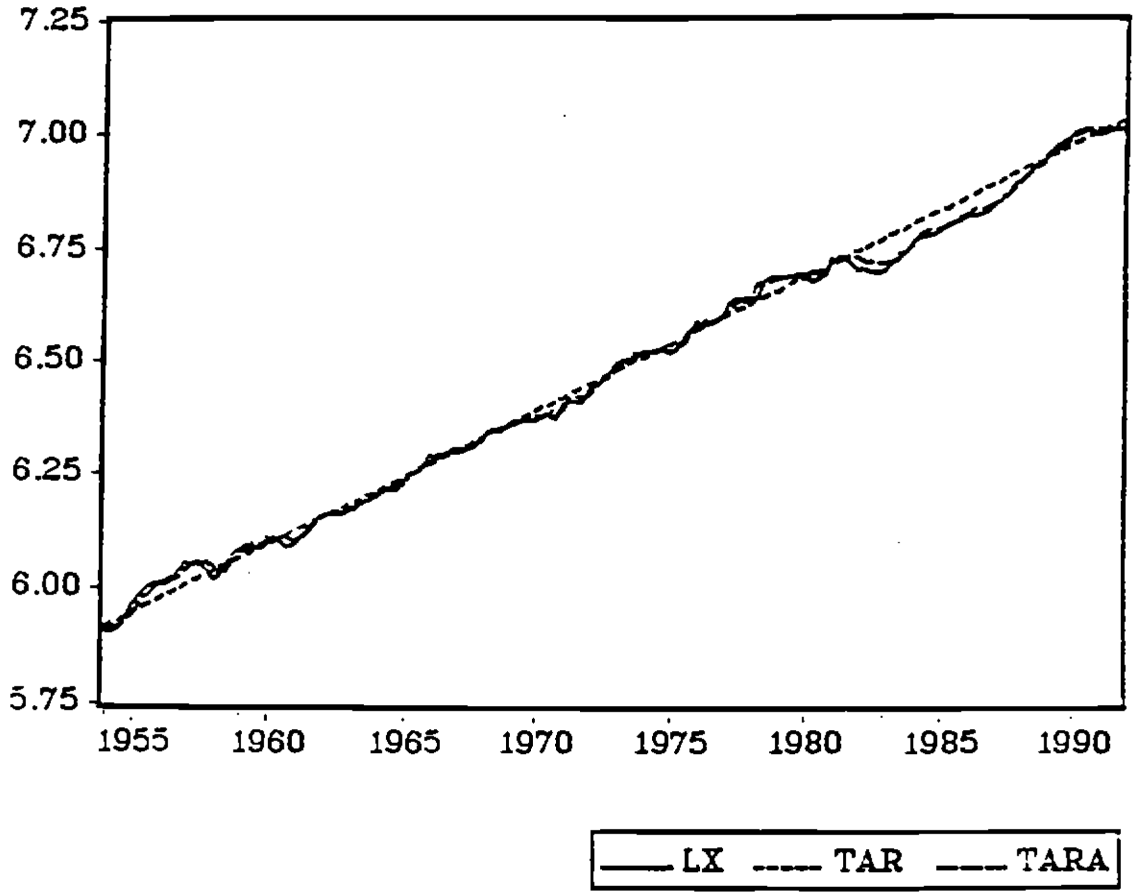
x_t^{*a} Target Values

	$\lambda = 0.25$			$\lambda = 0.50$		
	RMSE Relative to			RMSE Relative to		
Model	x_t^{*a}	x_t^{**}	x_t^{*}	x_t^{*a}	x_t^{**}	x_t^{*}
Single equation	.0125	.0099	.0413	.0109	.0099	.0305
4-variable VAR	.0111	.0100	.0306	.0107	.0104	.0239
Phillips Curve	.0110	.0099	.0343	.0103	.0100	.0260

Figure 2

Simulation with Target x_t^{*a},

Phillips Curve Model, and $\lambda = 0.5$: 1954-1991



TARA: target path x_t^{*a}

Table 4

Quarterly Values of Monetary Base
Implied by Simulation with
Rule (1), Target x_t^{**}, and $\lambda = 0.5$

obs	LB			
1954	3.699626	3.699201	3.701861	3.700723
1955	3.695663	3.685769	3.678821	3.670292
1956	3.663447	3.660838	3.653607	3.646640
1957	3.635705	3.622726	3.617845	3.607567
1958	3.610314	3.617946	3.615145	3.602111
1959	3.587843	3.577400	3.565968	3.567536
1960	3.566199	3.553598	3.555266	3.555225
1961	3.565991	3.571272	3.569220	3.566943
1962	3.562037	3.554727	3.551242	3.550338
1963	3.554655	3.556308	3.559981	3.559844
1964	3.562261	3.561246	3.564794	3.567481
1965	3.574026	3.566553	3.565190	3.563168
1966	3.557531	3.550862	3.552993	3.553147
1967	3.551403	3.552872	3.557957	3.557715
1968	3.559741	3.555497	3.550994	3.550638
1969	3.552911	3.550609	3.552800	3.552005
1970	3.558019	3.565338	3.571514	3.576477
1971	3.591054	3.586729	3.592183	3.599308
1972	3.609258	3.607779	3.609905	3.614645
1973	3.613902	3.609248	3.610332	3.613725
1974	3.609658	3.616153	3.617774	3.620023
1975	3.622591	3.633976	3.636605	3.629527
1976	3.624797	3.619938	3.622463	3.625583
1977	3.624269	3.621913	3.615692	3.610757
1978	3.615292	3.616438	3.599481	3.594176
1979	3.585975	3.581275	3.576563	3.570283
1980	3.571408	3.566808	3.577621	3.579534
1981	3.571942	3.559871	3.563561	3.562610
1982	3.570922	3.584987	3.595935	3.613094
1983	3.631518	3.649563	3.661737	3.677940
1984	3.690174	3.697853	3.710630	3.726509
1985	3.744710	3.761105	3.781000	3.800733
1986	3.821689	3.839503	3.864610	3.886189
1987	3.909599	3.927389	3.946029	3.963543
1988	3.978593	3.995090	4.010744	4.026279
1989	4.039557	4.051177	4.062631	4.073216
1990	4.084578	4.093219	4.103212	4.112802
1991	4.128195	4.144728	4.159743	4.172677

LB is the log of the St. Louis Fed's adjusted monetary base, measured in $ billions.

examination. Values of b_t for this simulation, which are reported in Table 4, imply corresponding Δb_t growth rates that will be used in the next section as the basis of intermediate targets specified at the weekly level, with the federal funds rate treated as the instrument variable.

IV. Hitting Base Targets with An Interest Rate Instrument

The purpose of this section and the next two is to determine whether it would be possible to exert sufficiently accurate base control, as suggested above, with an operating procedure that uses an interest rate instrument and involves rate smoothing as a means of providing LLR protection to the financial system. Our approach will be to conduct simulations with a system that pertains to weekly data for the United States. The system will consist of a policy rule that sets weekly values of the federal funds rate, together with a weekly model of monetary base determination that is intended to reflect the effects of federal funds rate behavior on realized magnitudes of the base. The model will be extremely simple, but should give some indication of the accuracy with which quarterly base targets can be achieved while holding down funds-rates movements, i.e., engaging in funds-rate smoothing.

The form of policy rule involved will be as follows, with time periods referring to weeks:

(2) $$R_\tau - R_{\tau-1} = -\theta[b^*_{\tau-1} - b_{\tau-1}]$$

Here R_τ denotes the funds rate (in annual percentage points) and b_τ denotes the log of the monetary base, both averaged over the week. The value b^*_τ is the target value of b_τ for week τ. The idea is that values of b^*_τ would be derived in practice from quarterly magnitudes specified by a higher-level policy rule such as those generated by equation (1) of Section III. For the purposes of the present exercise, b^*_τ values will be treated as exogenous and one objective will be to determine how closely realized b_τ values track those for b_τ^*. The magnitude of θ determines the tradeoff between feedback response and smoothing; small values imply a high degree of R_τ smoothing with relatively little response to b_τ target misses. The possibility under consideration is that, for a range of θ values, feedback responses will be strong enough to keep b_τ close to b_τ^* while weekly ΔR_τ values are nevertheless small (say, always less than 2 percent and typically much less).

The second ingredient of our system, then, is a model at the weekly frequency of the response of b_τ to fluctuations in R_τ. In principle, one would like to utilize a carefully specified and estimated structural model pertaining to banks' demand for reserves and the public's demand for currency. Data non-availability and time constraints have, however, made that infeasible. What I have done instead is to estimate a weekly univariate ARMA model for Δb_τ, which should serve to depict with fair accuracy the autocorrelation structure and variability of movements in the base. A term reflecting current-week responses to changes in the funds rate R_τ is then added to this relation, with the response coefficient being based partly on values taken from Federal Reserve literature and partly on empirical estimates. These estimates are generated from weekly movements in the funds rates and non-borrowed reserves, by means of a procedure that will be explained below. First let us consider the univariate dynamic behavior of b_τ, the log of the base.

Weekly ARMA models for Δb_τ have been estimated for five time periods, including Jan. 1969-Dec. 1978, Jan. 1974-Sept. 1979, Oct. 1979-Sept. 1982, Jan. 1983-Dec. 1991, and Jan. 1988-Dec. 1991. The estimates are presented in Table 5. In all five periods an AR(3) specification was found to be reasonably appropriate, but with point estimates that are fairly different for samples before, during, and after the 1979-1982 experience with "nonborrowed reserves targeting." In addition to the three AR terms, it was found that a moving-average term at lag 26 was significant in all five cases.[20] My interpretation is that this reflects some type of seasonal aberration that is present in the data but not in the market relationships that our ARMA model is intended to represent. This component will, accordingly, be suppressed in the simulations reported in Section V. The same is true for a dummy variable pertaining to one observation at the start of 1991, which will be discussed below.

Examination of the results in Table 5 suggests that the three later periods differ markedly from the first two, with negative coefficient estimates summing to absolute values greater than 1.0 in all post-1979 samples. Our first experiment, accordingly, will be based on one of the earlier periods. For the sake of sample-period homogeneity, the second sample--with exactly 300 observations--will be utilized.

To complete our model, that equation is augmented with the term $-0.0025\Delta R_{\tau}$, designed to reflect the immediate impact on the base of the open-market purchase or sale needed to bring about any programmed change in the funds rate. The magnitude of the slope coefficient was chosen on the basis of three different sources of information. The first of these is the rule-of-thumb relationship between borrowing levels and the funds rate-discount rate spread that, according to Cook (1989, p. 9) "the Fed has long used." That rule of thumb is described as $400 million per percentage point, but I would expect the <u>ratio</u> of borrowed to total reserves to be related to the interest spread with greater stability. A $400 million change in borrowed reserves would then amount to approximately a fraction of 0.02 of total reserves with the latter being about $20 billion at the date (May 1981) referred to by Cook. But a change in borrowed reserves brought about by an open market action would have an effect on the base of about the same magnitude in terms of <u>dollars</u>, so the percentage change in the base would be

Table 5

Weekly ARMA Models for Δb_t

Coeff.	Jan 1969-Dec 1978	Jan 1974-Sept 1979	Oct 1979-Sept 1982	Jan 1983-Dec 1991[a]	Jan 1988-Dec 1991[a]
Const.	.0022 (.0002)	.0026 (.0002)	.0027 (.0004)	.0034 (.0003)	.0028 (.0003)
AR(1)	-.4270 (.044)	-.4383 (.055)	-.6082 (.075)	-.7091 (.044)	-.6225 (.061)
AR(2)	-.0925 (.047)	-.0264 (.060)	-.2593 (.087)	-.4633 (.050)	-.3819 (.068)
AR(3)	-.1208 (.043)	-.1920 (.055)	-.3893 (.075)	-.1977 (.043)	-.2384 (.057)
MA(26)	.1480 (.045)	.3237 (.056)		.1737 (.046)	.4977 (.064)
R^2	0.193	0.328	0.439	0.449	0.574
SE	0.0029	0.0024	0.0042	0.0043	0.0037
DW	1.99	1.92	1.97	2.03	2.12
Q(36)	39.6	47.6	97.7	38.1	43.9

[a]Dummy variables also included for first week of 1991.

much smaller (and of the opposite sign). Taking 8 as the ratio of base to reserves, the 0.02 fraction in terms of reserves translates into about 0.0025 in terms of the base.[21]

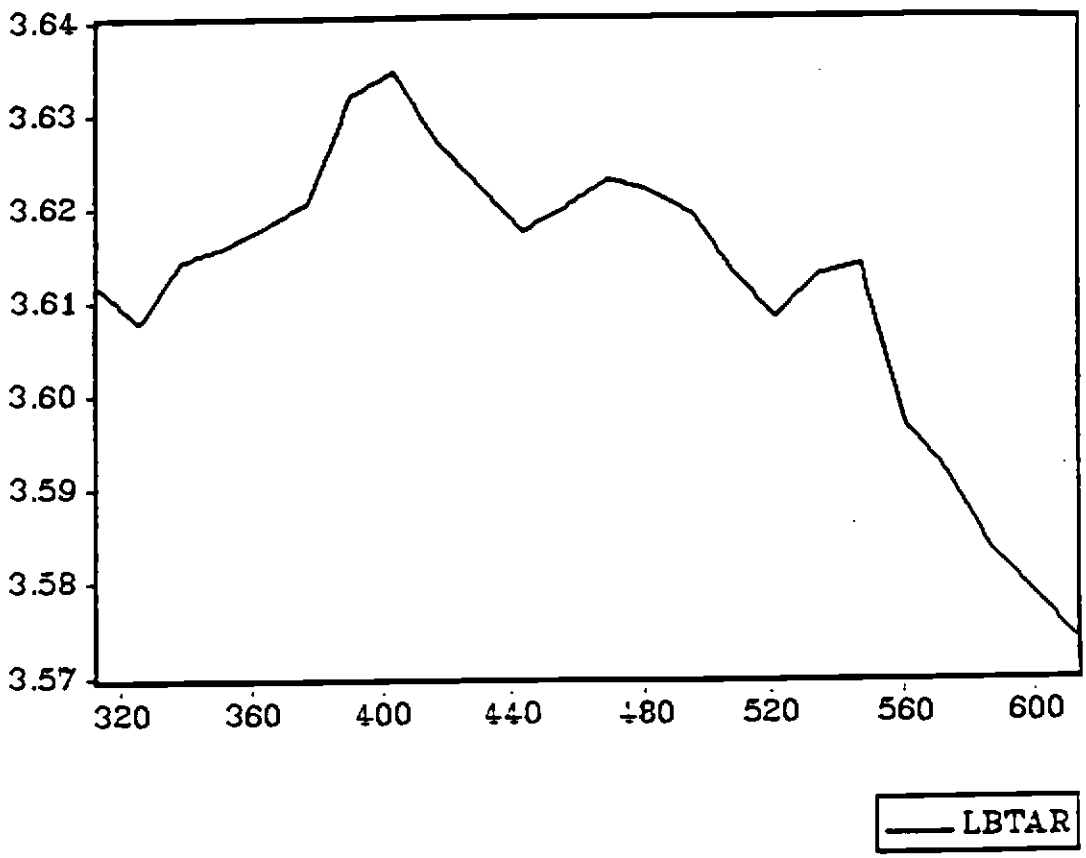
Our second source of information is a slope coefficient in a "daily reaction function" for the open market desk as estimated by Feinman (1993). The third column of Feinman's Table 1 suggests that a one percentage point excess of the funds rate, over its expected value, would induce the open-market desk to supply $1461 million in additional reserves. Presuming that the desk's action is designed to restore the funds rate to its expected level, this estimate appears at first to be considerably larger than that of the previous paragraph. But Feinman's quantity variable refers to the magnitude of effect on the average value of reserves over a two-week reserve maintenance period. So his value of $1461 million implies that this would be the magnitude of an action taken on the first day of the reserve maintenance period, with the implied figure being only half as large for an action taken in the middle of the two-week period. Taking this to be a "typical" day, we get a magnitude of $730 million per percentage point to be comparable to the $400 million of the previous paragraph. But Feinman's value pertains to a sample period of Jan. 1988 - Dec. 1990, during which time the average level of reserves was about $39 billion rather than $20 billion. So the fractional effect would be 0.730/39 = 0.0187 $billion/percentage point, which agrees very closely with the 0.02 figure (pertaining to reserves) of the previous paragraph.[22]

The third source of information is based on direct estimation of an equation similar to the one being considered, but in terms of non-borrowed reserves rather than the base. The reason that we have not attempted to estimate this relation with base data, by simply adding a ΔR_t term to the ARMA models of Table 5, is that weekly movements in the base are dominated by

Figure 3

Weekly Target Path for the Monetary Base,

Jan. 1974 - Sept. 1979



changes in currency or reserve demand rather than actions taken by the open market desk. But an increase in reserve demand would tend to produce an increase in the funds rate, so the estimated slope coefficient would tend to be positive rather than negative. With demand changes providing most of the movement, the response of concern is not identified in the data. There is more reason to believe, however, that the relevant response will be identified if nonborrowed reserves are used instead of the base.[23] And, indeed, least-squares estimation over the period Jan. 1974-Sept. 1979 yields the following values (with n_τ denoting the log of nonborrowed reserves):

(3) $$\Delta n_\tau = \underset{(.0012)}{0.0012} - \underset{(.0557)}{0.5471}\Delta n_{\tau-1} - \underset{(.0605)}{0.2312}\Delta n_{\tau-2} - \underset{(.0547)}{.2783}\Delta n_{\tau-3} - \underset{(.0054)}{0.0190}\Delta R_\tau$$

$$R^2 = 0.292 \quad SE = 0.0212 \quad DW = 1.97 \quad Q(36) = 92.2$$

Thus the estimated slope coefficient is almost exactly equal to the rule-of-thumb value cited by Cook (1989), in terms of reserve movements. So division by 8 will give almost the same slope coefficient as mentioned above for the base. The three sources of information agree quite closely in suggesting a response coefficient of about -0.0025.

In sum, the second equation in our simulation system is

(4) $$\Delta b_\tau = \text{const.} -0.4383\Delta b_{\tau-1} - 0.0264\Delta b_{\tau-2}$$
$$- 0.1920\Delta b_{\tau-3} - 0.0025\Delta R_\tau + e_{4\tau}.$$

Here $e_{4\tau}$ is the residual from the estimated equation in the second column of Table 5, so our simulation will feature shocks each period that reflect estimates of the shocks that actually occurred over the sample period of Jan. 1974-Sept. 1979.[24]

The other ingredient needed for simulation of the system (2) (4) is a set of values for the weekly targets b^*_τ. These are derived from the quarterly targets b^*_t, generated by policy rule (1), reported in Table 4. The quarterly values of b^*_t imply quarter-to-quarter growth rates Δb^*_t. These values have been divided by 13 to yield weekly growth rates Δb^*_τ that are constant within each quarter but change at each quarter's end.[25] Those Δb^*_τ rates then imply weekly values of b^*_τ. The target path so generated for Jan. 1974-Sept. 1979 is plotted in Figure 3.

Finally, an adjustment needs to be applied to the ARMA equation's constant term.[26] The reason is as follows. As a glance at Figure 3 will reveal, the base target values b^*_τ are decreasing, rather than growing, on average over the years 1974 - 1979. But the constant term in the estimated Δb_τ model in Table 5 is positive, since the base was actually growing over the sample period. In a complete model the average growth rate of the base would be determined endogenously, but our simplified weekly system does not include any component that would accomplish such an endogenization. That is, the system includes no mechanism that would generate a positive relationship between R_τ and Δb_τ values at low frequencies--i.e., on average over long spans of time. Only the short-term negative relationship is included. But the average value of Δb_τ generated in the simulation needs to match that of the Δb_τ targets; otherwise the weekly variations cannot possibly be matched. Consequently, the constant term in the ARMA model is altered to provide this match. In particular, the 0.0025 value reported in Table 5 for the Jan. 1974-Sept. 1979 sample is replaced with the value -0.000208 in the simulation runs.

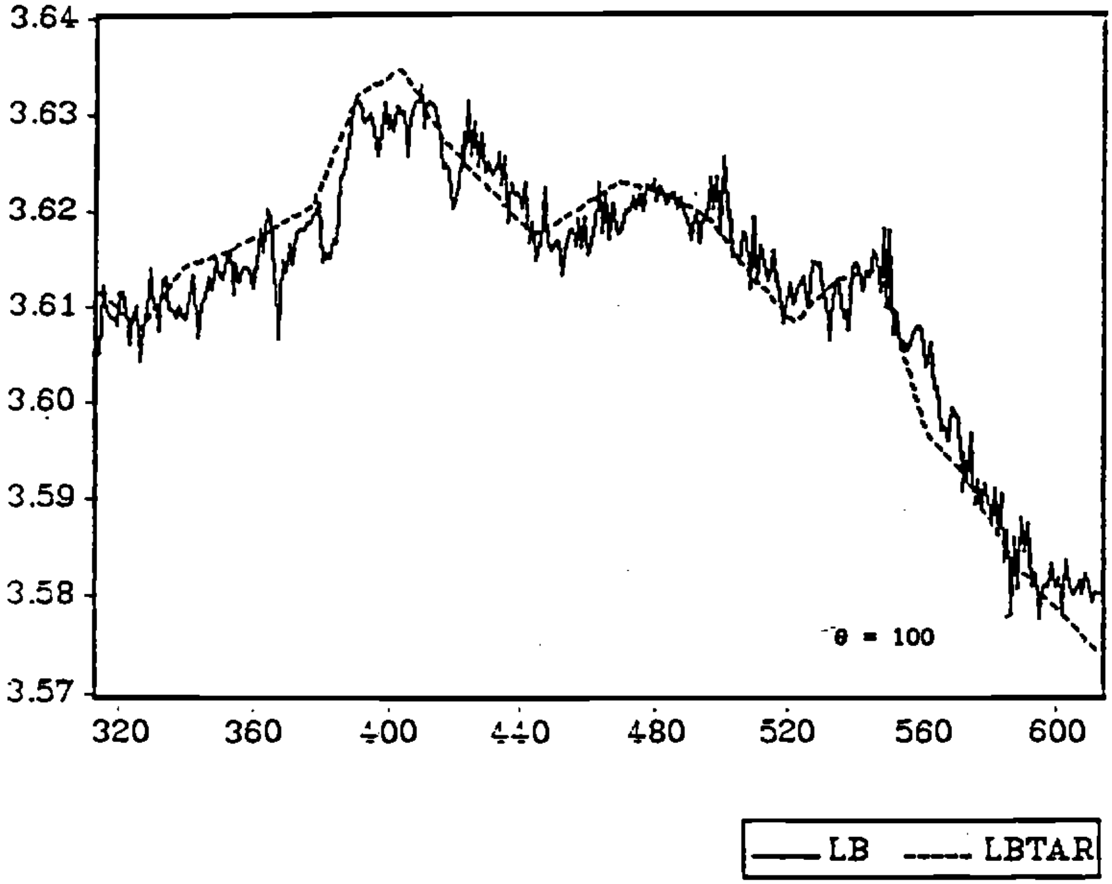
V. Basic Simulation Results

Let us now consider the outcome of the experiment described in the previous section. Some statistical results for four different values of θ, the policy parameter in rule (2), are given in Table 6. Before examining them, however, it may be useful to consult Figure 4, which plots the target path b^*_τ (denoted LBTAR) and the simulated path b_τ (denoted LB) in the case with $\theta = 100$. Visual inspection will show that the rule is rather successful in this simulation in keeping b_τ close to b^*_τ, especially when the unusually

Figure 4

Simulation with System (2) (4)

Jan. 1974 - Sept. 1979



LB: log of monetary base, simulated

LBTAR: target path, b_t^*

erratic nature of the target path is recognized.

In Table 6, summary statistics are reported for the following values of θ: 50, 100, 150, and 200. In the first row we have root-mean-square (RMS) values of the target miss, $b^*_\tau - b_\tau$, over the 300 weeks of the simulation period. Since b^*_τ and b_τ are natural logarithms, the RMS value is a measure of the typical error in fractional relative form. The second-column value 0.00370, for example, can be thought of as slightly above one-third of one percent. The second row indicates in the same fashion that the <u>maximum</u> deviation of outcome from target was just over one percent with $\theta = 100$, or nearly 1 1/2 percent with $\theta = 50$.

But how much interest rate variability is entailed? The last two rows give statistics pertaining to ΔR_τ, i.e., simulated weekly changes in the funds rate. Since R_τ is measured in (annualized) percentage points, these statistics also have those units. Thus in column two, we see that with $\theta = 100$ the RMS change is about 37 basis points while the largest week-to-week change in the 300 week sample is 120 basis points. These figures do not compare too badly with the actual historical record of Jan. 1974 - Sept. 1979, the actual RMS value being 0.21 and the largest absolute change being 158 basis points (which occurred between June 26 and July 3 of 1974).

The foregoing results are, I would contend, predominantly favorable to the suggestion under study, namely, that it would be possible to exert accurate base control with a procedure that involves smoothing--with its associated LLR properties--of an interest rate instrument. In the simulation with $\theta = 100$, for example, the implied degree of base control is highly accurate and funds rate variability is not excessive. In particular, there are no instances in which the required change in R_τ from the previous week would exceed 2 percent, the magnitude mentioned in Section II as a plausible limit reflecting Meltzer's penalty rate or the Goodfriend-King bound under a

Table 6

Simulation Results, System (2) (4)

Jan. 1974 - Sept. 1979

For $b^*_\tau - b_\tau$	$\theta = 50$	$\theta = 100$	$\theta = 150$	$\theta = 200$
RMS	.00534	.00370	.00317	.0030
MAV*	.0145	.0120	.0108	.0100
For ΔR_τ				
RMS	.265	.369	.474	.600
MAV*	0.73	1.20	1.62	1.99

*MAV denotes "maximum absolute value."

Table 7

Simulation Results, System (2) (5)

Jan. 1988 - Dec. 1991

For $b^*_\tau - b_\tau$	$\theta = 50$	$\theta = 100$	$\theta = 150$	$\theta = 200$
RMS	.00739	.00529	.00461	.00447
MAV	.0213	.0161	.0146	.0148
For ΔR_τ				
RMS	.369	.529	.692	.893
MAV	1.06	1.61	2.20	2.96

regime with LLR smoothing.[27]

In this context it may be of interest to determine how much R_τ variability would be entailed, in the model at hand, by exact base control. An answer can be obtained by replacing equation (2) in our simulation system with the condition $b_\tau = b_\tau^*$ and using (4) to determine a time path for R_τ. That exercise indicates that the RMS value for ΔR_τ, the one-week change in the funds rate, would be 0.998 percent, almost three times as large as in column 2 of Table 6. The maximum weekly change furthermore would be 3.64 percent--again about three times as large as with rule (2) and $\theta = 100$.

Now let us turn to our second selected time period for estimation and simulation results, namely, Jan. 1988 - Dec. 1991.[28] The simulation system is similar conceptually to the one used above and indeed includes policy rule (2) as before. The target path for b_τ^* is, however, quite different: it rises continually (though at varying rates) in contrast to the up-and-down path of Figure 3. The relation to be used in place of (4), based on the final column of Table 5, is as follows:

(5) $$\Delta b_\tau = \text{const.} - 0.6225\Delta b_{\tau-1} - 0.3819\Delta b_{\tau-2} - 0.2384\Delta b_{\tau-3} - 0.0025\Delta R_\tau + e_{5\tau}$$

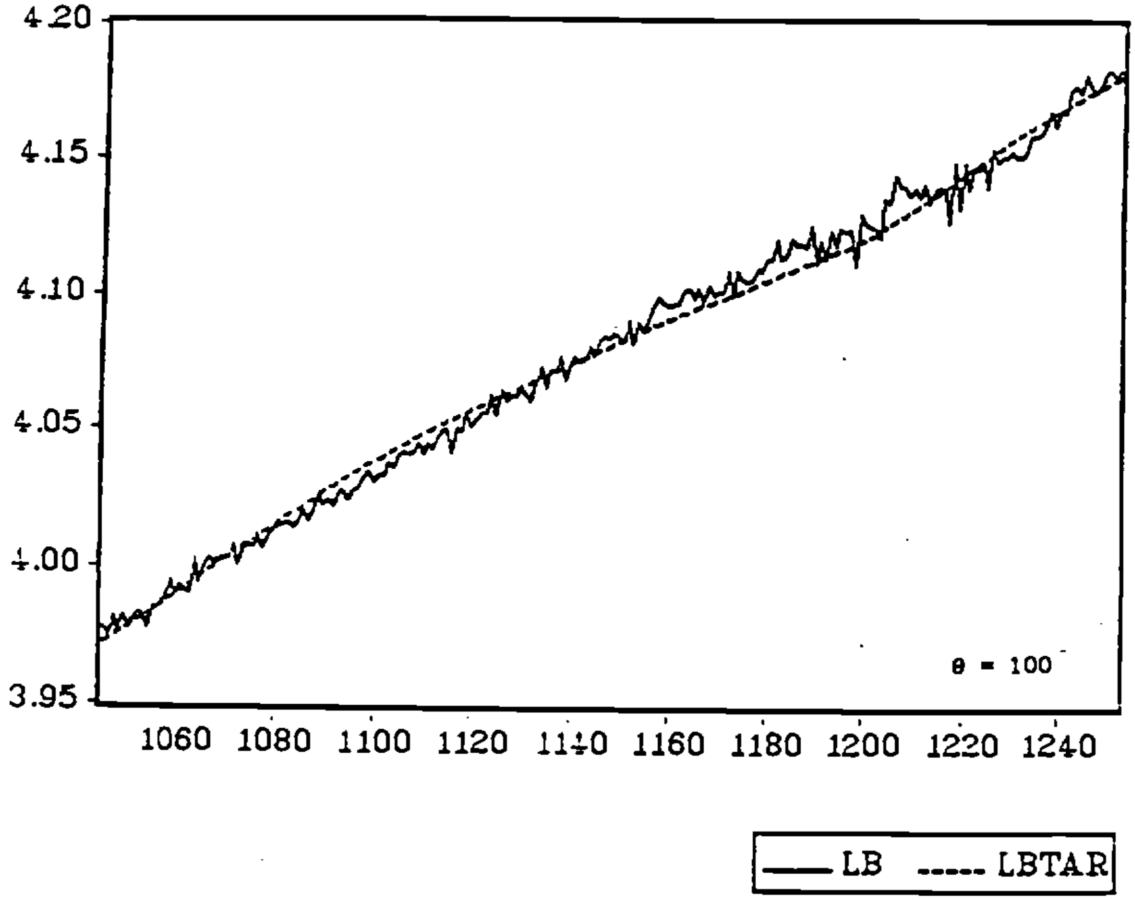
Here the utilized constant term is 0.0024, designed to match the sample trend as explained above for equation (4), and the MA(26) term has again been dropped for the simulation. In addition, the dummy variable mentioned in Table 5 has been suppressed. This dummy was included in the estimation stage because the St. Louis Fed's base statistics show a $10 billion increase in the week of Jan. 2, 1991, which is then reversed in the week of Jan. 9, 1991. This spike would appear to reflect a year-end or some other type of aberrational effect that our model is not intended to reflect.

The same slope coefficient for the effect of ΔR_τ on base growth is used

Figure 5

Simulation with System (2) (5)

Jan. 1988 - Dec. 1991



in (5) as in (4). That specification has been retained to be conservative despite the suggestion of a steeper slope provided by a regression estimate comparable to (3) but for the sample period 1988-1991.[29] There are two features of equation (5) that need to be mentioned. First, the values of the AR coefficients sum to -1.257, a somewhat larger negative number than in (4). Second, the variability of $e_{5\tau}$ is--as shown in Table 5--considerably greater than for $e_{4\tau}$, making accurate base control somewhat more difficult.

Results of the simulations are presented in Figure 5 and Table 7. The target path in the former is so different from that in Figure 4 that comparison is difficult. The statistic values reported in Table 7 verify, however, that base control is somewhat less accurate than in the 1974-1979 regime for a given level of ΔR_τ variability. Thus, a value of $\theta = 50$ yields about the same RMS value for ΔR_τ as with $\theta = 100$ in Table 6, but the RMS control error for b_τ is 0.0074 instead of 0.0037. Nevertheless, the results are still reasonably supportive of the Goodfriend-King proposal. With $\theta = 50$ or $\theta = 100$, the maximum value of ΔR_τ in the simulations stays below 2.0 and fairly tight base control is achieved. The actual sample values of RMS and MAV for ΔR_τ, incidentally, are 0.18 and 1.14.[30]

VI. Additional Results

In addition to the basic results reported in the previous section, a few more have been obtained using variants of the equations of the simulation system. The first variant alters the policy rule (2) so as to use the average value of $b_\tau^* - b_\tau$ over the previous two weeks, rather than one week, as the discrepancy to which the Fed responds. Because of the large negative value attached to $\Delta b_{\tau-1}$ in the ARMA models (4) and (5), it seems possible that such a change could reduce R_τ variability without substantially impairing the extent of base control. Results relevant to that possibility are presented in the top panel (System A) of Table 8, where it can be seen that there is not much difference for the 1974-1979 period, but that a noticeable reduction in variability of R_t occurs in the later (1988-1991) period. With θ = 100, for example, the RMS value for ΔR_t is reduced from 0.529 to 0.469 and the maximum absolute value from 1.61 to 1.41.

A second variant to the system involves a change in the slope coefficient attached to ΔR_t in our model of base determination--equation (4) or (5). It was mentioned above that our estimation of a relation like (3) for 1988-1991 yielded a larger estimate of the slope than those in the three basic sources of information. Furthermore, the rule-of-thumb cited by Cook (1989) pertains only to the slope of the borrowing function and thus does not include any effect working through money demand--e.g., any tendency for an open-market purchase and reduction in R_t to increase the quantity of money demanded. That neglect is perhaps appropriate for a one-week response coefficient, but it might be argued that it tends to understate the magnitude of the response. In any event our experiment in the middle panel of Table 8 presumes that the slope is -0.005, twice the value used above.

With θ = 100, the rule's performance is somewhat better than previously, especially for the 1988-1991 sample period. But with θ = 150, performance is actually worsened. That outcome is somewhat surprising, since a larger slope would seem to imply that Δb_t would be more controllable via manipulation of R_t. But apparently the system becomes uncomfortably close to suffering from instrument instability with the larger feedback coefficient θ.

That problem is mitigated, however, when the averaged discrepancy in the policy rule of System A is combined with the stronger response coefficient of System B. In the resulting System C, the performance measures (given in panel three of Table 8) are almost uniformly better than those in Tables 6

Table 8

Additional Simulation Results

		Period 1974-1979		Period 1988-1991	
		$\theta = 100$	$\theta = 150$	$\theta = 100$	$\theta = 150$
System A					
$b^*_\tau - b_\tau$	RMS	.0037	.0032	.0053	.0045
	MAV	.0127	.0120	.0159	.0153
ΔR_τ	RMS	.343	.418	.469	.559
	MAV	1.00	1.44	1.41	1.77
System B					
$b^*_\tau - b_\tau$	RMS	.0030	.0039	.0045	.0053
	MAV	.0100	.0107	.0147	.0180
ΔR_τ	RMS	.300	.581	.446	.795
	MAV	1.00	1.62	1.48	2.70
System C					
$b^*_\tau - b_\tau$	RMS	.0029	.0027	.0041	.0039
	MAV	.0114	.0103	.0155	.0153
ΔR_τ	RMS	.245	.316	.323	.416
	MAV	0.93	1.31	1.03	1.43

Note Systems A and C use the average $b^*_\tau - b_\tau$ discrepancy for $\tau-1$ and $\tau-2$ in rule (2); systems B and C use 0.005 as the ΔR_τ slope coefficient in models (4) and (5).

and 7. Indeed, with $\theta = 100$ they are quite favorable. This finding suggests that other specifications of the policy rule could be substantially superior to our equation (2), but a systematic investigation of that possibility will have to be reserved for future study. The object of the present paper is to explore the feasibility of a Goodfriend-King type of rule, not to attempt an optimization analysis.

The two sample periods utilized in our study were chosen for reasons--concerning possible regime changes and conformity with previous studies--that have considerable merit. Several commentators on the paper have suggested, however, that the study's value would be greater if the stock market crash of September 1987 were included in the second sample and simulation period. Accordingly, additional results have been obtained with that period extended so as to include July 1987 - Dec. 1991, rather than Jan. 1988 - Dec. 1991.

With that extension, the estimated weekly ARMA model corresponding to those in Table 5 differs only slightly from the results in the final column. In particular, the SE value rises only to 0.0038 (from 0.0037) and the Q(36) statistic actually falls somewhat, to 38.4. With the MA(26) coefficient and the Jan. 2, 1991 dummy variable again suppressed, and the constant term obtained as before, the implied base growth model is as follows:

$$(6) \qquad \Delta b_{\tau} = 0.0035 - 0.6436\Delta b_{\tau-1} - 0.4038\Delta b_{\tau-2} - 0.2156\Delta b_{\tau-3} - 0.0025\Delta R_{\tau} + e_{6t}.$$

Results using the basic policy rule (2) with θ values of 100 and 150, and also the three variants introduced in this section, are reported in Table 9. There it will be seen that inclusion of the October 1987 stock market crash in the sample and simulation periods does not significantly alter the outcome of our exercise. In fact, the results are slightly <u>better</u> than those reported for 1988-1991 in Tables 7 and 8. That finding, which is somewhat

Table 9

Simulation Results, System (2)(6)

July 1987 - December 1991

For $b^*_\tau - b_\tau$	Basic System $\theta = 100$	Basic System $\theta = 150$	System B $\theta = 100$	System B $\theta = 150$
RMS	.00512	.00451	.0044	.0051
MAV	.0153	.0148	.0149	.0183
For ΔR_τ				
RMS	0.512	0.677	0.438	0.760
MAV	1.53	2.23	1.49	2.75

For $b^*_\tau - b_\tau$	System A $\theta = 100$	System A $\theta = 150$	System C $\theta = 100$	System C $\theta = 150$
RMS	.0051	.0044	.0040	.0039
MAV	.0153	.0155	.0156	.0154
For ΔR_τ				
RMS	0.449	0.541	0.316	0.412
MAV	1.35	1.71	1.00	1.43

surprising, stems from the fact that residuals from the estimated ARMA model for Δb_t are not so large at the time of the crash as to outweigh their relatively small size during the remainder of the second half of 1987.

VII. Conclusion

It may be useful to conclude with a summary of the foregoing analysis and results. The argument begins by noting that a central bank's dual objectives of macroeconomic and financial stability imply a tension that may be expressed in terms of the following question: is the adherence to a macro-oriented rule for monetary policy compatible with satisfaction of a central bank's lender-of-last-resort (LLR) responsibilities? In Section II, a brief review of alternative views on the LLR role indicates that a proposal by Goodfriend and King (1988) might provide a way of reconciling the two objectives. For the proposal is to have LLR assistance supplied entirely by open-market operations, with no discount window lending but with high-frequency smoothing of movements of a money market interest rate. The point is that smoothing of day-to-day or week-to-week movements in this interest rate would automatically trigger open-market purchases whenever a sharp increase in the demand for high-powered money happened to occur. But such week-to-week smoothing could perhaps be compatible with use of this interest rate as an instrument for hitting slightly lower-frequency (e.g., quarterly average) intermediate targets conforming to a monetary policy rule designed to yield desirable macroeconomic performance.

The bulk of the present paper constitutes an attempt to explore this possibility quantitatively. Previous results pertaining to one macro-oriented quarterly policy rule for the United States are reviewed and used to generate weekly intermediate targets for the monetary base. Then (in Sections IV-VI) an empirically based weekly model of monetary base determination is developed and simulated together with a federal funds rate rule that entails weekly smoothing. The base growth model consists of an estimated ARMA equation with an additional term reflecting the response of the base to weekly changes in the federal funds rate, with the response coefficient based on three (compatible!) sources of information. Counterfactual weekly simulations, in which the funds rate is adjusted so as to hit base targets while practicing smoothing, are conducted for two sample periods; Jan. 1974 - Sept. 1979 and Jan. 1988 - Dec. 1991. Residuals from the ARMA model are fed into the simulation runs as estimates of shocks hitting the system.

The results of these simulations are predominantly supportive of the idea that the scheme under investigation would be successful. In particular, they suggest that quarterly base targets could be achieved rather accurately--with weekly root-mean-square (RMS) errors of about 0.5 percent--while holding weekly interest rate changes to less than 2 percentage points in all weeks and with a RMS average of about 0.5 percentage points. This last figure naturally reflects somewhat more interest rate variability than has been experienced in the United States, but the increase is not dramatic--actual RMS values for our two sample periods were about 0.2 percentage points with a maximum of almost 1.6.

It would admittedly be desirable in principle to conduct this type of exercise with a more elaborate and more nearly structural model of base determination. But data limitations and identification problems make the feasibility of such a study questionable. In any event, the results developed here should be useful as an initial quantitative indication of the workings of a macroeconomic policy rule for the lender of last resort.

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Footnotes

[1]Here I have described the first goal as "macroeconomic stability" rather than "price level stability" since most central banks are evidently concerned with the mitigation of cyclical fluctuations in economic activity as well as the avoidance of inflation. Issues involving the relative weight to be attached to these two aspects of macroeconomic stability will not be explicitly considered in this paper.

[2]See, for example, Summers (1991) and Solow (1982).

[3]Friedman (1960) argued much earlier for elimination of the discount window. His proposal is significantly different from that of Goodfriend and King, however, since it calls for a system with 100 percent reserves and does not promote interest rate smoothing. Other recent arguments for closing the discount window have been put forth by Kaufman (1991) and Schwartz (1992).

[4]Since Bagehot's proposal involves a penalty rate, it would appear that one could replace "at times of crisis" with "at all times." This implication was not mentioned by Bagehot, however, and has also been ignored by most writers on the subject.

[5]For a more complete discussion of Bagehot's position, see Humphrey (1989, 1992).

[6]More typical, I believe, is the view taken by Nakajima and Taguchi (1993).

[7]Although their main purpose is to present their own analysis and proposal, Merton and Bodie (1993) provide a large number of references. A synopsis of bank failures is provided by Goodhart and Shoenmaker (1993).

[8]As I have not provided evidence on this point, my statement is actually a conjecture. To develop such evidence adequately would itself consitute a major study.

[9]Regarding this claim, Humphrey (1992, p. 572) asserts that "Bagehot undoubtedly would have concurred"!

[10]Cagan also puts forth the argument that the incremental social costs of maintaining the discount window (and reserve requirements) are low, given that elimination of deposit insurance and its associated regulatory apparatus is politically out of the question.

[11]It might be thought that a counterargument involving learning behavior, rather than rational expectations, has recently been put forth by Howitt (1992). It is my impression, however, that this argument pertains to pegging rather than use of the interest rate as an instrument.

[12]That the central bank's role in providing daylight overdraft credit to the payments system does not fundamentally conflict with the Goodfriend-King proposal is implied by the analysis of Nakajima and Taguchi (1993, p. 32) who conclude that "if the role of the central bank ... is limited to settlement risk, ... [then] hardly any conflict of interest would arise between its regulatory responsibility and its monetary objective."

[13]Some readers may ask why we do not simply design an interest rate rule at the quarterly frequency to hit the macroeconomic targets, i.e., nominal GNP values. The answer is that the evidence in McCallum (1990a) and (1993) suggests that it is much more difficult to design an interest rate rule at the quarterly frequency with good macroeconomic properties. Indeed, attempts to date have been rather unsuccessful.

[14]The next few pages draw on the discussion in McCallum (1993).

[15]For additional discussion of this point, see McCallum (1988).

[16]Only one of the VAR systems considered in McCallum (1988) is included.

[17]It might be noted for comparative purposes that the RMSE value for the actual historical path is 0.771, over 30 times as large as the cases with the rule and a moderate λ. A more relevant comparison is the RMSE for the actual historical path relative to a fitted trend line; that value is 0.0854.

[18]These results were developed in my 1988 paper. In McCallum (1990a) it was found that substitution of an explicit price level target, rather than nominal GNP, is somewhat less satisfactory since it leads to an increased likelihood of instrument instability. Also, a few experiments with an interest rate instrument were attempted. In McCallum (1990b) the purpose was to determine whether adherence to rule (1) would have prevented the Great Depression of the 1930s. Counterfactual historical simulations for 1923-1941 were conducted with a small model of GNP determination, estimated with quarterly data for 1922-1941. The simulation results suggest 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 seems extremely unlikely that real output and employment would have collapsed, as they did in fact.

[19]Such a target would result in a nominal GNP path that has a unit-root component--indeed, that is close to a random walk with drift. But if the drift magnitude were 0.00739, or whatever is the average rate of output growth, then expected inflation over any horizon would be zero. Furthermore, price level variability over practical planning horizons would not be excessive if the variability of $x_t - x_t^{**}$ were small.

[20]This term is not included in the third column results of Table 5, which pertain to the Oct. 1979-Sept. 1982 period. The reason is that it enters much too strongly when included, suggesting a parameter redundancy situation.

[21]The argument of this paragraph can be spelled out more explicitly as follows. Let θ = (1/TR)dBR/drs be the parameter that is estimated as 0.02 on the basis of the quoted rule of thumb, with BR, TR, NBR, and rs denoting borrowed reserves, total reserves, nonborrowed reserves, and the funds rate-discount rate spread. But we presume that the relevant experiment is an open-market purchase (sale) that increases (decreases) nonborrowed reserves leaving borrowed reserves unaffected. The estimate of θ is then interpreted as (-1/TR)dNBR/drs = (-1/TR)dTR/drs and therefore as -dlogTR/drs. But with currency assumed not to respond within the week, we have dB/dTR = 1 (where B denote the base) so dlogB/dlogTR = (TR/B)dB/dTR = TR/B. Thus we finally obtain dlogB/drs = (dlogB/dlogTR)dlogTR/drs = $-\theta$(TR/B) = -0.02/8 = -0.0025.

[22]Feinman (1993) reports a smaller estimated value for the sample period Feb. 1984-Oct. 1987. But policy behavior during the 1988-1990 period should be more like that of 1974-1979, since both of these featured tighter control of the funds rate. During 1984-1987 the operating procedure was one of the "borrowed reserves targeting" type.

[23]This suggestion is related to a major theme of a recent paper by Christiano and Eichenbaum (1992).

[24]A weakness of our procedure that pertaims to this sample period is as follows. Since our simulation exercise presumes that total reserves (not currency) is the component of the base that responds during the week to open market actions, we are implicitly assuming that the regime is not one with lagged reserve requirements (which makes the demand for reserves almost entirely predetermined). That is of course counterfactual for 1974-1979.

[25] There is a slight timing inconsistency in my procedure, since quarter-to-quarter growth rates based on quarterly averages have been used for each week within a quarter. But that is of virtually no consequence, given the purpose of the present study--to see if the b^*_τ path can be matched by simulated b_τ values.

[26] This adjustment provides the reason why the constant term is designated "const.," with no numerical value listed, in equation (4).

[27] One unattractive feature of the results is that ΔR_τ values are predominantly negative over one long portion of the simulation period, and thus lead to large negative values for the level of R_τ. But that is arguably an artifact of the functional form used in (4): if a log-log function had been used instead, it would not have been possible to drive R_τ negative. I have kept the semi-log form nevertheless to avoid departing even farther from the Fed's "rule of thumb" relationship between borrowing and the funds-discount rate spread.

[28] In this case the initial date was chosen to coincide with that promoted by Feinman (1993). A few readers have suggested that the period of "non-borrowed reserves targeting," Oct. 1979 - 1982, would be appropriate for the study. My belief is just the opposite; the combination of a reserves instrument plus a regime with lagged reserve requirements is extremely poorly suited to monetary control and so would suggest much greater volatility than would be experienced under a more sensible regime.

[29] For this period, weekly-average statistics on nonborrowed reserves include observations only for every other week. With ΔR_τ denoting the two-week change in R_τ, the estimated relation is $\Delta n_\tau = .0017 - .4812\Delta n_{\tau-2} - .1665\Delta n_{\tau-4} - .033\Delta R_\tau$, with $R^2 = 0.314$, SE = .017, and no evidence of autocorrelation in the residuals.

[30] Again we can find how much R_τ variability would be required for exact base control, according to our model. The RMS and MAV figures are 1.50 and 5.50 for the 1988-1991 internal, considerably larger--as one would expect--than for 1974-1979.