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*All views expressed in this paper are those of the authors and are not necessarily those of the Federal Reserve Bank of Chicago or the Federal Reserve System.

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LESSONS FROM THE EXPERIENCE WITH MONEY GROWTH TARGETS

ABSTRACT

The cutting edge of recent efforts to reshape monetary policy in many countries has been to impose a price target on the central bank. This paper examines such a policy in light of the Federal Reserve System's experience with money targeting from the late 1970s through the mid 1980s. The empirical analysis documents the Federal Reserve's initial use and subsequent disregard of money growth targets, and shows that abandoning these targets was a sensible response to the changing mix of shocks affecting the U.S. economy -- specifically, an increase in the relative volatility of money demand shocks. This experience provides little ground for confidence that a price target would be optimal for U.S. monetary policy. Even if the structure of the relevant shocks at any particular time were to appear favorable, a policy based on a price target would likewise be undermined if the relative volatility of aggregate supply shocks increased.

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Sometimes it is hard to leave well enough alone. During the first half of the 1980s, U.S. monetary policy was the central actor at work in reducing the American economy's ongoing rate of price inflation from low double digits to low single digits -- and, moreover, doing so at a real cost that was at most consistent with existing estimates of the cost of disinflation, if not perhaps a little better. In the first half of the 1990s, inflation slowed yet further, again at a real cost well within the range of standard "sacrifice ratio" calculations. For well over a year, as of the time of writing, unemployment has been at or below the conventional 6% estimate of the corresponding "non-accelerating inflation" rate, while inflation itself, after allowance for the upward bias in the current consumer price index (as recently evaluated by the Boskin Commission), is within one percentage point of absolute zero. Yet despite this impressive track record of achieved success, over a period now spanning a decade and a half, there is still no end of calls for fundamental reform of the way in which the Federal Reserve System goes about making monetary policy.

For practical purposes the cutting edge of this urge to redesign the U.S. monetary policymaking framework is a bill, currently pending before the United States Senate, that would formally establish the target of price stability as the Federal Reserve's sole ongoing policy guideline. In recent years several other countries have likewise adopted either a price-stability target or an inflation target for their central banks, including New Zealand (1990), Canada (1991), the United Kingdom (1992) and Sweden (1993). In none of those countries, however, was the experience of either inflation or real growth in the years leading up to this change anything like as favorable as it has been lately in the United States. Moreover, the United Kingdom and Sweden adopted their inflation targets in the wake of sizeable currency devaluations as they withdraw from the European exchange rate mechanism. By contrast, in the United States the proposal to institute a formal price-stability target reflects less a response to a current problem (what is it?) than a generic desire to impose constraints on the central bank.

This desire is of long standing, and it has given rise to an extremely rich literature of theoretical analysis as well as empirical evaluation.[1] A constant thread running throughout that literature is the crucial tension between the valid objective of making directly responsible to higher political authority what is, after all, an essential governmental function and the also valid objective of leaving monetary policy free to respond as appropriate to unforeseen contingencies: in other words, "rules versus discretion." The heart of the matter, as Tobin (1983) and others have long emphasized, is that while in theory it may be possible to design a rule that specifies in advance the central bank's response under an extremely wide variety of circumstances, in practice the only effective rules in this context are simple rules.[2] Giving up policymakers' discretion is therefore likely to be costly, and so imposing a policy rule on a central bank is worth while only if doing so avoids some even greater cost.

Fifteen years ago, when high and rising inflation rates loomed as a (in some cases, the) major economic issue in many industrialized countries around the world, the theory of "time inconsistency" plausibly suggested that this inflation was a natural consequence of a policymaking framework that allows for discretionary monetary policy, so that the gain from restricting that discretion by a policy rule was potentially large. Today that claim is far less persuasive. Not only have most countries succeeded in slowing their economies' inflation, in most cases they have done so under monetary policymaking institutions no different from what they had before. The United States is an especially good example in this regard. It is therefore ironic that a price-stability target, which would directly address the time inconsistency problem, should be proposed just as time inconsistency no longer appears as a compelling concern.

The more general point is the tendency, which may be inevitable, for policy rules to fight the last war -- or, more accurately for purposes of monetary policy, fight the same war on last time's terrain -- in the sense of preparing policy to respond only to those contingencies that have actually occurred in the fairly recent past, rather than those that will arise in the future when the rule is in place. To be sure, assessing the potential importance of different kinds of disturbances when looking backward is far less problematic than when looking forward. But that is precisely the point.

The object of this paper is to examine this tendency to impose policy rules that amount to fighting the war on last time's terrain by studying the last effort by Congress to impose a form of working rule on U.S. monetary policy: the injunction, under Concurrent Resolution 133, to formulate monetary policy by setting explicit targets for money growth. In brief, beginning in 1975 Congress required the Federal Reserve to establish specific numerical money growth targets, publicly announce these targets in advance, and report back to Congress on its success or failure to achieve them. In 1979 the Federal Reserve publicly declared an intensified dedication to controlling money growth and implemented new day-to-day operating procedures designed to enhance its ability to do so. In 1987 the Federal Reserve gave up setting a target for the narrow money stock (M1) but continued to set targets for broader measures of money (M2 and M3). In 1993 the Federal Reserve publicly acknowledged that it had "downgraded" even its broad money growth targets -- a change that most observers of U.S. monetary policy had already noticed some time before. Since 1993, the Federal Reserve has continued to report to Congress "ranges" for broad money growth (Congress has never repealed Resolution 133, and so the requirement to do so remains the law of the land), but it scrupulously avoids ever designating these ranges as targets -- or, for that matter, even saying what is their relevance to monetary policy.[3]

Section I presents evidence documenting that the Federal Reserve did -- for a while -- genuinely use its money growth targets to conduct monetary policy, but eventually wound up ignoring the targets even through the legislation calling for their use remained (and today remains) in force. Section II shows that the abandonment of money growth targets was a sensible response on the Federal Reserve's part to the collapse of prior empirical relationships between money and either output or prices. Section III poses the question of why these empirical money-output and money-price relationships disintegrated as they did, suggesting four different hypotheses with sharply differing policy implications. Section IV exploits a more structured analysis to test the three of these four hypotheses that cannot be immediately rejected by mere inspection of the relevant data. To anticipate, the evidence points mostly toward increased instability of money demand as the main reason why observed money growth lost its predictive content with respect to fluctuations of either output or prices, and therefore why targeting money growth became untenable as a way of conducting monetary policy. Section V uses these conclusions to draw lessons about the likely usefulness of the proposal now to direct the Federal Reserve to follow a price-stability target.

I. The Use and Disuse of Money Growth Targets[4]

Observing what central banks do is usually straight forward. Establishing why they have done it is more problematic. Central bank purchases and sales of securities, the resulting changes in bank reserves, and fluctuations in the relevant short-term interest rate are all known data not long after the fact. But few central banks make clear -- genuinely clear -- just why they have chosen the actions they have taken.

The usual critics notwithstanding, the problem in this regard reflects more than a mere preference for obfuscation. Under institutional arrangements like those at the Federal Reserve System, where the key decision-making authority rests in a sizeable committee (the Open Market Committee has twelve voting members), different participants in the policy process may have differing reasons for favoring the same action. Requiring them to agree not only on what to do but on a precise statement of why they choose to do it would significantly raise the hurdle facing a policymaking process that must play out in real time. The situation is even more complicated in that the Federal Reserve is legally responsible to the Congress, which historically has been not only vague and inconsistent in stating its objectives for monetary policy but also -- as subsequent sections of this paper argue -- slow to alter its formal charges to the Federal Reserve as economic circumstances have changed.

Has the Federal Reserve, then, actually attempted to implement its stated money growth targets? And if so, how would one know?

If there were never any disturbances to the relationships connecting money growth to prices and real economic activity, pursuing a money growth target would be empirically indistinguishable from simply varying the interest rate or the quantity of reserves so as to come as close as possible to achieving the desired objectives for prices and real activity themselves. Because money growth does not covary precisely with these indicators of macroeconomic performance, however, there is a difference between a monetary policy that responds only to movements of prices and real activity and a monetary policy that, at least in part, targets money growth.

The approach taken here to inferring whether the Federal Reserve's money growth targets have actually affected its monetary policy actions is to look for <u>independent</u> effects of fluctuations in money, relative to the stated growth target, that are not already accounted for by prices and real economic activity. In particular, Taylor (1993) has suggested that a simple formula relating the level of the federal funds rate to price inflation and the level of real activity relative to trend has approximately characterized U.S. monetary policy in recent years.[5] The approach taken here is to ask whether, and when -- <u>in addition</u> -- the federal funds rate has also responded to departures of money from the stated target.

The first row of Table 1 presents estimated coefficient values and Newey-West t-statistics for the regression

$$r_t = \alpha + \beta_1\pi_{t-1} + \beta_2\pi_{t-2} + \gamma_1(U-U^*)_{t-1} + \gamma_2(U-U^*)_{t-2} + \delta(m-m^T)_{t-1} + u_t \quad (1)$$

where r is the federal funds rate; π is the inflation rate measured over the preceding twelve months;[6] U and U* are, respectively, the unemployment rate and Gordon's (1993) estimate of the corresponding "natural" rate (Taylor's formula instead uses the deviation of real output from trend, but establishing the appropriate output trend is problematic over as long a time period as is ultimately treated here);[7] and m and m^T are, respectively, the actual M1 money stock and the mid-point of the corresponding target range (both in logarithms).[8] For each year's observations, both m and m^T refer to the definition of M1 in use

TABLE 1

ESTIMATED MONETARY POLICY REACTION FUNCTIONS (FEDERAL FUNDS RATE)

Aggregate	Constant	Lag Sum	π_{t-1}	π_{t-2}	$(U-U^*)_{t-1}$	$(U-U^*)_{t-2}$	$(m-m^T)_{t-1}$	$D_t \cdot (m-m^T)_{t-1}$	SE	$\bar{R}^2$	DW or h
M1	2.228	—	1.765	−0.846	−1.162	1.188	0.499	—	2.36	.596	.16
	(4.0)	—	(3.3)	(−1.4)	(−1.1)	(1.1)	(1.9)	—			
M1	−0.007	0.983	0.016	0.011	−0.951	0.869	0.085	—	0.61	.973	−.30
	(−0.1)	(63.7)	(1.4)	(0.9)	(−2.3)	(2.3)	(1.7)	—			
M1	2.490	—	1.712	−0.854	−0.835	0.886	0.295	1.185	2.28	.623	.17
	(4.5)	—	(3.2)	(−1.4)	(−0.9)	(0.9)	(1.5)	(2.2)			
M1	0.106	0.967	0.012	0.009	−0.920	0.850	0.041	0.349	0.59	.975	2.24
	(1.5)	(74.2)	(1.1)	(0.9)	(−2.6)	(2.5)	(1.7)	(2.6)			
M2	2.365	—	1.605	−0.659	−1.226	1.184	0.408	—	2.25	.561	.14
	(4.4)	—	(3.1)	(−1.1)	(−1.3)	(1.3)	(1.4)	—			
M2	0.048	0.985	0.010	0.007	−0.829	0.769	0.091	—	.55	.974	−1.20
	(0.8)	(86.9)	(0.9)	(0.7)	(−2.4)	(2.4)	(1.9)	—			
M2	2.448	—	1.605	−0.688	−1.059	1.034	0.247	0.858	2.24	.566	.13
	(4.5)	—	(3.1)	(−1.2)	(−1.3)	(1.2)	(0.8)	(0.9)			
M2	0.074	0.983	0.007	0.004	−0.789	0.726	0.033	0.334	.54	.975	−.41
	(1.4)	(85.1)	(0.7)	(0.4)	(−2.6)	(2.5)	(1.4)	(1.4)			

Notes: Coefficient estimates and summary statistics for equations (1) and (2) as shown in text. (Numbers in parentheses are Newey-West t-statistics.)

Dependent variable is the federal funds rate.

Data are monthly. Sample is 1960:1-1986:12 for regressions using M1 and 1960:1-1995:12 for regressions using M2.

in that year, and the data used for m and used to construct m^T are taken from Federal Reserve sources dated shortly after the year's end. (For purposes of this exercise it is essential to estimate the regression using data that correspond to what policymakers saw and construed as M1 at the time, rather than the standard data available today incorporating subsequent revisions and changed definitions.) All variables included in the regression are measured monthly, beginning in 1960:1 and all are in units corresponding to "percent."

Following the passage of Resolution 133, the Federal Reserve's first formally stated money growth targets specified growth ranges for the M1, M2 and M3 aggregates over the one-year period from March 1975 to March 1976. April 1975 was therefore the first month for which the actual value of any given measure of money could be compared to the value implied by the corresponding growth target (and with a one-month observation lag, May 1975 was the first month in which success or failure in achieving its money growth target could plausibly have influenced the Federal Reserve's setting of the federal funds rate). For purposes of the regression, therefore, $(m-m^T)$ simply assumes the value zero for all months in the sample through 1975:3. For 1975:4-1975:6, m^T is defined by tracing out for those three months the growth path implied by the 6 1/4% per annum mid-point of the 5 - 7 1/2% M1 growth target specified for the period running from the first quarter of 1975 to the corresponding quarter of 1976.

In June 1975 the Federal Reserve moved forward the base from which it was targeting the monetary aggregates and also shifted to a <u>quarterly</u> computation basis, so that the new targets specified growth ranges for the period 1975:II to 1976:II. For purposes of the monthly regression, therefore, m^T for 1975:7-1975:9 is defined by the monthly values along the path implied by the mid-point of this new M1 growth target (again 5 - 7 1/2% per annum, but from the

1975:II base). Similarly, m^T for 1975:10-1975:12 is defined from the mid-point of the next new target for M1 growth, set in September for the period 1975:III-1976:III (yet again 5 - 7 1/2% per annum, but now from the 1975:III base). For 1976:1 through 1978:12, values of m^T are similarly defined from the successive mid-points of the rolling annual growth targets that the Federal Reserve continued to establish for M1 on a quarterly basis.

Beginning with 1979, the Federal Reserve shifted to annual money growth targets, in each case based from the fourth quarter of the previous year, and with the possibility of changing the target at midyear. For 1979:1 through 1986:12, therefore, m^T is defined from the mid-points of these successive annual target ranges for M1 (in some years called "monitoring ranges"), as amended during the year in both 1983 and 1985.[9] The Federal Reserve has not designated a formal growth target for M1 since 1986, and so the regression sample ends with 1986:12.

The estimates for (1) shown in the first row of Table 1 are roughly consistent with standard interpretations of monetary policy behavior, including Taylor's. Faster inflation leads the Federal Reserve to set a higher interest rate, although the specific combination of β_1 and β_2 values suggests a response both to inflation and to the change in inflation. Similarly, the combination of γ_1 and γ_2 values suggests that an increase in unemployment (relative to the "natural" rate), rather than a greater level, leads to a lower interest rate.

More importantly, for purposes of this paper, the coefficient on $(m-m^T)$ does suggest -- albeit with only marginal statistical significance -- an independent response by the Federal Reserve to movements of M1 growth in relation to the corresponding target path. Specifically, a level of M1 that is 1% above the target range mid-point leads, on average over the entire time when the Federal Reserve was setting M1 growth targets (1975:5-1986:12), to a federal funds rate 50 basis points higher than what prevailing levels of inflation and unemployment would otherwise warrant.

To be sure, evidence of this form does not distinguish between monetary policy responses that constitute genuinely targeting money -- that is, once observed money has departed from the designated range, taking the proximate objective of policy to be getting the actual money stock back within range -- and policy responses that merely exploit variations of observed money relative to the designated range as an "information variable."[10] (Similarly, a significant coefficient on unemployment would not necessarily constitute evidence that preferences with respect to unemployment *per se* were guiding monetary policy; even if the Federal Reserve had been solely seeking to control inflation, it might have varied the federal funds rate in response to observed fluctuations of unemployment if those observations helped to predict future inflation.) Under either interpretation, however, evidence of a direct, independent response to $(m-m^T)$ represents reliance on money growth targets that clearly differs from the kind of behavior posited by Taylor for more recent years.

Not surprisingly, the estimates for equation (1) shown in the first row of Table 1 suffer from severe serial correlation (hence the use of Newey-West t-statistics). The Federal Reserve's well-known preference for smoothing interest rates makes the policy response to any independent variable like those included here -- money growth too -- equivalent to a partial adjustment process. The second row of the table reports the results of re-estimating (1) with twelve lags of the federal funds rate also included as independent variables, and the annualized one-month inflation rate substituted for the twelve-month rate. (Preliminary investigation indicated that eliminating all significant first-order serial correlation requires at least eleven lags.) Given these lagged interest rate terms, the coefficients on inflation become smaller and lose all statistical significance. By contrast, the coefficients on the unemployment term became distinctly more significant. The estimated <u>long-run</u> response of the federal funds rate to observed M1 that remains permanently 1% above the target mid-point is 500 basis points (.085/(1-.983)).

There is no reason, however, to assume that the Federal Reserve's behavior with respect to its M1 growth target remained unchanged over the nearly twelve-year period during which it formulated a target for the narrow money aggregate.[11] Most obviously, the Federal Reserve's own official statements as well as the widespread opinion among observers of U.S. monetary policy indicated that money growth targets played an especially important role in the policymaking process during the three-year period beginning in October 1979. As a test of this proposition, the third and fourth rows of Table 1 present estimates (with and without twelve lags of the dependent variable, respectively) for the expanded regression

$$r_t = \alpha + \beta_1\pi_{t-1} + \beta_2\pi_{t-2} + \gamma_1(U-U^*)_{t-1} + \gamma_2(U-U^*)_{t-2}$$

$$+ \delta(m-m^T)_{t-1} + \theta(m-m^T)_{t-1}\cdot D_t + u_t \qquad (2)$$

where D is a dummy variable equal to 1 in each of the 36 months spanning 1979:10-1982:9 and zero both before and after, so that the regression distinguishes the Federal Reserve's attempt to target M1 growth during the "monetarist experiment" from that at other times.

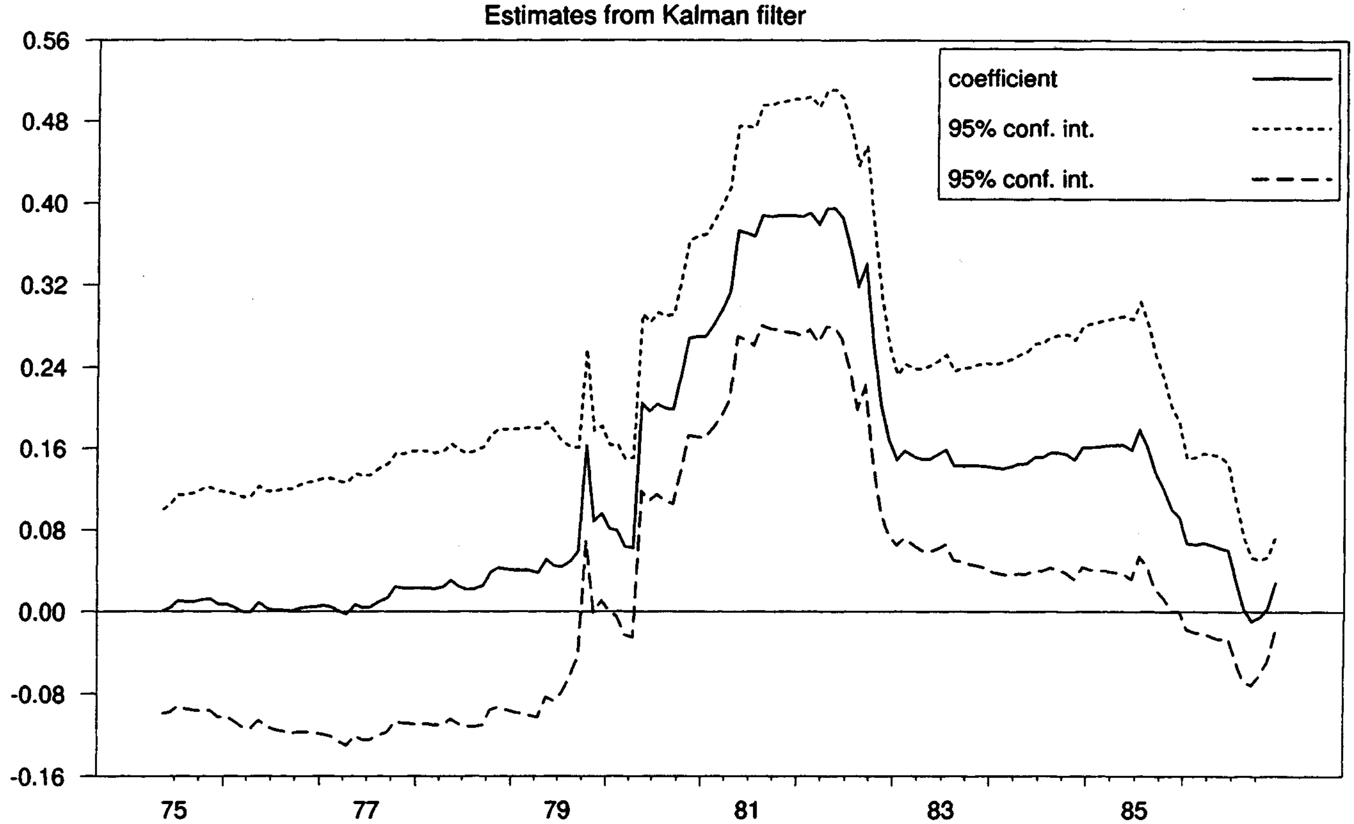
The results of estimating (2) do support the claim that the Federal Reserve placed much greater emphasis on its M1 target during the 1979-82 episode. The regression without lags indicates an interest rate response of 148 basis points

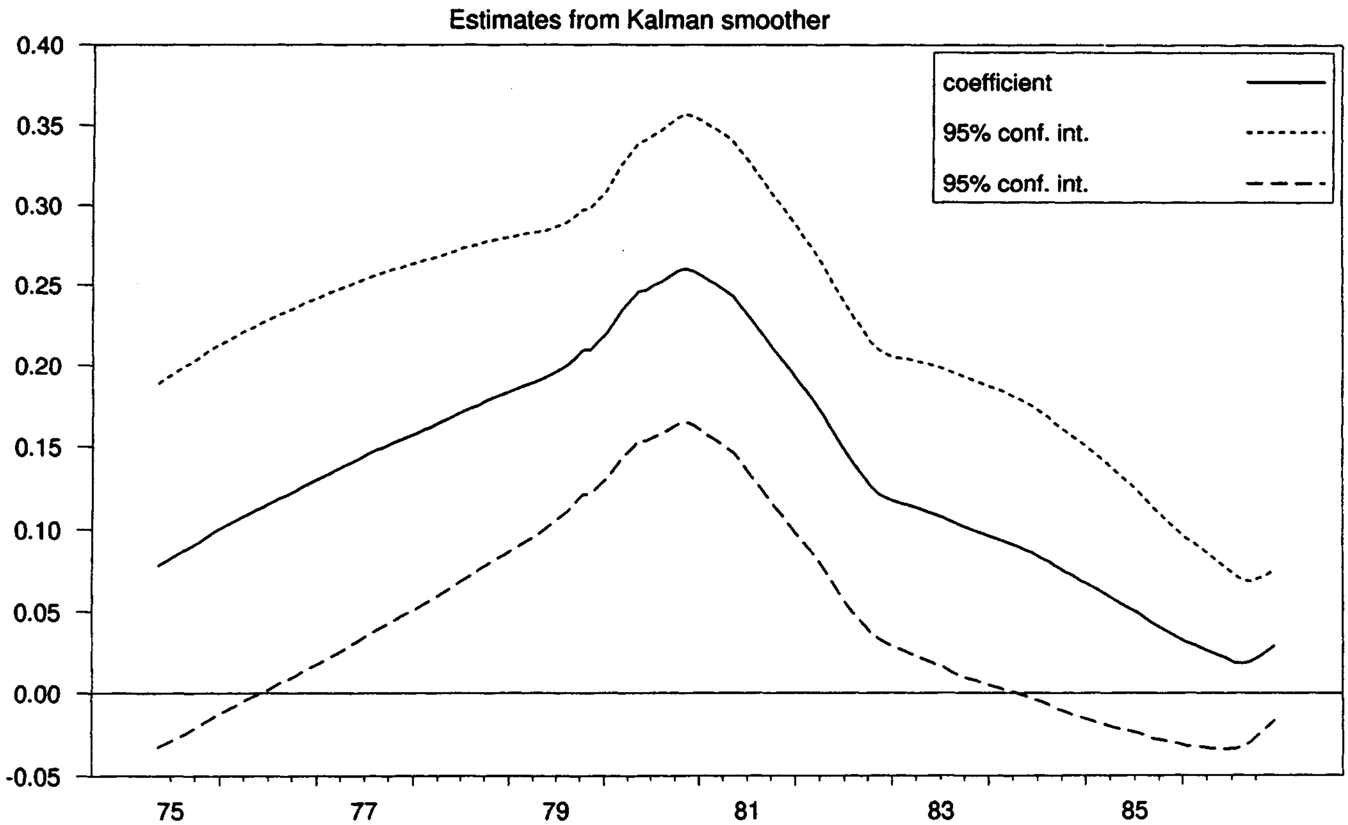
(.295 + 1.185) to a 1% movement of M1 away from the target mid-point during 1979-82, and only 30 basis points otherwise. The larger estimate is significant at standard levels (the t-statistic for the sum of δ and θ is 2.7), while the smaller is not. The regression with lags indicates a corresponding long-run response of 1,182 basis points ((.041 + .349)/(1 - .967)) -- which even seems too large to be entirely credible -- during 1979-82, and 124 basis points otherwise. Here the larger estimate is easily significant at standard levels, and the smaller is marginally so.

Figure 1 shows the result of yet a finer attempt to explore the changing importance of the M1 growth target for U.S. monetary policy by estimating equation (1), again including twelve lags on the federal funds rate, using an explicit time-varying-parameter model for coefficient δ. The upper panel displays the time series of recursively updated δ_t estimates computed from the Kalman filter, in which any given month's estimate of δ relies on data only through that month and therefore corresponds to the behavior of monetary policy as apparent at that time.[12] The lower panel displays the equivalent time series of δ_t estimates computed from the Kalman smoother, which uses data from the entire sample to construct the minimum-mean-square-error retrospective estimate of each month's δ_t.

The filtered estimates provide no evidence that the money growth target actually mattered for Federal Reserve policy in the first two years or so following the adoption of Resolution 133. The estimated coefficient on $(m-m^T)$ begins to rise modestly in late 1977, but it does not become consistently significant until early 1980 when it rises much more sharply. It then declines sharply in mid 1982 but remains significant. It begins to decline again in early 1985 and continues to do so, ceasing to be significant some time in 1986.[13]

Figure 1. Coefficient on Money Deviation Term in Monetary Policy Reaction Function with M1





The smoothed estimates tell much the same story. From its peak in late 1980, the coefficient on $(m-m^T)$ declines steadily, and it becomes statistically insignificant by mid 1984. Only for the late 1970s do the two sets of time-varying-parameter estimates present differing views of monetary policy, in that the smoothed estimates do indicate a positive influence on the federal funds rate due to the gap between observed money and the target range mid-point. In part, however, this apparent difference merely reflects the imprecision of the estimated coefficient in the early part of the sample.

One potential source of concern about results like those presented in Table 1 or Figure 1 is the consistent use of the federal funds rate as the dependent variable representing the direct operating instrument of monetary policy. While there is substantial agreement that the federal funds rate was indeed the relevant policy instrument both before and after the 1979-82 experiment, during this period the Federal Reserve stated that it was using a different operating procedure that in effect made the instrument variable the growth of nonborrowed reserves.[14] To verify that the results presented in Table 1 are not a spurious consequence of the use in the regression of an incorrect dependent variable during the period when money growth targets apparently mattered most, the first two rows of Table 2 show the results of estimating equations (1) and (2) with the annualized growth of nonborrowed reserves plus extended credit as the dependent variable. (The estimated regressions include no lagged dependent variables, because there is no evidence of serial correlation.)

The positive coefficient on $(m-m^T)$ reported in the first row of Table 2 for the entire period during which the Federal Reserve formulated M1 growth targets is consistent with the implication of the use, over most of that time, of an operating procedure based on the federal funds rate as the direct instrument variable. For a given interest rate level, a greater level of money (relative

TABLE 2

ESTIMATED REACTION FUNCTIONS FOR NONBORROWED RESERVES

Aggregate	Constant	π_{t-1}	π_{t-2}	$(U-U^*)_{t-1}$	$(U-U^*)_{t-2}$	$(m-m^T)_{t-1}$	$D_t \cdot (m-m^T)_{t-1}$	SE	$\bar{R}^2$	DW
M1	4.099	5.683	-5.775	12.94	-11.98	1.716	—	18.87	.025	1.99
	(2.6)	(1.7)	(-1.7)	(2.2)	(-2.1)	(1.3)	—			
M1	2.947	5.917	-5.740	11.50	-10.65	2.615	-5.220	18.70	.043	2.02
	(1.9)	(1.7)	(-1.6)	(2.2)	(-2.1)	(2.6)	(-2.1)			
M2	4.212	5.457	-5.468	11.36	-9.62	-0.472	—	17.31	.020	1.88
	(2.1)	(1.7)	(-1.6)	(2.3)	(-2.0)	(-0.3)	—			
M2	3.928	5.454	-5.367	10.79	-9.11	0.083	-2.949	17.31	.021	1.88
	(2.0)	(1.7)	(-1.6)	(2.3)	(-2.0)	(0.0)	(-1.0)			

Notes: Coefficient estimates and summary statistics for equations (1) and (2) as shown in text. (Numbers in parentheses are Newey-West t-statistics.)

Dependent variable is the annualized percentage change in nonborrowed reserves plus extended credit.

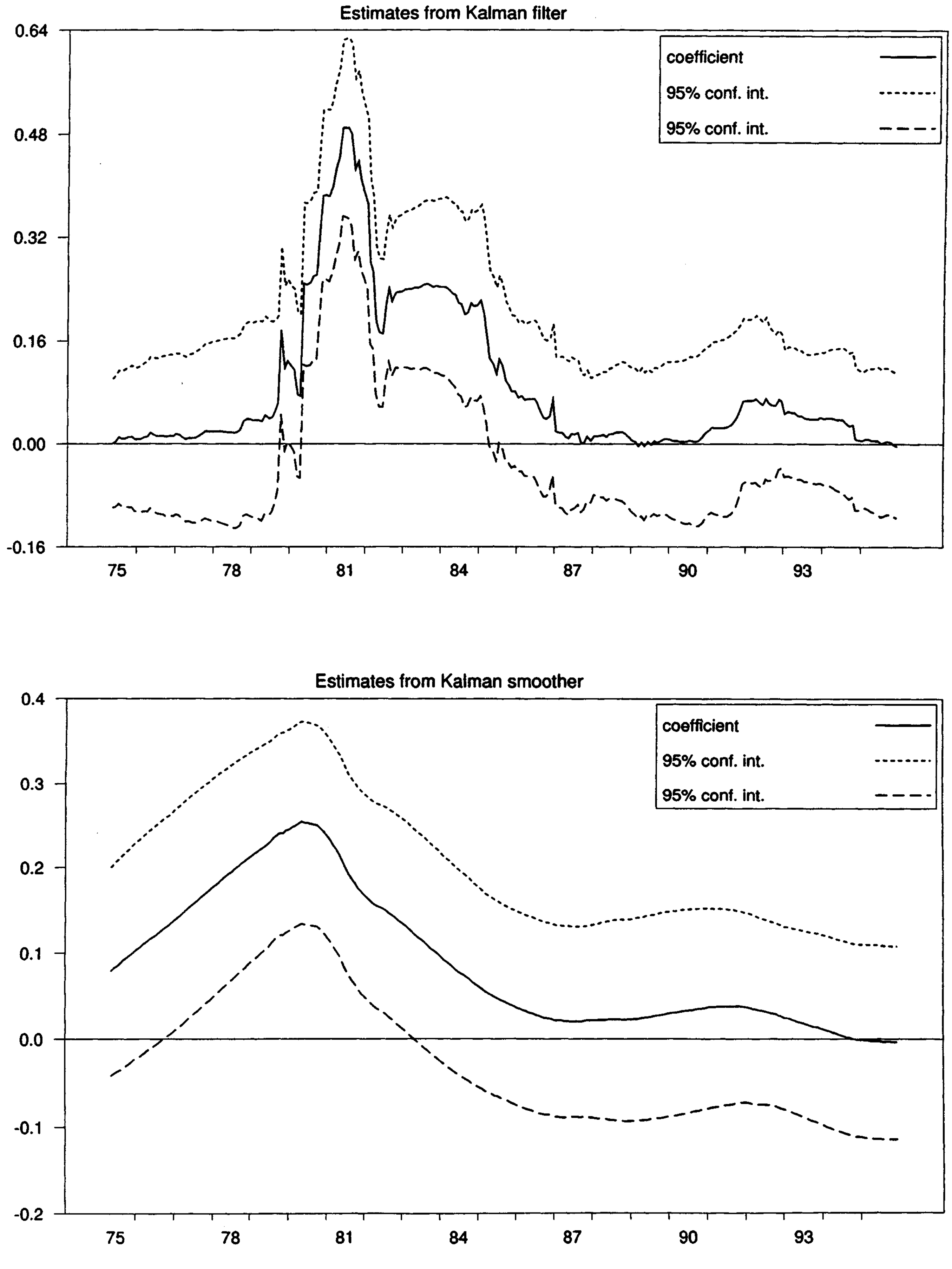
Data are monthly. Sample is 1960:1-1986:12 for regressions using M1 and 1960:1-1995:12 for regressions using M2.

to target) means more reserves to be provided via open market operations. By contrast, when the dummy variable distinguishes 1979:10-1982:9 from the period before and after, the different response of nonborrowed reserves to $(m-m^T)$ is clearly evident. When the Federal Reserve was using nonborrowed reserves as its operating instrument, reserves growth instead responded negatively to observed deviations of money from the target mid-point.

The lower rows of Tables 1 and 2, and Figure 2, present similar analyses for the Federal Reserve's M2 target -- in this case extending through yearend 1995. The results are roughly in line with those reported above for M1, although in the case of M2 the coefficient estimates are almost always less significant. In the time-varying-parameter model, however, the response to $(m-m^T)$ is again easily significant from mid 1980 through late 1986. Thereafter the estimated coefficient remains positive, but it is never again statistically significant.

In sum, the evidence is clear that the Federal Reserve did -- for a while -- target money in the sense that it varied either the federal funds rate or nonborrowed reserves (whichever was its operating instrument at the time) in response to observed fluctuations of either M1 or M2 that departed from the corresponding stated targets. The failure to do so in the first few years after Congress adopted Resolution 133 can perhaps be explained away as a delayed, or cautiously gradual, response to the new legislation. What is more interesting, for purposes of this paper, is the effective abandonment of the money growth targets in the mid 1980s, when the pertinent legislation remained in force (as it does today): Why has the Federal Reserve come to disregard the instruction given to it by Congress, to which the central bank as an institution is directly responsible? To answer this question, it is necessary to examine next the relationship between money and the objectives that monetary policy seeks to

Figure 2. Coefficient on Money Deviation Term in Monetary Policy Reaction Function with M2



achieve in the first place.

II. The Changing Information Content of Money

The standard rationale for using a money growth target to guide monetary policy is that, under the right conditions, doing so provides a coherent way of taking into account the consequences of unforeseen developments. The opportunity to exploit a variable like money for this purpose arises because central bank actions and their economic effects are separated both by time and by behavioral process: A change in the interest rate (or the quantity of reserves) makes a difference for economic activity later on, and the economic behavior that gives rise to that difference involves actions along the way that are, at least in principle, observable. Money growth -- in principle -- is an observable element of that intermediate behavior standing between central bank actions and their ultimate economic effects.

Given that the central bank's main form of monetary policy action in a fractional reserve banking system is the purchase or sale of securities in exchange for bank reserves, most familiar models of the behavioral process connecting monetary policy to economic activity plausibly provide at least a potential role for fluctuations in some measure of money to anticipate movements in prices and/or real output. In the most conventional models, open market purchases provide reserves that enable banks to create more deposits, thereby reducing interest rates (as long as the demand for deposits is negatively interest elastic) and thus stimulating spending. A closely related alternative focuses on the importance of bank lending in financing either business or household expenditures, so that movements in money anticipate spending primarily because they reflect what is happening on the other (credit) side of the banking system's balance sheet. Yet a different view focuses initially on the presumed link between money and prices, with any effects on real activity arising as a consequence of the output decisions of producers unsure of how to interpret the limited information they receive as prices change.

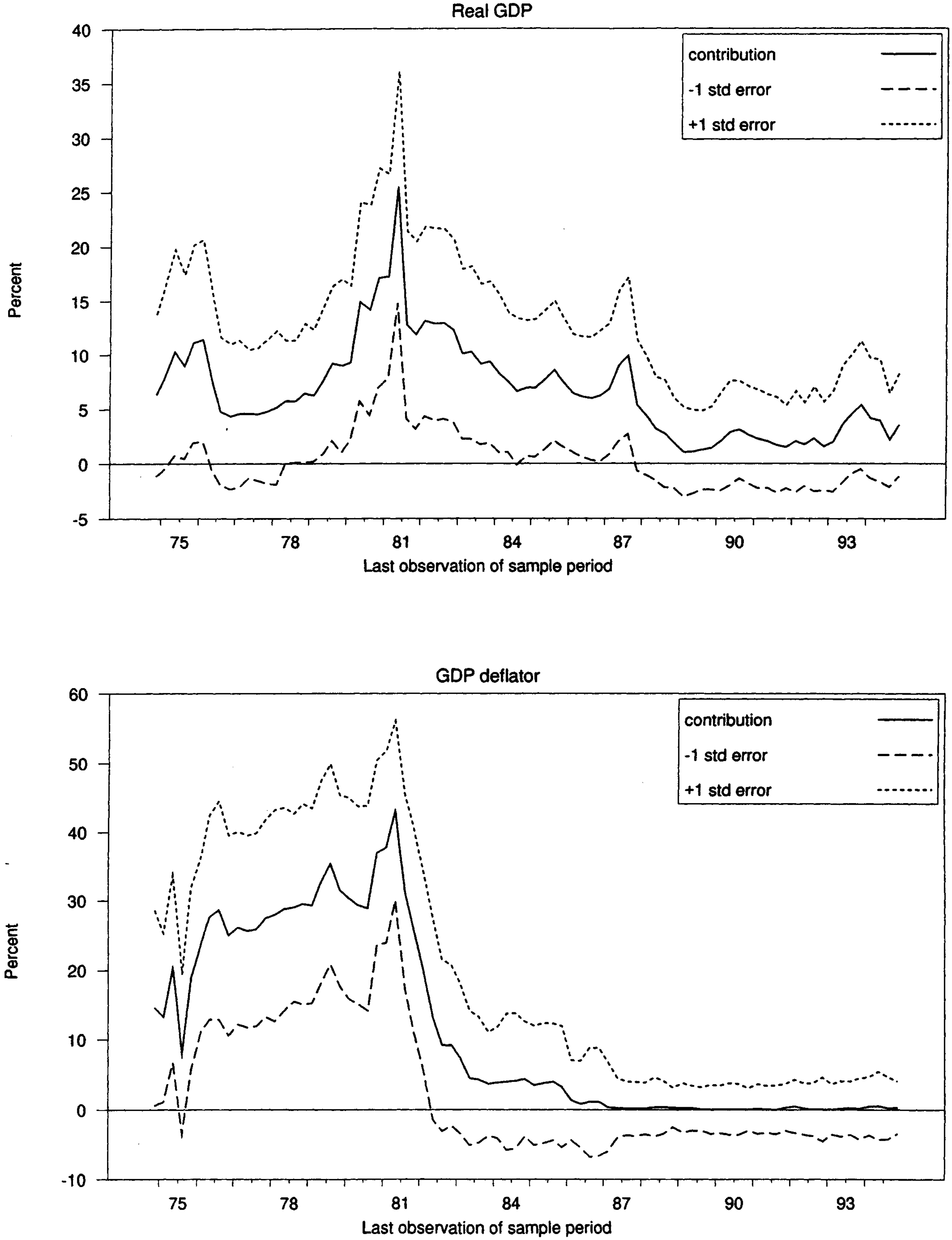
In each of these models, however, the behavior that ultimately generates changes in prices and/or real activity also involves movements of money. To the extent that these movements in money occur not just logically but chronologically before the corresponding movements in prices and/or output, therefore, the central bank can -- again, under the right conditions -- exploit them to make the changes in its interest rate or reserves instrument that unforeseen events warrant. Strictly defined, the use of a money growth target means that the central bank not only treats all unexpected fluctuations in money as informative in just this sense but also, as a quantitative matter, changes its instrument variable in such a way as to restore money growth to the originally designated path. Alternatively, the central bank could incorporate money growth into its monetary policymaking process in a more flexible way, recognizing that movements in money are not always a sign of movements in prices and output to come and hence deciding on a case by case basis whether, and if so by how much, to move its instrument variable when observed money growth behaves unexpectedly. Doing so amounts to using money growth not as a target but as an information variable.

But regardless of whether the central bank makes money growth a formal target or uses it as an information variable, the whole concept is senseless unless observed fluctuations in money do anticipate movements of prices, or output, or whatever constitutes the ultimate objective of monetary policy: What would it mean to exploit an information variable that contains no relevant information? What would be the point in pursuing an intermediate target that is not observably intermediate between the central bank's actions and the intended consequences? In either case, whether movements in money anticipate movements in prices and/or output is crucial.[15] That issue, in turn is an empirical question. Moreover, because economic circumstances change, the answer at one point in time need not be the same as at a later point.

Figure 3 addresses this issue by showing, for each of a series of 81 overlapping sample periods, the contribution of money to subsequent movements in real output (top panel) and prices (bottom panel) as estimated via the standard unrestricted vector autoregression methodology. For each of the 81 samples, the figure indicates the respective percentages of output and prices accounted for by money at a two-year horizon.[16] Each such percentage plotted is the product of a variance decomposition based on an underlying quarterly four-variable vector autoregression including real gross domestic product, the corresponding price deflator and the M1 money stock (all in logarithms and all seasonally adjusted), and the federal funds rate (not seasonally adjusted), with four lags on each variable. The orthogonalization of this system for purposes of the variance decomposition places output first, prices second, money third. and the interest rate fourth. In each panel the solid line plots the estimated contribution of money to either output or prices, as estimated over a sample ending at the date denoted on the horizontal axis, while the pair of dashed lines indicate the one-standard-error band of uncertainty associated with this estimate.

The initial percentage plotted in each panel of Figure 1 refers to the variance decomposition based on the four-variable vector autoregression estimated using data beginning in 1959:I and ending in 1974:IV. (Because of the four lags on each variable, the regression's first observation is 1960:I and so this initial sample includes 60 observations.) The two initial percentages plotted therefore indicate how someone applying this methodology in early 1975 would have assessed the contribution of the M1 money stock to predicting that part of the subsequent fluctuation of output and prices that is not already

Figure 3. Contribution of M1 to Output and Price Variance



predictable from the prior fluctuation of output and prices themselves.[17]

The answer -- as of 1975 -- is that knowing the recent movements of M1 contributes fairly little to predicting output, but modestly more in the case of prices.[18] At the two-year-ahead horizon considered in Figure 3, money accounts for about 6% of the subsequent variation of output, but over 14% of the variation of prices. The output percentage is not significantly different from zero even at the weak level reflected by the one-standard-error band. The percentage for prices is barely significant at this level.

The other 80 points plotted in each panel of Figure 3 indicate the results of analogous variance decompositions based on sample periods ending in 1975:I, 1975:II, and so on through 1994:IV. In each case the question at issue is the same -- how much M1 contributes to predicting that part of the subsequent fluctuation of output and prices not already predictable from output and prices themselves -- but the vantage point in time from which the question is asked continually moves forward. As the sample end date advances from 1974:IV to 1979:IV, the initial observation remains 1960:I so that the sample size expands (one observation at a time) from 60 to 80 quarters. Thereafter the end date and the beginning date both advance together, so that the sample size remains 80 quarters.

Matters change substantially as the end-of-sample vantage point advances from 1975 to 1995. The contribution of M1 to explaining subsequent <u>output</u> fluctuations briefly increased somewhat (and even became statistically significant) but mostly remained small until the early 1980s. It then increased sharply (and briefly became highly significant), and since the mid 1980s it has mostly declined and remained insignificant.[19] The contribution of M1 to explaining subsequent <u>price</u> fluctuations increased rapidly in both magnitude and statistical significance after 1974, only to decline equally rapidly and lose all significance in the early 1980s. It has since become negligible.

An alternative way of addressing the contribution of money to predicting the subsequent variation of output or prices is to test explicitly the hypothesis that money has no such predictive power at all. In principle, the 81 vector autoregressions underlying the variance decompositions reported in Figure 1 readily admit such a test. Because each of the four included variables -- the respective (log) levels of output, prices and money, and the nominal interest rate -- is nonstationary, however, standard test statistics based on the normal distribution would be inappropriate for these regressions. Moreover, the distributions of the appropriate test statistics are known only for certain special cases.[20]

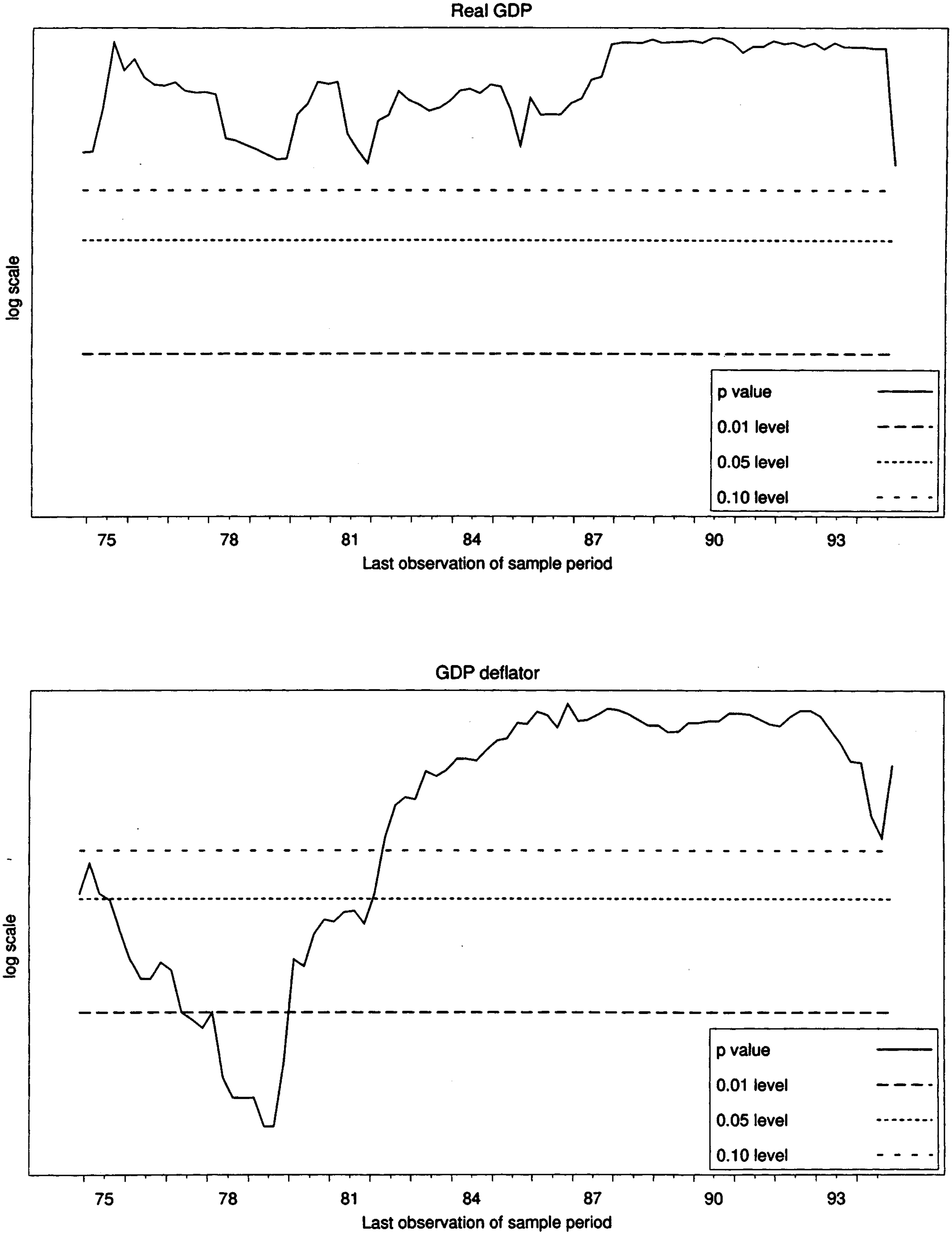
The two panels of Figure 4 therefore plot p-values for tests of the null hypothesis that all coefficients δ_{xi} or δ_{pi} are zero in the two <u>differenced</u> equations

$$\Delta x_t = \alpha_x + \sum_{i=1}^{4} \beta_{xi}\Delta x_{t-i} + \sum_{i=1}^{4} \gamma_{xi}\Delta p_{t-i} + \sum_{i=1}^{4} \delta_{xi}\Delta m_{t-i} + \sum_{i=1}^{4} \theta_{xi}\Delta r_{t-i} + u_t \quad (3)$$

$$\Delta p_t = \alpha_p + \sum_{i=1}^{4} \beta_{pi}\Delta x_{t-i} + \sum_{i=1}^{4} \gamma_{pi}\Delta p_{t-i} + \sum_{i=1}^{4} \delta_{pi}\Delta m_{t-i} + \sum_{i=1}^{4} \theta_{pi}\Delta r_{t-i} + v_t \quad (4)$$

where x, p and m are, respectively, the logarithms of real gross domestic product, the price deflator and the M1 money stock; r is again the federal funds rate; u and v are disturbance terms; and α and the β_i, γ_i, δ_i and θ_i in each equation are all coefficients to be estimated. In parallel with Figure 3, the first p-value plotted in each panel of Figure 4 gives the result of testing the null hypothesis of zero predictive content of money over the sample ending in 1974:IV, and the subsequent 80 values refer to the samples ending in 1975:I,

Figure 4. Significance of M1 in Predicting Output and the Price Level



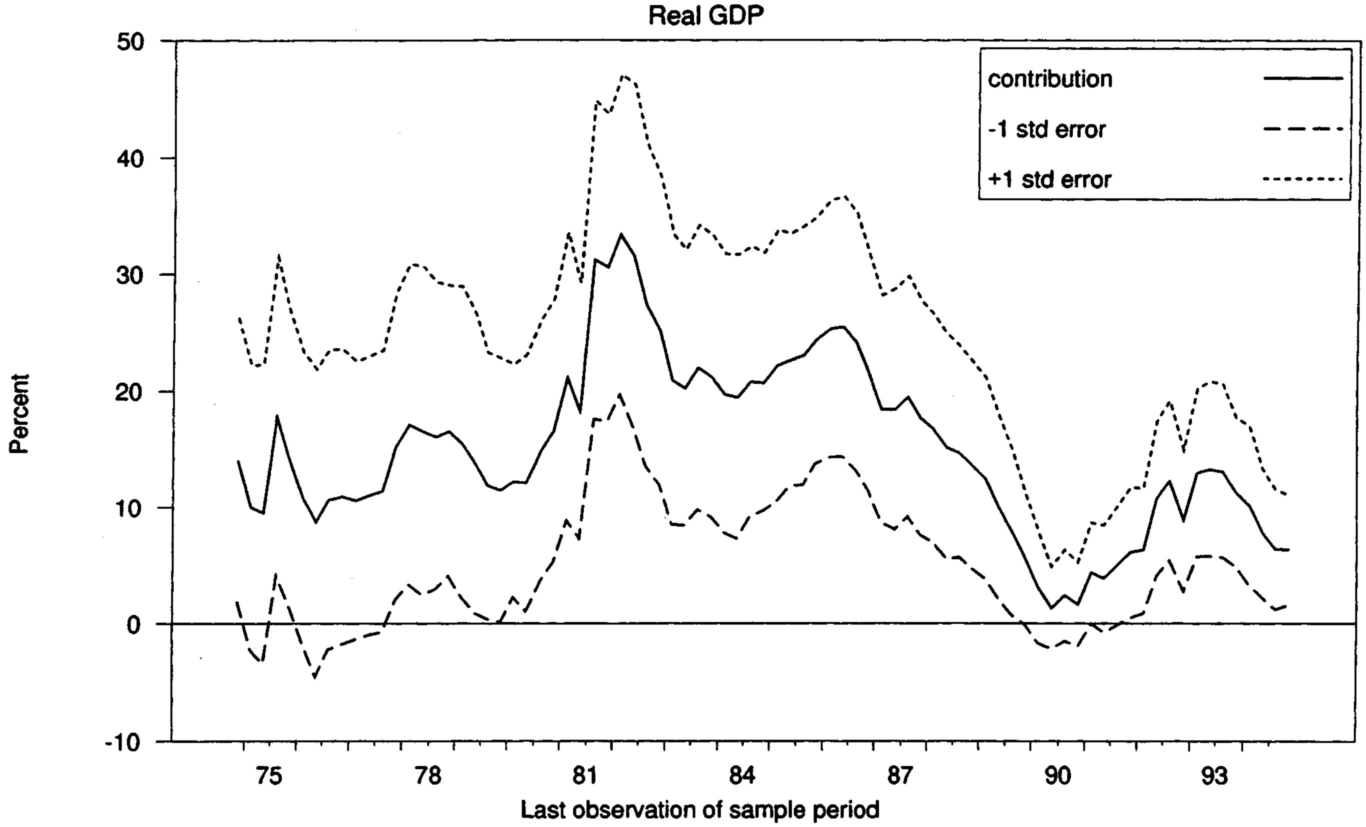
1975:II, and so on through 1994:IV. The dashed horizontal lines in each panel indicate the .01, .05 and .10 levels.

The results generated by this more explicit hypothesis test differ conceptually from the variance decomposition results shown in Figure 1 for several reasons. Most basically, asking the yes-or-no question of whether money has <u>any</u> predictive content with respect to output or prices is not the same as asking <u>how much</u> predictive content money has. In addition, the significance test based on the regression coefficients refers (by construction) to one-quarter-ahead prediction, while the variance decompositions reported above refer to an eight-quarter horizon. Finally, levels are not the same as growth rates (although it is impossible to evaluate the force of this distinction because of the nonstationarity problem).

Given all of these differences of method, it is not surprising that the p-values shown in Figure 4 do not fully correspond to the variance decomposition results in Figure 3. Here money never has predictive power with respect to <u>output</u> that is significant, even at the .10 level, as seen from any of the 81 vantage points spanning these twenty years.[21] Money has significant predictive content with respect to <u>prices</u> when judged from any vantage point through early 1983. During most of this early period, this predictive content is significant at the .05 level, and for a brief period it is significant at the .01 level. From any vantage point since 1983, however, there is no evidence of predictive content with respect to prices even at the .10 level.

Figures 5 and 6 present evidence for M2 that is analogous to that presented for M1 in Figures 3 and 4, respectively. In Figure 5 the percentage of the subsequent variation of <u>output</u> explained by M2 is consistently significant (by the weak criterion of the one-standard-error band) as seen from all vantage points from 1977 through 1989, and again (surprisingly) after 1991 -- although

Figure 5. Contribution of M2 to Output and Price Variance



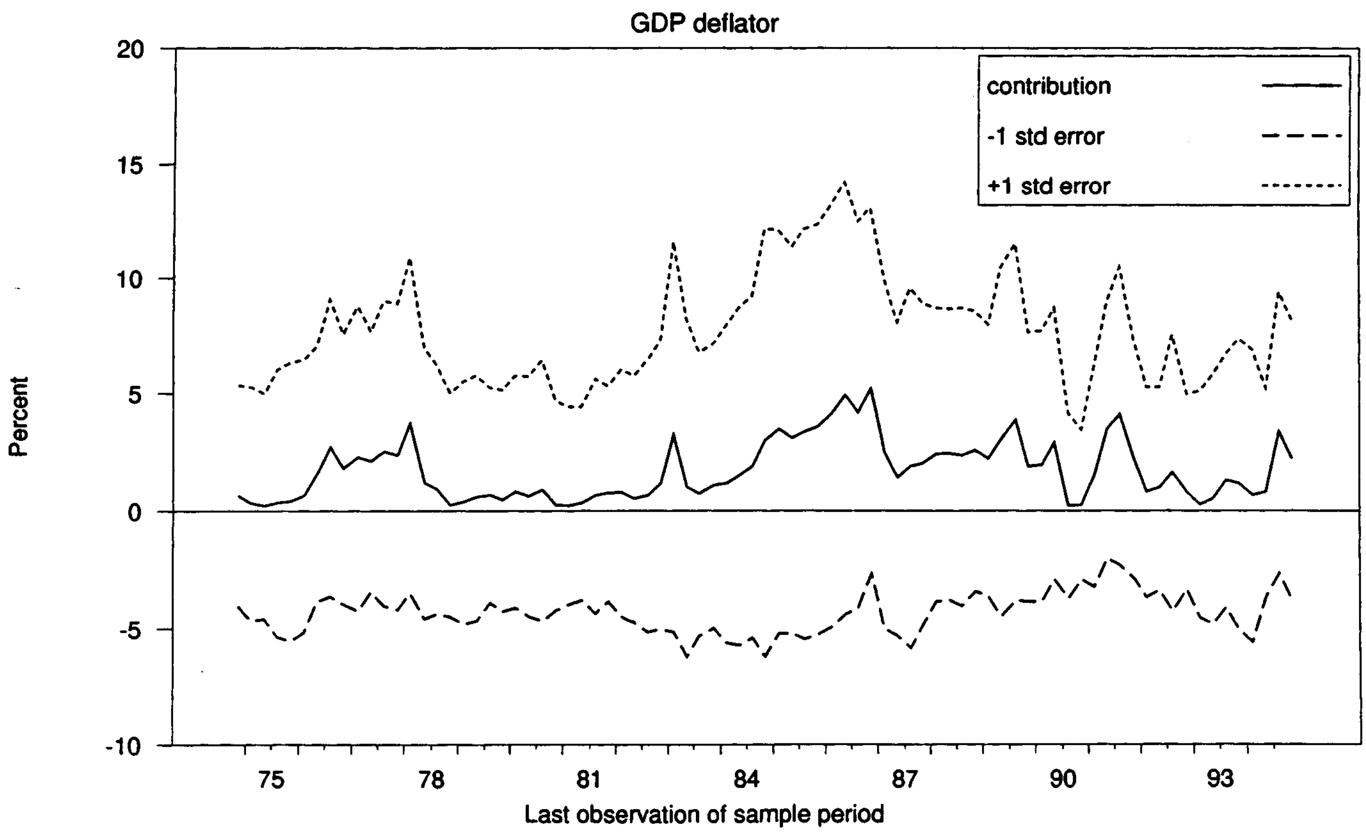
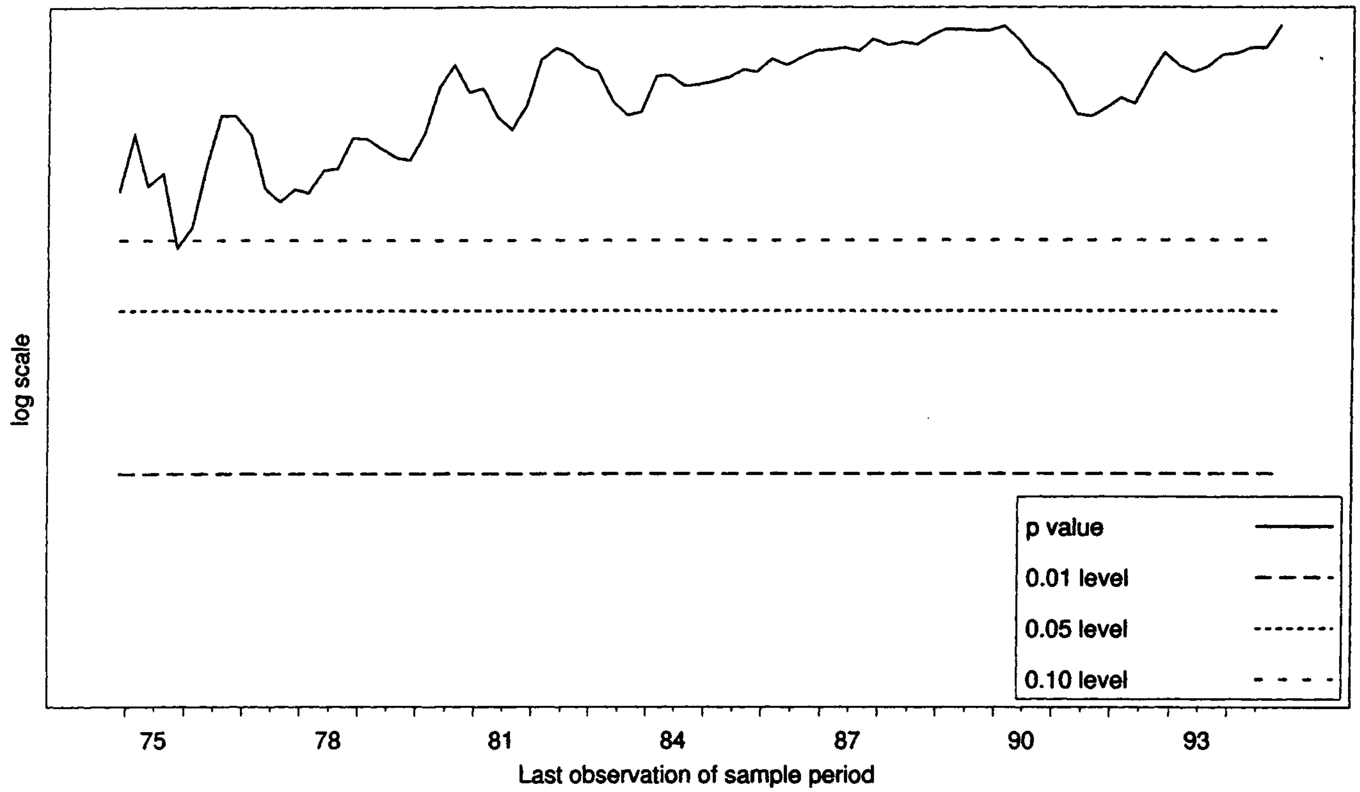
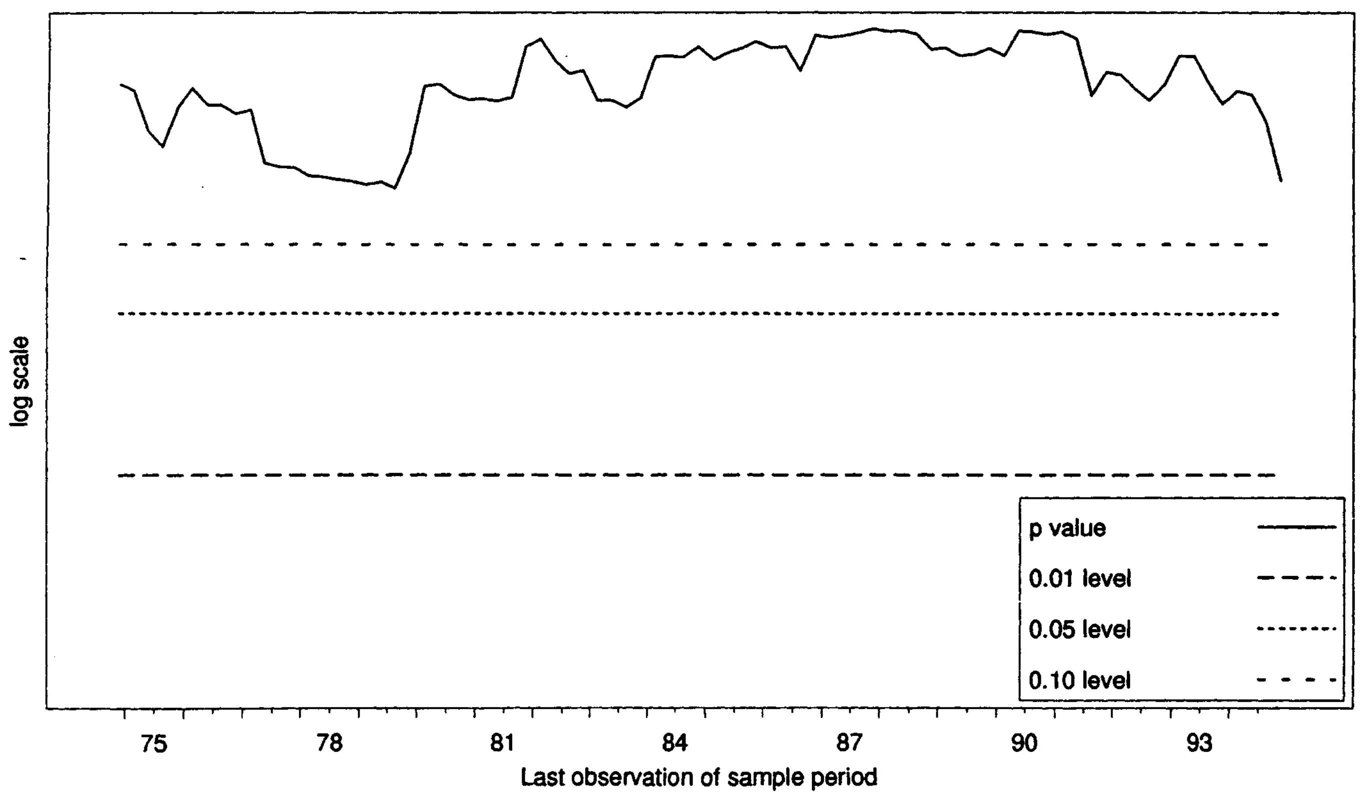


Figure 6. Significance of M2 in Predicting Output and the Price Level

Real GDP



GDP deflator



then the estimated percentage is mostly smaller. By contrast, M2 accounts for only a small and insignificant percentage of the subsequent variation of prices throughout. As Figure 6 shows, however, with the exception of a solitary vantage point at the end of 1975, the predictive content of M2 with respect to output as measured directly from the differenced autoregression is never significant even at the .10 level, and the directly measured predictive content of M2 with respect to prices is never significant even at the .10 level.

Whether money does or does not have predictive content with respect to output and/or prices is essential to whether the use of money growth targets, or even the use of money as an information variable, constitutes a potentially effective strategy under which to carry out monetary policy. Policymakers need not have been tracking estimated relationships of the exact form as those reported in Figures 3 and 4 for M1 and 5 and 6 for M2, but to the extent that these results, based as they are on data only up through specific points in time, provide an indication of whether money did or did not have such predictive content, that kind of evidence -- or lack of it -- at least should have been an important factor in the central bank's choice of monetary policy strategy.

For the most part, the Federal Reserve System's use and disuse of money growth targets as guidelines for U.S. monetary policy over the past twenty years appears to have been roughly consistent with what this changing evidence on money-output and money-price relationships has warranted. The evidence presented in Section I above suggests that, with some notable exceptions, money growth targets have been a visible influence on U.S. monetary policy actions primarily at times when at least some forms of evidence (though certainly not all) on these money-output and money-price relationships appeared to justify it. More obviously, the Federal Reserve's turning away from money growth targets has been entirely consistent with what the evidence on these changing relationships has warranted.[22] Former Bank of Canada Governor John Crow's often quoted description of the Canadian experience aptly summarizes the Federal Reserve's actions as well: "We didn't abandon the monetary aggregates; they abandoned us."

III. Why the Loss of Money's Predictive Content?

Wholly apart from whether U.S. monetary policymakers were right or wrong to respond to the change in the observed relationship of money to output and prices by de-emphasizing their money growth targets, for purposes of this paper's inquiry the more pertinent question is why these key relationships changed as they did. Four potential explanations -- more seriously, only three -- are familiar from long-standing discussions centering on these issues:

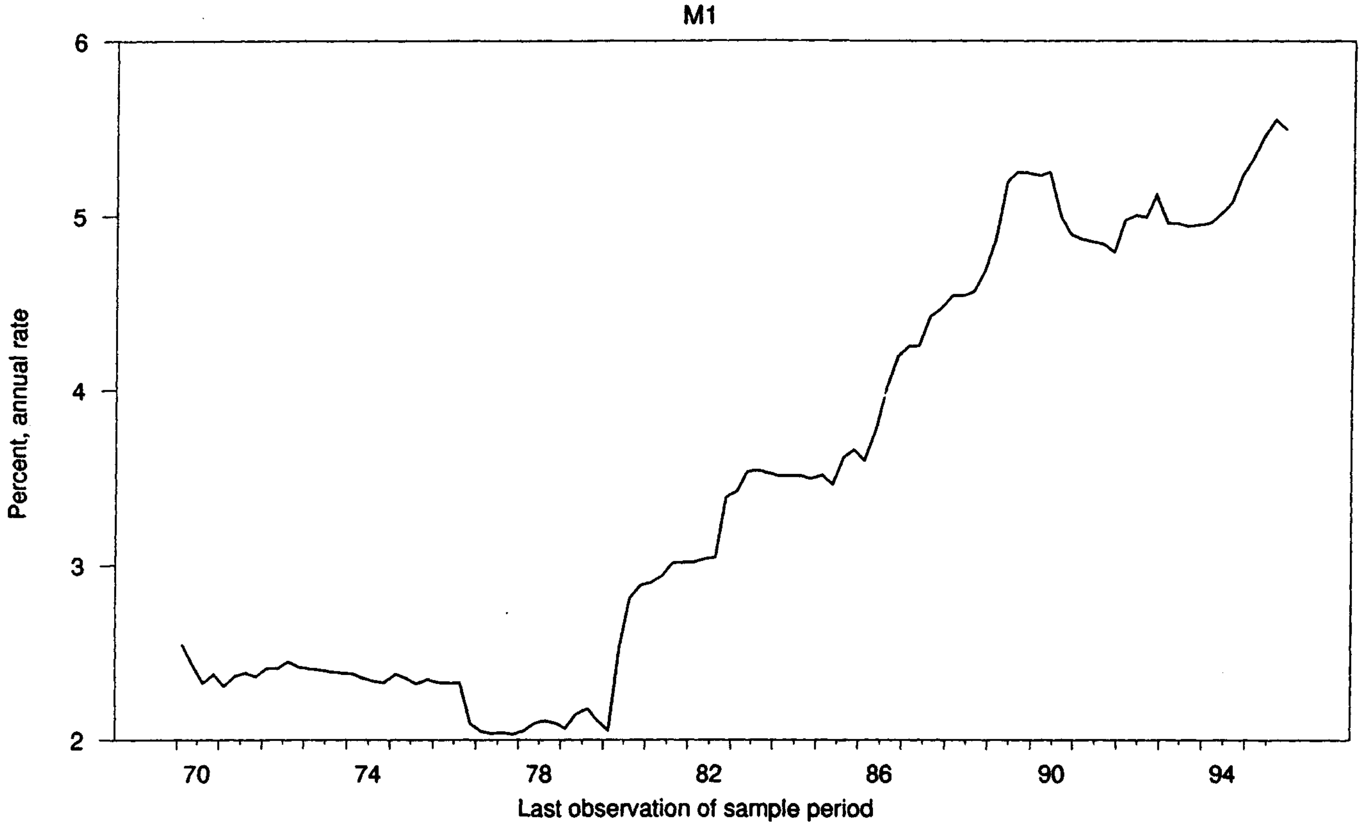
Hypothesis #0: Stable Money Growth. The most obvious reason why fluctuations in money could in principle have ceased to predict subsequent movements in either output or prices is that money itself (or its growth rate) could have ceased to fluctuate. Traditional advocates of stable money growth rules have always maintained that the ideal world would indeed be one in which money in fact had zero correlation with either output or prices -- but also in which the variation of output and prices would therefore be much less than would be the case if money also varied. In terms of Milton Friedman's (1953) classic argument against activist policy, the variance of output (or prices) σ_X^2 can be expressed as

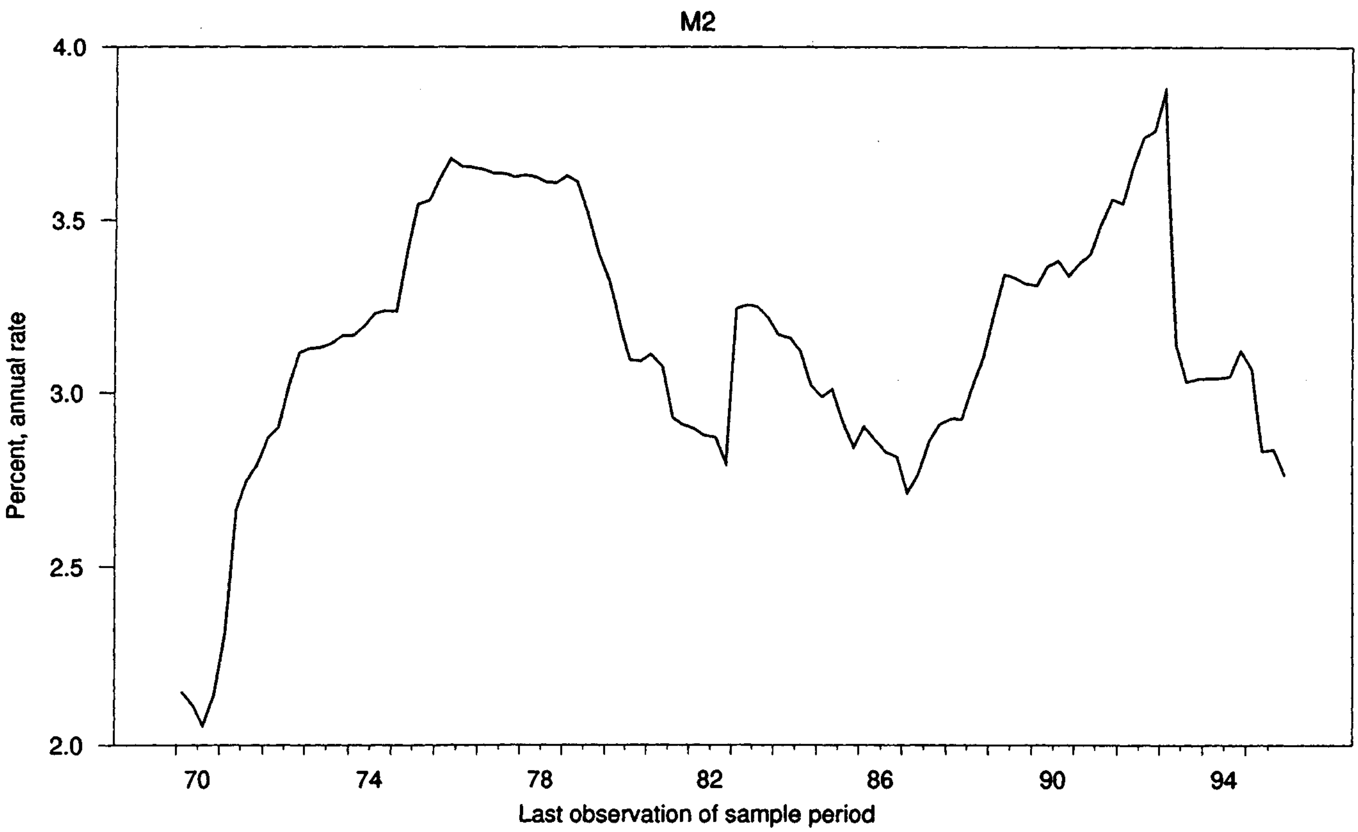
$$\sigma_X^2 = \sigma_Z^2 + \sigma_M^2 + 2\rho\sigma_Z\sigma_M \tag{5}$$

where σ_M^2 reflects that part of σ_X^2 due to variance of money (or its growth rate), σ_Z^2 the part of σ_X^2 due to factors independent of the variation of money, and ρ the correlation between these two components. Friedman's point was that fixed money growth would immediately eliminate both σ_M^2 and the covariance term, leaving σ_X^2 simply equal to σ_Z^2.[23]

As Figure 7 shows, however, the disappearance of the predictive content of money with respect to income and prices is certainly not due to a smaller

Figure 7. Standard Deviation of Nominal Money Growth



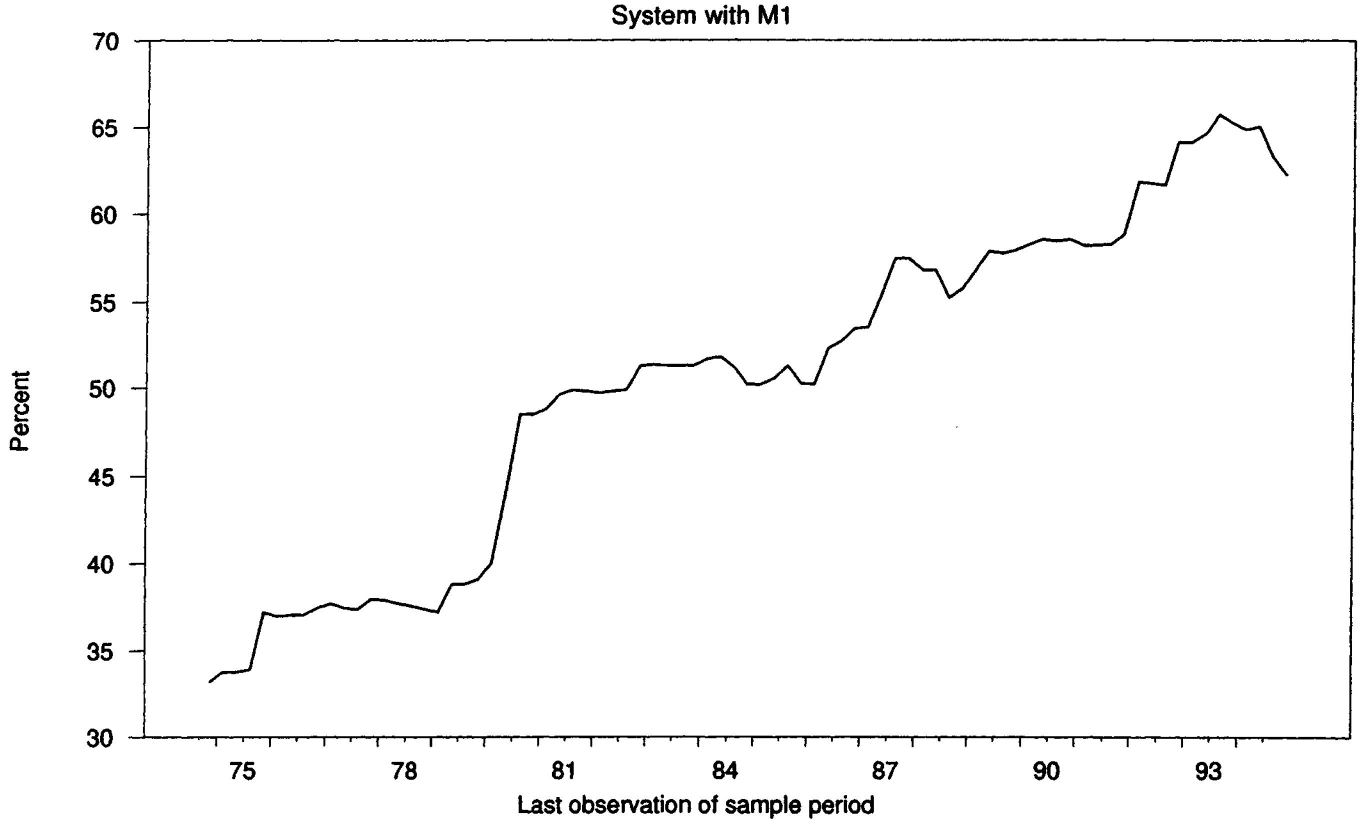


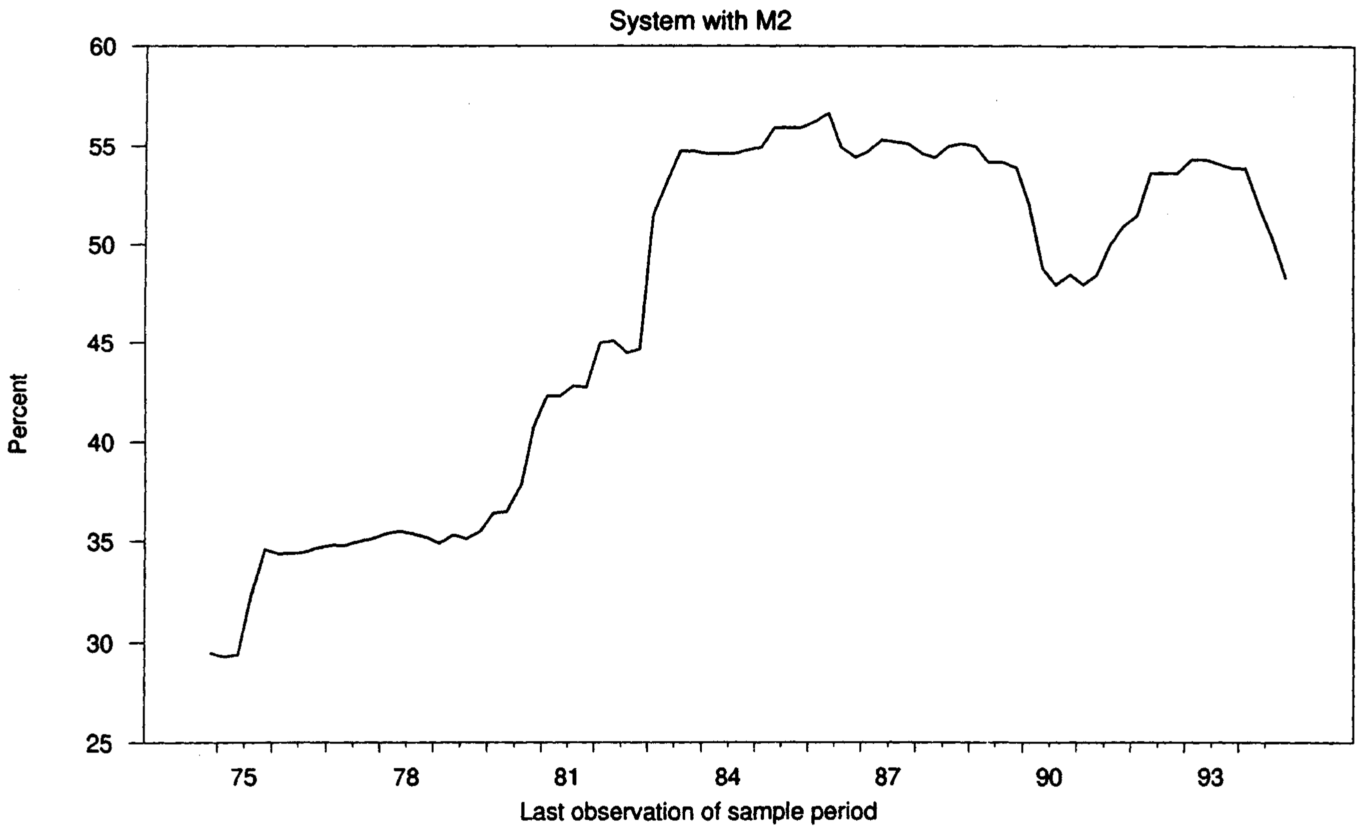
variance of money growth. The quarterly moving-average standard deviation of M1 growth, measured with a ten-year window, increased dramatically at the beginning of the 1980s and then kept on increasing -- just as the predictive content was vanishing, as shown in Figure 3 above. The moving-average standard deviation of M2 growth behaved more irregularly over this period, but there is no evidence of a systematic trend toward smaller variation.

A closely related analog to Friedman's (1953) idea also suggests a reason why -- again, in principle -- money might have lost its predictive content. To recall, the vector autoregression methodology underlying the results reported in Section II infers the consequences of fluctuations in money solely from the "innovations" by which money departs from whatever is its typical systematic relationship to prior values of the other variables in the system.[24] The F-tests underlying Figures 4 and 6 test the <u>incremental</u> predictive power of money, over and above that part of the fluctuation of output or prices that is not already predictable from past values of output and prices themselves (and of the interest rate). The variance decompositions reported in Figures 3 and 5 likewise refer to the share of the variation of output or prices attributable to the orthogonalized <u>residuals</u> in the equation relating money to past values of these same variables. If the observed movements of money consisted entirely of systematic responses to prior movements of output, prices and the interest rate, therefore, then these fluctuations in money might still have large effects on output and prices but they would be impossible to detect within the standard VAR methodology. (Moreover, because money is ordered after output and prices for purposes of the orthogonalization, the same result follows for systematic reponses of money to <u>contemporaneous</u> output and price movements.)

Figure 8 shows that this alternative version of the hypothesis is no more consistent with the facts than the original. For each of the 101 samples used

Figure 8. Standard Deviation of Orthogonalized Money Residuals





in constructing Figures 3-6, the respective panels of Figure 8 plot the standard deviation of the orthogonalized M1 or M2 innovations. In this case, instead of shrinking as the predictive content of money disappeared, the nonsystematic variation of both M1 and M2 became much larger, with the standard deviation approximately doubling over time for both innovation series.

Hypothesis #1: Stabilization Policy. A quite different potential explanation, which is also implicit in Friedman's (1953) idea, is that money has lost its predictive content not because the Federal Reserve has abandoned the attempt to stabilize the economy but because it has largely succeeded in doing so. As equation (5) immediately shows, fluctuations in money growth will have an observable effect on output or prices if they are independent of the influence on these variables due to whatever forces are represented within σ_Z^2 -- for example, shocks to aggregate demand or aggregate supply. By contrast, if the central bank accurately anticipates those independent influences and varies money growth so as to offset them (that is, $\rho < 0$), then standard regression methods may under-estimate the effect due to money or miss it altogether, or possibly even estimate the wrong sign for this effect.

In principle, this situation is just what vector autoregression -- or, for that matter, partial regression as opposed to simple correlation -- is meant to address. The problem, however, is that no simple regression system includes all relevant variables. As Goldfeld and Blinder (1973) and more recently Poole (1994) have pointed out, if the central bank varies money growth because it is seeking to offset some disturbance to output or prices that is not captured by the system's other variables, then the regression will under-estimate the effect of the change in money growth, and in the limit it would find zero effect. Worse yet, if the central bank seeks to offset such disturbances only in part, as is optimal in the presence of uncertainty, then the regression would even imply the wrong sign for the effect of money growth on output and prices. (For the case of a positive aggregate demand shock, for example, money would be smaller but subsequent output larger. For an adverse aggregate supply shock, money would be smaller but subsequent prices higher.)

Establishing whether or not increasingly effective stabilization policy by the Federal Reserve was responsible for the disappearance of the predictive content of money clearly requires an empirical approach that goes beyond the unstructured vector autoregression underlying the results presented in Section II. In particular, some more structured analysis is necessary to distinguish the different behavioral disturbances that lie behind the residuals in the unstructured VAR.

Hypothesis #2: Unstable Money Demand. Any notion that money covaries positively and systematically with output and/or prices -- regardless of whether that covariation is taken to be causal or not -- implicitly begins from the assumption of a stable functional demand for money. As an enormous empirical literature has documented, however, during the last twenty years or so the demand for money (however defined) in the United States has been far less closely and consistently related to income, prices, interest rates and the other usual arguments suggested by the standard theory of the demand for cash balances. Familiar suggested explanations for this increased instability include the effects of advances in data processing technology, deregulation, innovations in forms of deposit holding (prompted in part by both deregulation and changing technology), sharply increasing and then decreasing price inflation, increasingly integrated global financial markets, and so on.[25]

When money demand is unstable, observed fluctuations in money need not anticipate subsequent movements of output or prices. Faster money growth, for example, could simply mean that the public is choosing to hold larger deposits in place of other forms of wealth holding, for reasons unrelated to its spending or production decisions (and, of course, that monetary policy is allowing this greater money demand to boost the observed money stock). This problem is, at least potentially, especially severe in a modern financial system that offers myriad forms of liquid instruments, of which only an arbitrary subset is defined as any particular measure of "money" like M1 or M2.

As in the case of Hypothesis #1, establishing whether increasing instability of money demand is what has caused observed money to lose its predictive content with respect to income and prices requires some kind of structural methodology. More specifically, the money residuals estimated in an unstructured VAR do not necessarily represent just money demand shocks, and to test this hypothesis it is necessary to identify the distinct money demand shock component.

Hypothesis #3: Ineffective Monetary Policy. Finally, a view that has become popular in many non-academic discussions of monetary policy is that modern economies, including in particular their financial systems, have evolved to the point that what the central bank does has little influence over economic activity anyway.[26] The basic claim is that with ever more institutions able to advance credit and even issue deposit-like instruments without having to hold reserves at the central bank -- familiar examples are brokerage firms, money market mutual funds, non-bank finance companies, and in some cases even insurance companies -- the central bank's position at the apex of the fractional reserve banking system is simply no longer relevant. Numerous empirical researchers have attempted to test this view, and the evidence has mostly not supported it.[27] Even so, it bears examination here as yet one more possible reason why money has lost its predictive power with respect to output and prices.

This explanation too requires a more structural approach to test. In parallel with the need to distinguish the unstructured VAR's money residuals from behavioral money demand shocks, here what is needed is to identify the structural shocks due to the central bank's independent monetary policy actions and the real economic consequences of those shocks.[28]

IV. Testing the Three Structural Hypotheses

What is needed, then, is an analytical framework capable of identifying, from the output-prices-money-interest rate autoregression system of Section II, structural disturbances corresponding to aggregate demand (or "IS") shocks, aggregate supply shocks, money demand shocks, and monetary policy shocks. With a four-variable vector autoregression, and hence a residual variance-covariance structure made up of ten distinct elements, six restrictions are needed to render the system "just identified" in this way.

Figures 9 and 10 plot moving-average standard deviations of these four structural shocks -- aggregate demand, aggregate supply, money demand, and monetary policy -- derived by applying the following plausible set of six restrictions suggested by Gali (1992) for exactly the four-variable system used here: First, as initially suggested by Blanchard and Quah (1989), none of the three "demand side" disturbances -- those to aggregate demand, money demand, or monetary policy -- has a long-run effect on the level of real output (three restrictions). Second, neither money demand disturbances nor money supply disturbances have a within-quarter effect on real output (two restrictions). And third, the demand for money is such that demand for real balances depends on real output and the nominal interest rate (equal to inflation plus the implied real interest rate), but not on either inflation or the real interest rate separately (one restriction).[29]

As Gali demonstrated, with these six restrictions the four-variable system estimated in Section II can be interpreted as consisting of an aggregate demand equation (or IS curve), an aggregate supply equation, a money demand equation, and an equation representing the within-quarter relationship among the interest rate, money, output and prices. Following the discussion and evidence in Section I above, this fourth relationship readily bears interpretation as a

Figure 9. Standard Deviation of Structural Shocks, System with M1

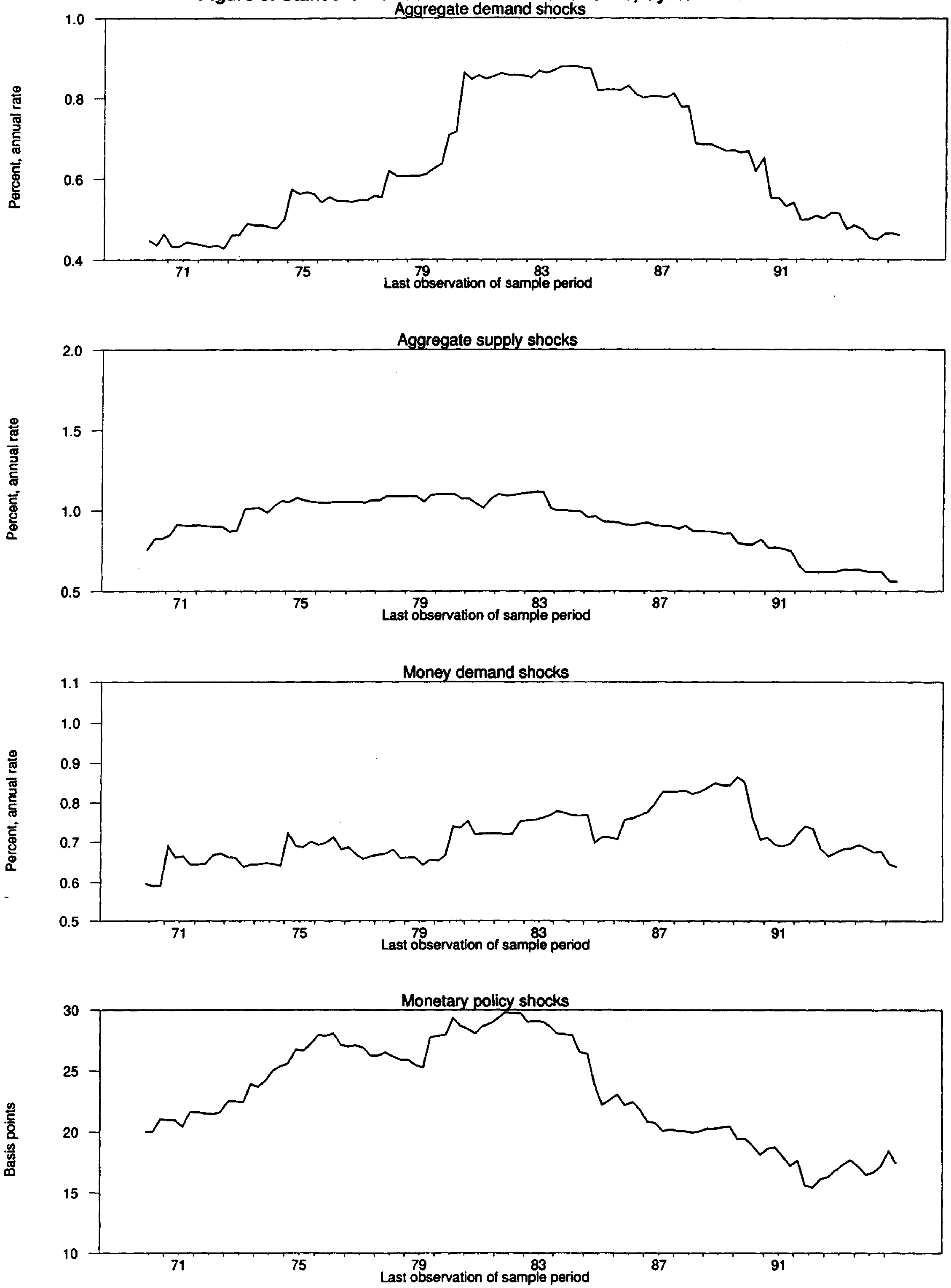
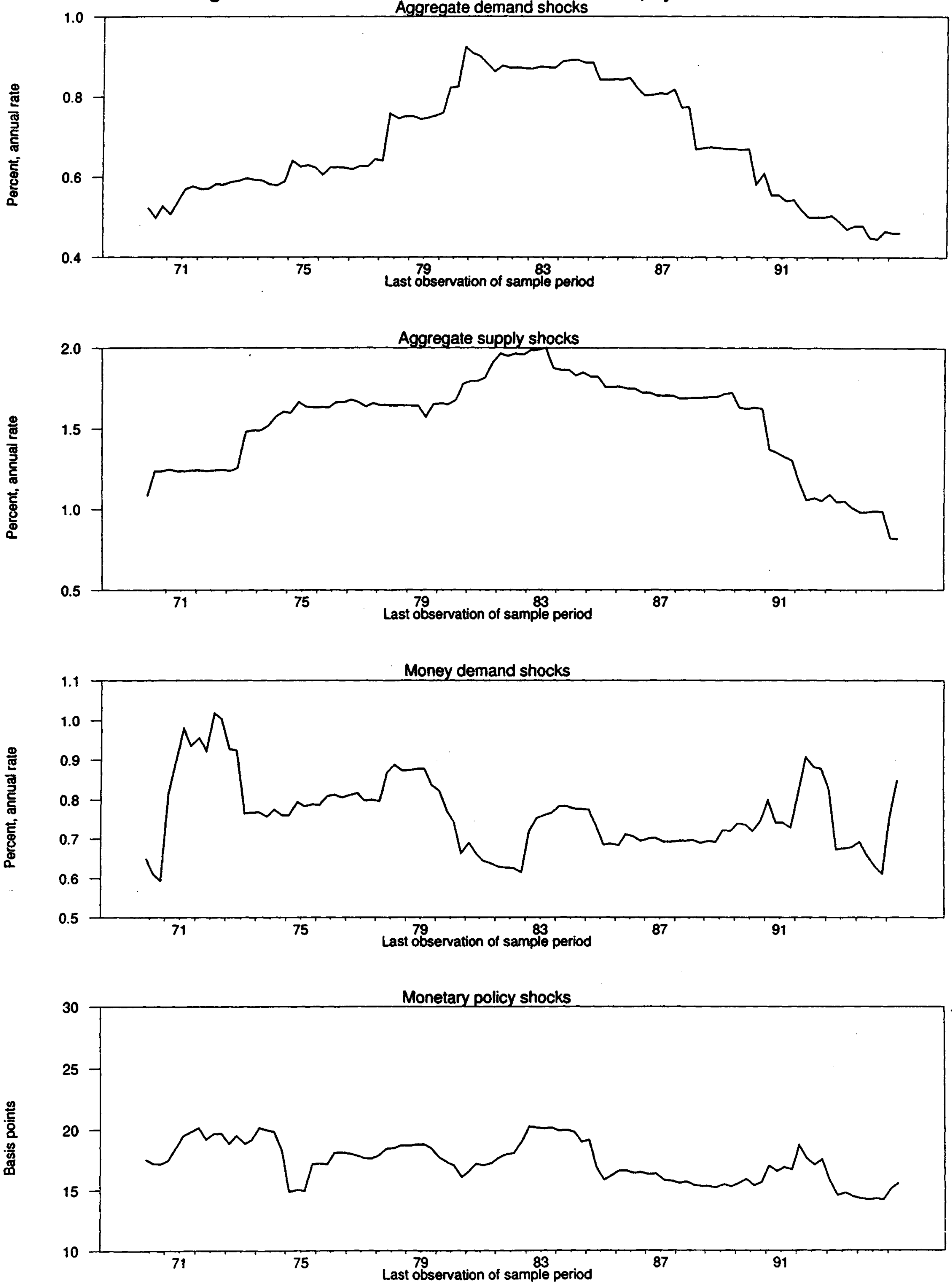


Figure 10. Standard Deviation of Structural Shocks, System with M2



"monetary policy" equation.

The four-variable system underlying the results plotted in Figures 9 and 10 also follows Gali by specifying the autoregression in terms of the growth (log change) of real output, the change in the federal funds rate, the level of the federal funds rate minus the growth of prices (in other words, the level of the real interest rate), and the growth of money minus the growth of prices:

$$\Delta x$$

$$\Delta r$$

$$r-\Delta p$$

$$\Delta m-\Delta p$$

This normalization is consistent with treating each of the four underlying variables -- output, inflation, money growth, and the interest rate -- as stationary in first differences. It also implies that the nominal interest rate and the inflation rate are cointegrated (so that the real interest rate is stationary), as well as that nominal money growth and inflation are cointegrated (so that the growth of real balances is stationary).[30]

One way of capturing the variation over time that is the focus of interest in the context of this paper's inquiry would be to follow the method used in deriving the instructured VAR results presented in Section II -- that is, now to estimate the <u>structural</u> VAR separately over the same 81 sample periods and, in a manner directly analogous to the exercise underlying Figure 8, examine the resulting 81 structural variance-covariance estimates given by applying the Gali restrictions. The alternative procedure used here, in the interest of conserving degrees of freedom, is instead to estimate the underlying vector autoregression only once, using quarterly data for 1960:II-1995:II, but then to perform separately the decomposition of the estimated VAR residuals into the four structural disturbances using a rolling ten-year window.

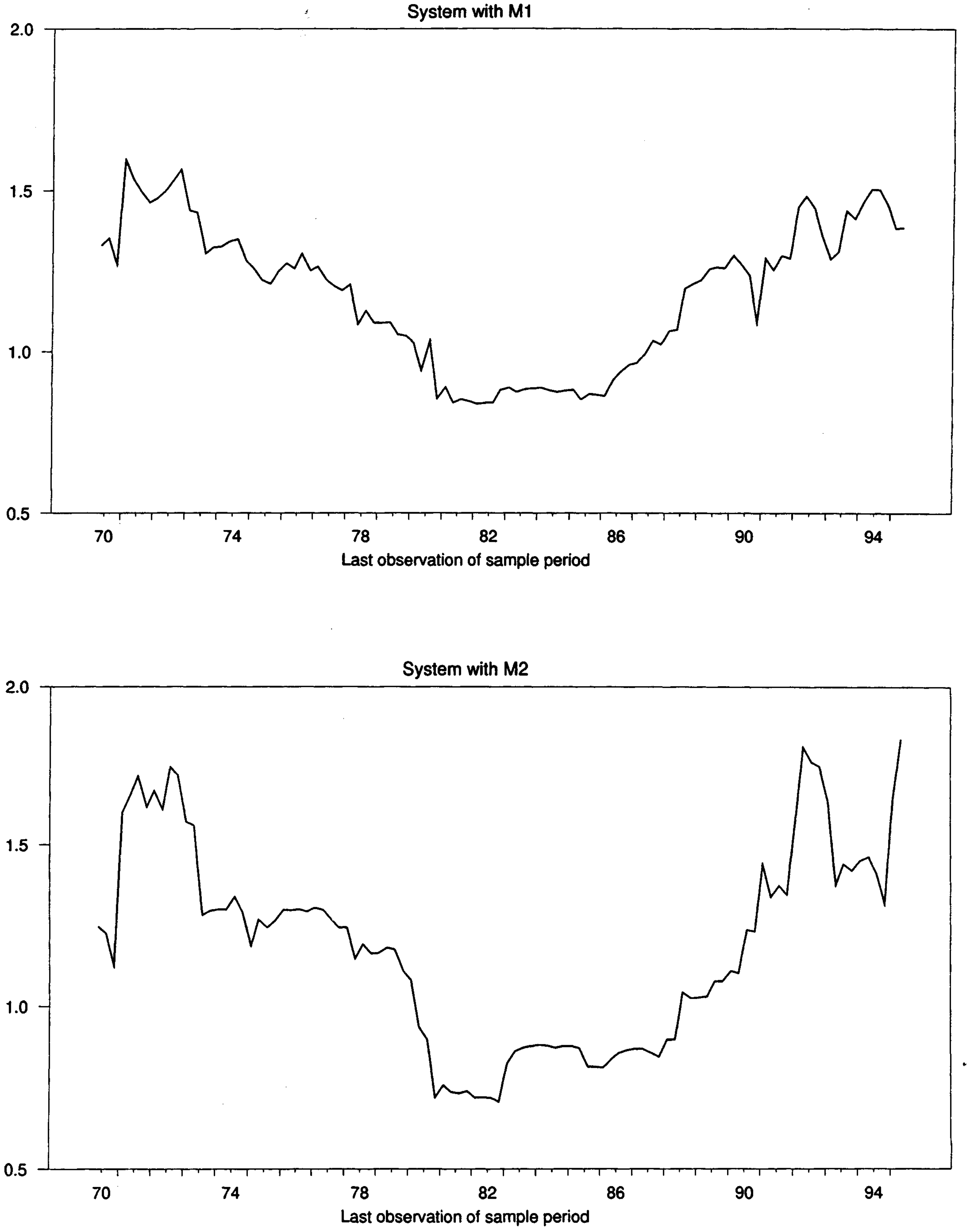
The obvious shortcoming of this procedure is that it holds the coefficients on the lagged variables constant over the entire 35-year period. The benefit, however, is that it permits the use of a shorter window than in the Section II results (40 quarters versus 80, but even 20 is now a possibility) for estimating the contemporaneous relationships between the model's variables and the disturbances. Especially since the contemporaneous relationships embody most of the model's structural content, the trade-off seems well worth while. Figure 9 plots the resulting moving-average standard deviations for the system based on M1 growth, and Figure 10 does the same for the system relying on M2 growth.

The most obvious lesson conveyed visually by the changing variability of these structural disturbances is simply that they do indeed change over time -- and, most importantly for purposes of the implications of familiar ways of analyzing alternative policy regimes, they change relative to one another. In the system where money growth is defined as M1, aggregate demand shocks became sharply more variable in the late 1970s only to reverse this movement, albeit more gradually, a decade later. (The dates shown on the horizontal axis give the end of the rolling ten-year window). Aggregate supply shocks became more variable with the first OPEC price increase in 1973, remained highly variable through the early 1980s, and since then have steadily declined in variability. Money demand shocks behaved irregularly in this regard until the early 1980s but then became progressively more variable throughout the decade, before this movement too ultimately reversed itself. Monetary policy shocks irregularly increased in variability until the early 1980s, and since then they have become steadily less variable.

What matters for most analyses of alternative policy regimes is not just the absolute variability of any particular source of uncertainty but the variability of one kind of disturbance relative to another. In terms of Poole's (1970) classic analysis, for example, whether it is better to fix money growth (in a simple model in which doing so is feasible) or an interest rate depends in part on the relative variability of aggregate demand shocks and money demand shocks (in Poole's model, IS shocks and LM shocks, respectively). As the top panel of Figure 11 shows, after at first declining in variability relative to aggregate demand shocks, since the mid 1980s M1 money demand shocks have sharply increased in variability relative to aggregate demand shocks. The ratio of standard deviations for ten-year windows ending in the early 1990s is nearly double that for windows ending in the first half of the 1980s. While the correspondence is not precise, comparison of the top panel of Figure 11 with either panel of Figure 3 provides support for Hypothesis #2 among the different possibilities suggested in Section III above: that increasingly unstable money demand has been at least partly responsible for the disappearance of the predictive content of M1. (An analogous plot of the standard deviation of money demand shocks relative to that of aggregate supply shocks would show roughly the same pattern, especially from about 1980 onward.)

Figure 10 and the lower panel of Figure 11 tell approximately the same story for the system based on M2. In this representation also, aggregate demand shocks became first more variable and then less so. Aggregate supply shocks have become less variable since the early 1980s, and especially so in the early 1990s. The variability of money demand shocks has changed more irregularly, but the first few years of the 1980s clearly marked a low point and the first few years of the 1990s a high point. The ratio of the respective standard deviations of money demand shocks and aggregate demand shocks (Figure 11, lower panel) again shows a relative movement very like what happened in the case of

Figure 11. Ratio of Std. Deviations of Money Demand to Aggregate Demand Shocks

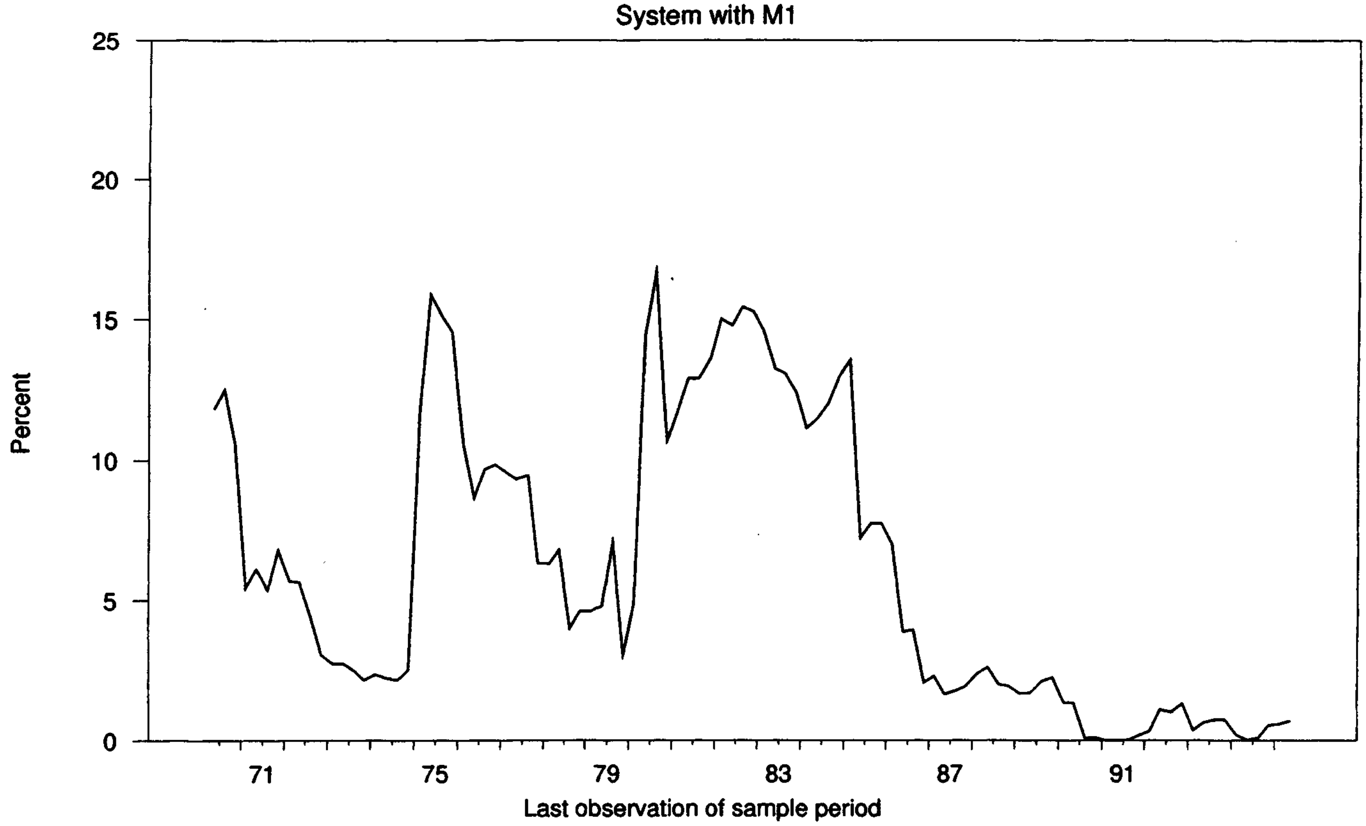


M1. Comparing this ratio to either panel of Figure 5 again provides support for Hypothesis #2, which attributes the declining predictive content of money to increased instability of money demand.

What about the other two hypotheses advanced in Section III? A sharp implication of Hypothesis #1, which posits deliberate stabilizing variation of money to offset shocks originating from other sources, is that those other non-policy shocks should be playing a greater role in determining observed money growth. The evidence from the relevant variance decompositions, shown in Figure 12, directly contradicts this proposition, however. The percentage of the variation of observed M1 growth attributable to aggregate demand shocks at a four-quarter horizon was at its peak (which even then was only 17%) in 1980 -- when M1 did have modest predictive content -- and since the mid 1980s it has declined nearly to zero. The analogous percentage of the variation of M2 growth explained by aggregate demand shocks was larger in the early 1970s, but since then it has been quite small (note the difference in scale between the upper and lower panels), and it was nearly zero during much of the 1980s. Comparing the upper and lower panels of Figure 12 to Figures 3 and 5, respectively, hardly generates confidence in Hypothesis #1.

The basic assumption underlying Hypothesis #3, which posits a diminished ability of the Federal Reserve to influence economic activity because of institutional changes in the financial system, is that monetary policy shocks have had a diminishing impact on output. Interestingly, the evidence from the relevant impulse responses does provide some support for this proposition, albeit only for the most recent few years. The respective panels of Figure 13 show the variation over time in the impact of a constant-value monetary policy shock (a 100 basis point decline, where the equation is normalized on the federal funds rate) on the <u>level</u> of output (hence the cumulation of the effect

Figure 12. Contribution of Aggregate Demand Shocks to the Variance of Money Growth



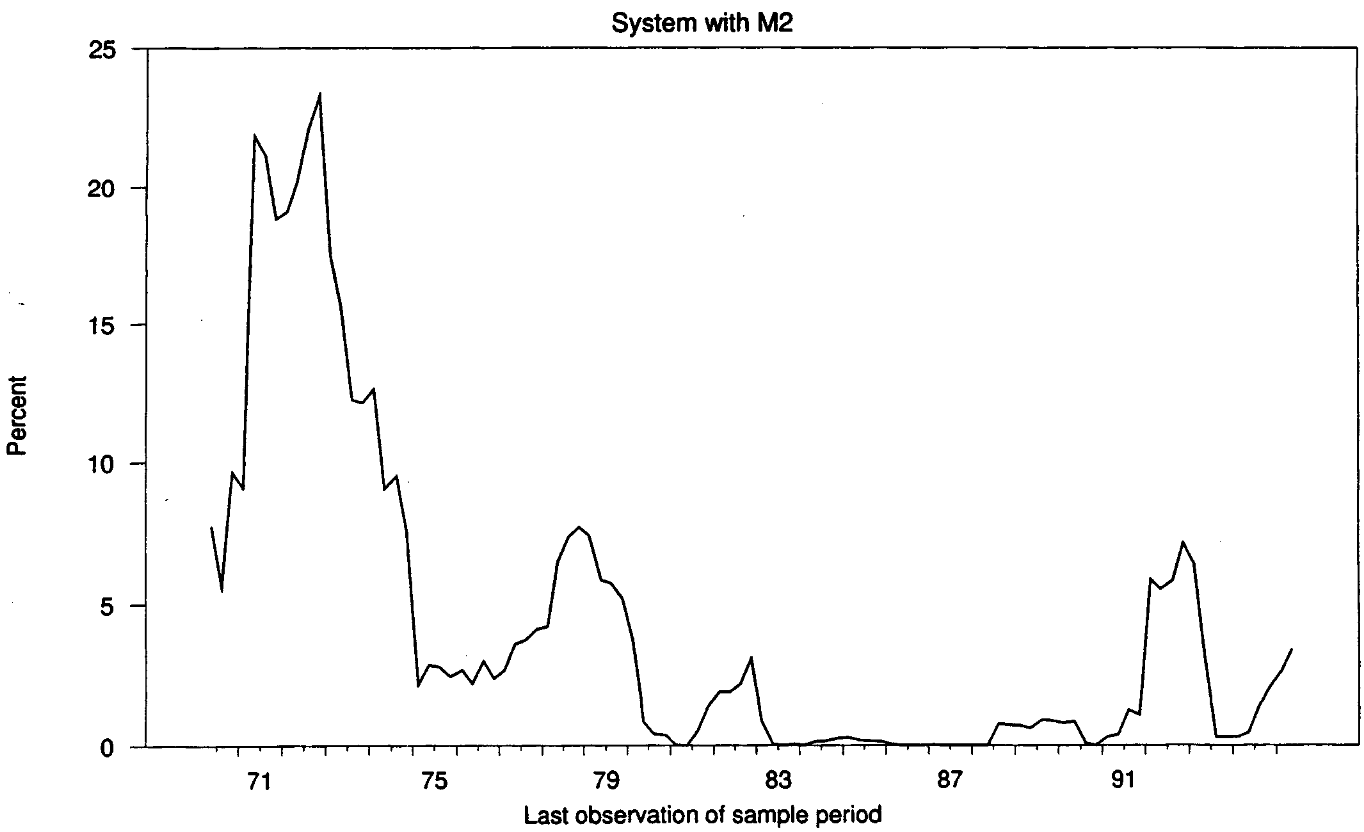
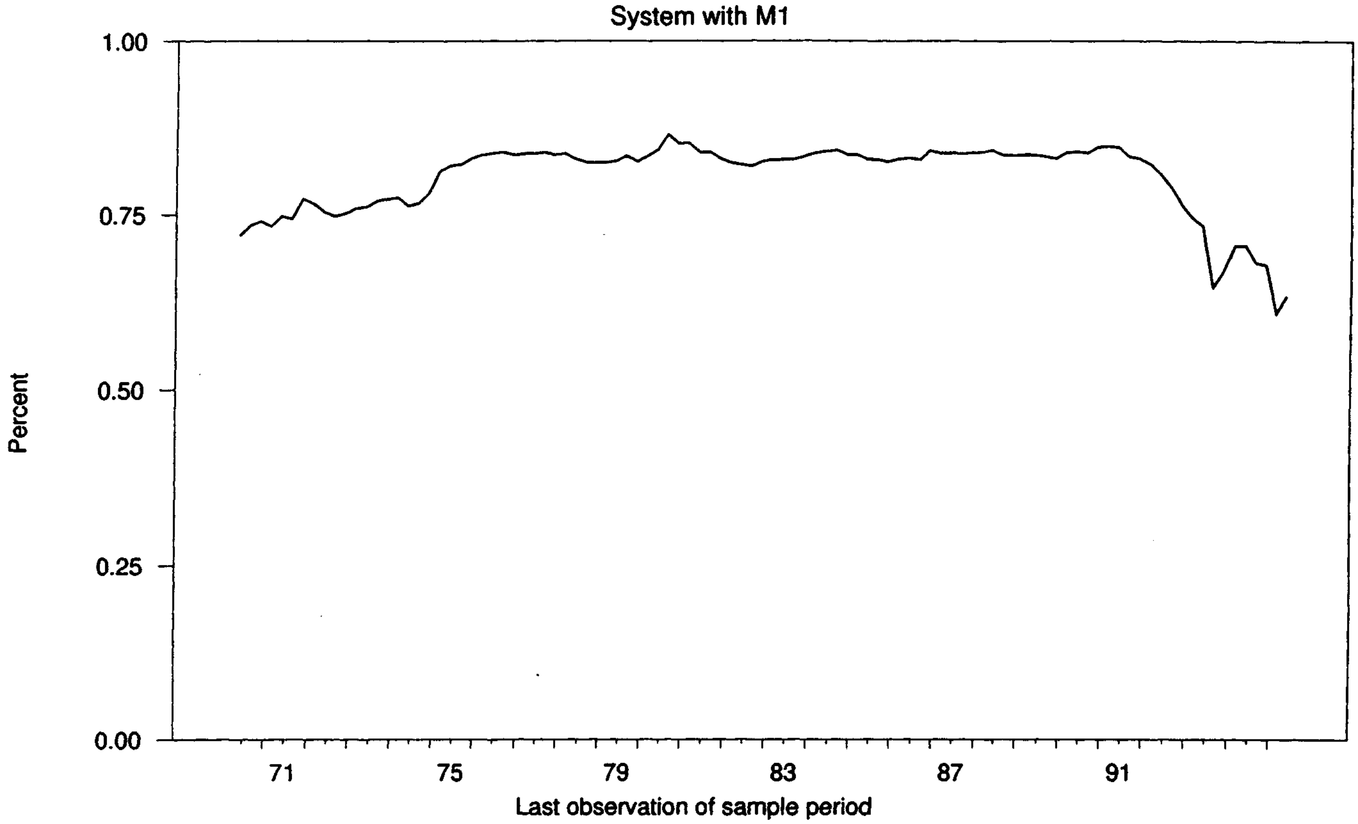
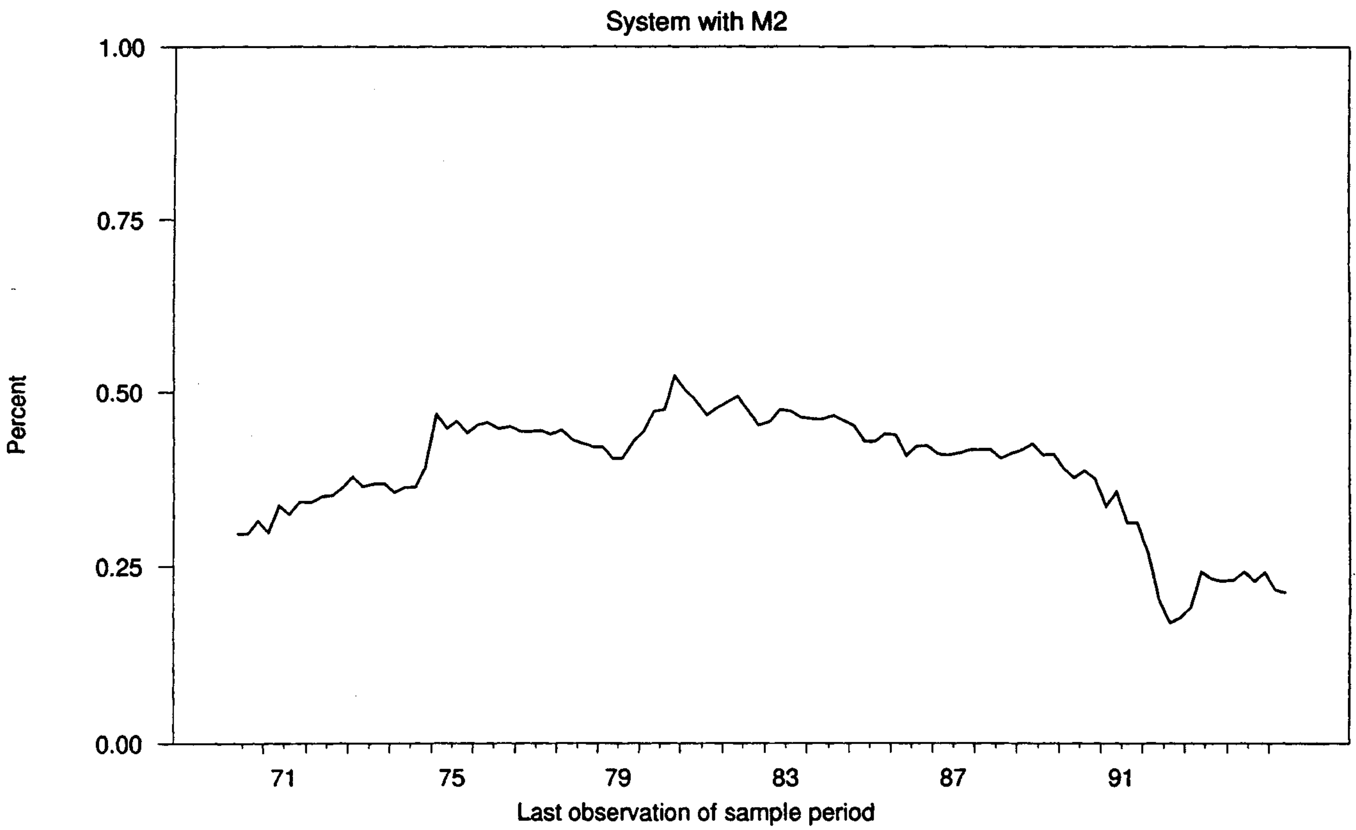


Figure 13. Response of Real GDP to 100 Basis Point Monetary Policy Shock





on output growth due to the monetary policy shock) at an eight-quarter horizon. (Analogous results for a four-quarter horizon are highly similar.)

For the system based on M1, the effect of a 100 basis point monetary policy shock on the level of output was roughly unchanging, at about .8%, until the early 1990s, when that impact decreased to somewhat over .6%. In the system based on M2, the impact on output from a 100 basis point monetary policy shock varied irregularly around an average value of roughly .4% until the early 1990s, and more recently it has averaged approximately .25%. Especially for M1, the timing of the decline does not match that of the vanishing predictive content of money with respect to real output (see again Figures 3 and 5). Even so, these results do provide some limited support for Hypothesis #3.

In sum, the evidence drawn from this more structured analysis of the four-variable autoregression system suggests that increasing instability of money demand is the most consistent explanation for the fact that, some time during the mid to late 1980s, fluctuations in money growth ceased to anticipate subsequent fluctuations in either output or prices. The change in empirical relationships that presumably led the Federal Reserve to abandon its money growth targets, notwithstanding that Congressional Resolution 133 remained in force, was therefore <u>not</u> itself merely a creation of the Federal Reserve's own policy regime as Hypothesis #1 (and #0) implies. In abandoning money growth targets, the Federal Reserve was therefore <u>not</u> just "chasing its tail," as wistful defenders of these targets have suggested. Changes in objective conditions -- new technology, deregulation, new forms of deposit holding, globalization, and so on -- eroded over time the main behavioral prop that had always underpinned the idea of basing monetary policy on money growth targets: stable money demand. The Federal Reserve simply reacted accordingly.

V. More General Lessons About Monetary Policy Rules

What lessons do these conclusions provide for a regime that would dedicate U.S. monetary policy to a price-stability target?

The currently pending "Economic Growth and Price Stability Act," which is sponsored by the chairman of the Joint Economic Committee and cosponsored by the then Senate Majority Leader, gives the Federal Reserve System two basic monetary policy instructions: "(1) establish an explicit numerical definition of the term 'price stability'; and (2) maintain a monetary policy <u>that effectively promotes long-term price stability</u>" (emphasis added). The proposed bill specifically repeals the Full Employment and Balanced Growth Act of 1978, which constitutes the current Congressional instruction on monetary policy. It also explicitly amends the Employment Act of 1946 insofar as that legislation applies to monetary policy.

For purposes of comparison, the section of the <u>current</u> Federal Reserve Act (as amended under the Full Employment and Balanced Growth Act) that the pending bill proposes to replace by the language quoted immediately above instructs the Federal Reserve to "maintain long run growth of the monetary and credit aggregates commensurate with the economy's long run potential to increase production, <u>so as to promote effectively the goals of maximum employment, stable prices, and moderate long-term interest rates</u>" (emphasis added).

Reading the current and the proposed new language together makes clear that what is new in the pending bill is not that the Federal Reserve would be instructed to seek price stability, but that it would be instructed <u>only</u> to seek price stability.[31] A subsequent section of the pending bill also instructs the Federal Reserve to "take into account any potential short-term effects on employment and output," but this section refers to the initial transition to price stability, presumably from a starting point involving positive inflation.

Moreover, the specific injuction to pursue "long-term" price stability" (emphasis again added) presumably means that, after this initial transition, any episodes in which prices do increase are to be offset by subsequent episodes of absolute price decline. Unlike in the more general case of a period-by-period inflation target, a target of long-term price stability means that bygones are not simply bygones.

Setting a target for a variable like prices that constitutes an ultimate goal of monetary policy is, of course, not the same as setting an intermediate target for a variable like money. In terms of Debelle and Fischer's (1994) useful taxonomy, "goal independence" and "instrument independence" differ in ways that are important in principle and potentially important in practice. Legislating targets like price stability, or maximum employment, or stability of the banking and financial system, means that the higher authority to which the central bank is responsible is defining what contribution monetary policy is expected to make to the nation's economic well-being. By contrast, under a legislated interest rate rule or reserves rule, that higher authority is telling the central bank not just what objectives to seek to achieve but also how, operationally, to go about doing so. Legislating a target for a variable like money growth represents an intermediate stage, but over time horizons long enough to render money growth controllable, it too in effect means that the central bank is not instrument independent.

As Debelle and Fischer, and others, have shown, there is a good case for giving the central bank instrument independence but not goal independence. No legislated rule governing the instruments of monetary policy can plausibly take account of the vast range of unforeseeable circumstances to which actual central banks need to respond on a real-time basis, including just the kind of changes in empirical relationships that the evidence presented in this paper documents for the United States. And as the U.S. experience examined here demonstrates, legislated targets for intermediate variables like money growth suffer from the same shortcoming. By contrast, for monetary policy to pursue basic goals determined by the higher governmental authority that is the ultimate source of the central bank's political legitimacy -- under the U.S. Constitution, that means the Congress -- is no more than what is consistent with the fundamental principles of a democracy.

Merely drawing the distinction between goal independence and instrument independence, however, does not constitute an argument showing that a price-stability target -- or, for that matter, any other particular specification of goals -- is necessarily a good way to conduct monetary policy. To the contrary, several well known analyses have shown that a price-stability target makes good sense for monetary policy under some conditions but not others. The usual conclusion is that when wage rates are not fully flexible, holding prices stable is not optimal in the presence of supply shocks that represent disturbances to productivity. By contrast, holding prices stable may be optimal under plausible circumstances as long as the disturbances to the economy consist entirely of demand shocks of one kind or other.

Aizenman and Frenkel (1986), for example, demonstrated the non-optimality of a strict stable-price monetary policy in a static model in which supply shocks are explicitly productivity shocks and the basic impediment that prevents the economy from reaching the correct post-shock equilibrium is inflexible wages. Simply put, the argument is that this new equilibrium warrants a changed real wage (higher after a favorable productivity shock, lower after an adverse shock). But if wages are not fully flexible, holding prices stable prevents the real wage from adjusting as it should.

For example, a large literature has compared the more favorable growth and employment experience of the United States to the less favorable European experience in the years following the OPEC oil shocks of 1973 and 1979, along just the lines suggested by this line of analysis. To be sure, part of the difference between the U.S. and the European post-OPEC experience stems from differences in labor market institutions. But the message of Aizenman and Frenkel's analysis, and the host of similar models, is that the U.S. experience in this regard would have been very different had the price level not been able to adjust. In particular, given the downward rigidity of nominal wage rates, an increase in the price level was necessary to bring about lower real wages in line with the adverse productivity shock due to OPEC.[32] Under a price-stability target, the Federal Reserve would have had to pursue a sufficiently tight monetary policy to prevent that rise in prices, thereby also preventing the downward reduction in real wages that kept such a large fraction of the American labor force employed. And if prices had risen anyway (nobody pretends that the central bank has perfect control over the price level in the short run), the "no bygones" character of a <u>long-term</u> price-stability target means that the Federal Reserve would have had to maintain this tight policy long enough to drive the price level back down.

In making arguments like these it is important to be clear that what enables an economy to adjust to supply shocks is <u>not</u> a new permanent level of inflation but rather a once-for-all change, up or down, in the price level. (In principle one could imagine a permanent stream of productivity shocks, but that idea strains the notion of "shock.") This distinction cannot be explicit in static models like that of Aizenman and Frenkel, but it is so in Rogoff's (1985) dynamic model. Here, again, what is subversive of the optimality of holding to a price-stability policy target is shocks to productivity when wage rates are not fully flexible.

Rogoff's main result is that while placing a large weight on inflation stabilization relative to employment stabilization reduces the long-run average rate of inflation associated with the time inconsistency problem, doing so "suboptimally raises the variance of employment when supply shocks are large." While the optimal policy regime therefore places large weight on inflation stabilization, it does not focus exclusively on price objectives. Moreover, a long-run price-stability target, which not only places exclusive weight on prices but also requires that any inadvertant price level changes (again, for example, in response to supply shocks) be offset by subsequent price level changes in the opposite direction, represents an extreme form of Rogoff's "suboptimality."

Evaluating just how serious these problems would be in practice, for the United States or any other country, would require an analytical apparatus well beyond that developed in this paper. As Aizenman and Frenkel, Rogoff, and many others have shown, the crucial comparisons depend not only on the variance-covariance structure of the relevant disturbances but also on the magnitudes of key structural parameters.[33] Moreover, it would also be necessary for this purpose to distinguish supply shocks that represent disturbances to productivity from supply shocks that merely change the economy's "natural" rate of output without affecting production relationships at the margin.[34] Constructing such a model and then carrying out this kind of exercise -- comparatively evaluating a price-stability target, an inflation target, a nominal income target, various mixed inflation-output or inflation-employment targets (for the sake of nostalgia, even money growth targets) -- would perhaps be a useful endeavor.

But the main lesson of this paper's look back at the Federal Reserve System's experience with money growth targets is that even if the relevant relationships as seen today did appear to warrant adopting a price-stability rule, there would be little ground for confidence that they would continue to do so over the length of time that would make legislating this or any other monetary policy target sensible. For a while, money did have significant predictive content with respect to income and prices, and the Federal Reserve did formulate money growth targets and respond to deviations of observed money from these targets in setting the federal funds rate. The underlying money-output and money-price relationships changed, however -- and not merely as a consequence of the Federal Reserve's own changed regime but mostly because money demand became functionally unstable. In other words, a key behavioral disturbance that once appeared quantitatively modest enough to be acceptable (even though qualitatively it obviously was not helpful under a money-growth-target strategy) later became much more volatile, both absolutely and relative to other kinds of shocks.

Even if productivity shocks were to look sufficiently small at any given time to warrant adopting a price-stability target, therefore -- and notwithstanding the declines shown in Figures 9 and 10 above, that case remains to be made -- there is no assurance that they too would not likewise grow more volatile. If that happened, and if Congress had legislated a price-stability target, the Federal Reserve would once again face the dilemma of either holding to a poorly designed monetary policy framework or disregarding the legal instructions given to it by the higher governmental authority to which it is accountable. Neither choice would do much to enhance the cause of responsible monetary policymaking.

Footnotes

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1. See Fischer (1990) for a thorough review. For more recent contributions, see Debelle and Fischer (1994), McCallum (1995), Walsh (1995), Posen (1995) and the references cited by these authors.

2. This principle has attracted wide agreement. See also Flood and Isard (1989), Taylor (1993), Friedman (1993) and McCallum (1995).

3. In an amusing usage obviously designed to avoid the word "target," the standard "growth cone" chart in the semi-annual Humprey-Hawkins report now plots the "Actual Range and Actual Level" of M2 and M3. (What, one is tempted to ask, is the meaning of an "actual range" when the actual level is outside it?)

4. This section and Section II below draw in part on Friedman (1996).

5. Bernanke and Blinder (1992), among others, have argued that the federal funds rate is the best single measure of monetary policy in the United States.

6. The price index used is "core CPI-U" -- that is, the consumer price index for all urban consumers, excluding food and energy items. The twelve-month inflation rate is calculated as $\pi_{t-1} = p_{t-1} - p_{t-13}$ and $\pi_{t-2} = p_{t-2} - p_{t-14}$, where p is the logarithm of the price index.

7. The unemployment rate is the rate for the civilian labor force aged sixteen and over. The natural rate is from Gordon (1993), Table A-2, rendered into monthly values and continued at 6.0% after 1992. (Gordon's series ends in 1992:II, but it is constant at 6.0% throughout 1980-1992.)

8. Friedman (1996) also experimented with an alternative representation that distinguishes discontinuously between values of money that are with or outside the target range by setting $(m-m^T)$ equal to zero whenever observed money is within the corresponding range and, for observations outside the range, equal to the algebraic difference between m and the monthly path traced by either the upper or lower end of the target range, whichever is closer. The results were very close to those found using the continuous representation here based on the mid-point.

9. For 1980 and 1981 the Federal Reserve established separate targets for what were then called M1-A and M1-B. For those two years the regression relies on the M1-B aggregate, which as of 1982 was simply relabeled M1.

10. On the distinction between an intermediate target variable and an information variable, see, for example, Friedman (1993). One way to draw this distinction empirically would be to include the Federal Reserve's forecasts of inflation and unemployment in the regression. McNees (1992) carried out an analysis of this kind, albeit for a different specification of the reaction function than that used here, and found evidence indicating that the Federal Reserve did treat M1 growth as an independent target variable, not just an information variable.

11. There is also ground for supposing that the response to inflation and unemployment changed over time -- see, for example, the evidence presented in Friedman (1996) -- but that is not the focus of attention in this paper.

12. The model replaces the time-invariant δ coefficient in equation (1) with a time-varying δ_t, which is assumed to follow a random walk: $\delta_t = \delta_{t-1} + \epsilon_t$. The other coefficients are not allowed to vary over time. The initial conditions for the coefficients other than δ were taken from the ordinary-least-squares regression of the federal funds rate on the variables other than $(m-m^T)$ over the 1960:2-1974:4 sub-sample. The starting value of δ was set to 0, with a variance of 0.25. Other plausible starting values yielded virtually indistinguishable results. The standard deviation of the shock to the δ_t coefficient σ_ϵ, was set to 0.01. (In principle, maximum likelihood estimation of σ_ϵ is feasible, but the results were very similar for a wide range of assumed values of σ_ϵ.)

13. These results are highly similar to those presented by Friedman (1996) using an expanding/rolling-sample regression model with dummy variables intended to mimic a time-varying-parameter model in a step-wise fashion.

14. For a description of the nonborrowed reserves procedure, see New Monetary Control Procedures (1981). Subsequent research has mostly supported the claim that the instrument variable during this period was nonborrowed reserves; see, for example, Bernanke and Mihov (1995).

15. What matters for this purpose is merely that movements in money precede movements in prices and/or output. It is not necessary that money play any part in "causing" prices or output in the classical sense. The discussion below follows Tobin (1970) in emphasizing this distinction. In particular, the use of the vector autoregression methodology here merely determines whether money has predictive content, not whether money is causal.

16. Results are highly similar for a one-year horizon; see Friedman (1996).

17. To show more precisely how someone in early 1975 would have answered this question would require using data that existed then -- not, as here, the revised data for 1959-74 that exist now. The work reported in Section I above follows that approach. By contrast, here and below the emphasis is on how the relevant economic behavior has changed over time, and so the results reported rely on the latest revised data available as of the time of writing.

18. Moreover, ordering money ahead of the interest rate for purposes of the orthogonalization biases the results shown here in favor of a predictive content for money.

19. Because of the rolling-sample procedure, the odd spike at 1981:II in the output panel of Figure 3 (and, to a lesser extent, in the price panel) could in principle be due to sequentially adding 1981:II and then 1981:III to the sample, or to sequentially dropping 1961:II and then 1961:III. Experimentation shows that what matters is sequentially adding the new observations. When the underlying vector autoregression is run on differenced data, the same general pattern appears but these spikes are much less pronounced.

20. See the discussion in Sims et al. (1990). As they point out, the "levels" regression used above for purposes of the variance decompositions preserves any cointegrating relationships that obtain among the included variables without explicitly imposing those relationships. One potential cost of using differenced relationships like (3) and (4) below is that they do not incorporate the long-run relationships implied by cointegration. Evidence for the existence of cointegration in this context is weak, however; see, for example, Friedman and Kuttner (1992) and Miyao (1996).

21. Stock and Watson (1989), among others, argued that also including a time trend in the regression restored the predictive content of M1 with respect to output in this kind of regression, but Friedman and Kuttner (1993) showed that this result depended on the use of a specific interest rate. Stock and Watson's result also disappeared when the sample was extended

past 1985.

22. See Friedman (1996) for a detailed evaluation of changes in the Federal Reserve's reliance on money growth targets in light of evidence corresponding to that presented here in Figures 3-6.

23. Friedman also went on to show that _if_ the central bank attempts to offset shocks from other sources _fully_ (so that $\sigma_M^2 = \sigma_Z^2$), activist policy is stabilizing only if $\rho < -1/2$. This result has often been misunderstood, however, and its importance consequently overstated. In the presence of uncertainty, the optimal activist policy is to offset expected shocks less than fully (that is, $\sigma_M^2 < \sigma_Z^2$), and so ρ need not be so negative as $-1/2$ for policy to be stabilizing; Brainard's (1967) exposition of optimal policy under uncertainty, though couched in different terms, in effect makes this point.

24. This point again stems from the ability of the VAR methodology to provide evidence only on chronological precedence, not causation; see again footnote 15.

25. Two well known reviews of this vast literature are Judd and Scadding (1982) and Goldfeld and Sichel (1990).

26. See, for example, the lengthy survey aptly entitled "Who's in the Driving Seat?", published in _The Economist_, October 7, 1995.

27. See, for example, Akhtar and Harris (1987), Bosworth (1989) and Friedman (1989).

28. The same identification objective underlies, for example, Romer and Romer's (1989) use of non-quantitative data drawn from the minutes of Federal Open Market Committee meetings.

29. Gali also suggested two potential alternatives to this sixth restriction -- that monetary policy does not respond contemporaneously to real output, and that monetary policy does not respond contemporaneously to inflation -- but both are contradicted for quarterly time aggregation by the results presented in Section I above based on monthly data.

30. See Gali (1992) for evidence and discussion in support of these stationarity assumptions.

31. The proposed bill would also eliminate the instruction to formulate monetary policy in terms of money (and credit) growth targets. As the evidence discussed in earlier sections of this paper indicates, this change is well warranted and the Federal Reserve has already implemented it even while the existing instruction remains in force.

32. See the evidence reviewed by Akerlof et al. (1996) on the downward rigidity of nominal wages in the United States.

33. The same is true in simpler models like Poole's (1970) that incorporate only demand-side disturbances.

34. This distinction emerges especially clearly from the exchange between Bean (1983) and West (1986).

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