THE EVOLUTION OF FEDERAL RESERVE CREDIBILITY: 1978–1984

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Abstract—A random coefficients Kalman filter model of the response of commodity prices to weekly M1 announcements indicates a gradual evolution in the credibility of the Federal Reserve as an inflation fighter. The October 1979 announcement of a change in monetary policy aimed at reducing inflation did not result in an immediate increase in credibility, and the October 1982 announcement of a policy reversal did not diminish credibility. Credibility does vary with the underlying rate of inflation, which shows that markets pay attention to policy results not simply policy announcements.

CREDIBILITY is an important ingredient for the effectiveness of policy. The more credible an announced policy change, the quicker the response of the private sector and the faster the attainment of policy targets. In this article we examine the evolution of the Federal Reserve's credibility as an inflation fighter from the beginning of 1978 through the end of 1984. During this period the Federal Reserve made a conscious and well-publicized effort at lowering the rate of inflation. After an unusual Saturday FOMC meeting in October 1979, the Federal Reserve announced the adoption of strict M1 targets aimed at reducing the rate of inflation. To emphasize its commitment to the new targets, the Fed also adopted non-borrowed reserves as its operating target allowing interest rates to fluctuate relatively freely. Then in October 1982, in an apparent policy reversal, the Fed announced that it would adopt wider monetary aggregates as additional targets, changed its operating target from non-borrowed to borrowed reserves, but reiterated its commitment to low rates of inflation.

The questions we address in this article are: Did the Fed have credibility in the market before it announced a policy change in October 1979? Was it able to establish credibility after the announced policy change, and if so, how quickly? How did the October 1982 or earlier apparent abandonment of M1 targeting affect its credibility as an inflation fighter?

Credibility is a concept that is difficult to quantify because it depends on market perceptions. In this article, we capture market perceptions of Fed policy by examining the response of commodity prices to the weekly announcements of the narrowly defined stock of money, M1. We claim that the changing sign and size of this response provides evidence on the temporal variability of Federal Reserve credibility.

A central feature of our analysis that differs from most previous work is our use of a random coefficients Kalman filter. This estimation technique allows the data to reveal the temporal evolution of Fed credibility without imposing our own prior beliefs. By contrast, much of the recent literature simply takes the October 1979 and sometimes the October 1982 policy regime shifts as given, and then compares parameters of interest across the different subperiods.[1]

Section I discusses how commodity price reactions to announced money surprises can provide an empirical proxy for Fed credibility. Section II presents the estimation methodology and the major empirical results. Section III explores a possible connection between the economy's underlying

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[1] Some authors have used a method suggested by Quandt (1960) to locate breaks in economic series without imposing a priori October 1979 and October 1982 as break points. Huizinga and Mishkin (1986) examine the real rate of interest and find breaks in October 1979 and October 1982, while Walsh (1988) finds breaks in October 1979 and April 1983. Antoncic (1986) examines the volatility in the real interest rate and finds a break in March 1980. Finally, Walsh examines the rate of inflation and finds breaks in October 1979 and October 1982.

rate of inflation and the degree of Fed credibility. Section IV summarizes our principal findings.

I. Commodity Prices, Money Announcements and Credibility

Cornell (1983), Hardouvelis (1984), Barnhart (1989) and many others have reported that when the Fed announces the recently collected weekly M1 number and it turns out to be larger than expected, interest rates increase, and vice versa. Clearly interest rates respond to revisions of the expected future path of the money stock. But nominal interest rates are an ambiguous indicator of expectations. On the one hand, if the Fed lacks credibility, the unanticipated increase in M1 may indicate a higher Fed target growth rate and higher inflationary expectations. The subsequent increase in interest rates is then explained as an inflation premium. On the other hand, if the Fed has credibility, markets may interpret the increase in M1 as an unintended but persistent fluctuation originating in both money demand and the banking system. Markets would then expect the Fed to contract the money supply in order to keep M1 on target. In this case the change in nominal interest rates is interpreted as a change in real interest rates, without any necessary change in expected inflation.

Frankel and Hardouvelis (1985) showed that spot prices of daily traded commodities can be used to distinguish the lack or presence of Fed credibility. If after an unanticipated increase in M1 expectations of future money growth and inflation are revised upward, investors will instantly shift out of money and into commodities to protect themselves, thus causing current commodity prices to rise. Alternatively, if expectations of future money growth and inflation are revised downward, investors will instantly shift into money and out of commodities, thus causing current commodity prices to fall. Frankel and Hardouvelis found that the response of commodity prices was positive before October 1979, indicating lack of credibility, and negative after October 1979, indicating the presence of credibility.[2]

Credibility, of course, is something that could change over time in response to many other events such as the Humphrey–Hawkins Act in 1978, the special Credit Control program of April–July 1980, or the introduction of NOW accounts nationwide in January 1981, money market deposit accounts in late 1982, and Super NOW accounts in early 1983. Credibility can also vary continuously with the arrival of new information about the Fed's behavior. Hardouvelis (1985) presents a theoretical model (for exchange rates and interest rates) in which price responses are time-varying as investors continuously update their subjective probabilities of future money growth policies. If investors follow the Bayesian rules of inference, the response parameters are Kalman filter weights. At the empirical level, Loeys (1985), using a rolling regression, and Belongia, Hafer and Sheehan (1988), using a Kalman filter, have both investigated the issue of time variability in interest rate reactions. However, no one has examined commodity prices, and thus the interesting question of possible temporal variability in credibility.

Finally, note that the response of commodity prices to unanticipated money is not always an unambiguous indicator of Fed credibility. For example, suppose that markets, like the Fed, believe that due to velocity shifts M1 no longer carries the information it once did. The response of commodity prices may become zero not because the Fed became more or less credible, but because the information in M1 shocks has dissolved. Fortunately, we are able to address this problem by also analyzing the response of a representative short-term interest rate. The presence or absence of a significant interest rate response reveals the presence or absence of informative content in the M1 surprise.[3]

[2] The Frankel-Hardouvelis approach exploits the "moneyness" of commodities and applies better to metals. It is different from recent efforts to isolate a proxy of the ex-ante real rate of interest by using commodity own rates (see Cornell and French (1986), Hamilton (1987), or Mishkin (1986)). These studies presume the lack of a hold and carry relation between futures and spot markets and, therefore, apply better to non-metals.

[3] One could argue that a time-varying response of commodity prices to unanticipated money may not reflect time-varying credibility, but may reflect a credible and time-varying policy because the Federal Reserve places a time-varying weight in its inflation objective. However, this distinction is semantic. Our definition of Fed credibility as an inflation fighter is based on the assumption of a constant inflation weight in the Fed's objective function.

II. Temporal Variability in the Response of Commodity Prices

A. Data and Definitions

In our empirical analysis we present the response of commodity prices and the six-month T-bill yield to the unanticipated percentage change in M1 from October 6, 1977 to December 28, 1984. We use the percentage change in a commodity price, DCP_t, defined as $100[\ln(S_o/S_c)]$, where S_o is the post-announcement market opening price and S_c is the pre-announcement market closing price. We report results for gold, the most "money-like" commodity, and three aggregate commodity indices: all commodities, metals, and nonmetals. Each index is constructed as a weighted average of the individual commodity percentage price changes with weights that sum to unity and are inversely proportional to the sample standard deviation of each individual commodity percentage price change. Each aggregate commodity series provides a convenient summary measure and contains less noise. Individual commodity prices are affected by macroeconomic factors and factors which are specific to the commodity in question. By averaging across commodity price changes, the commodity-specific noise may cancel out. The results for each individual commodity are contained in our earlier working version of this paper.[4]

The commodity data are prices on nearby futures contracts for three metals and fourteen nonmetals.[5] The commodities and the exchanges at which they are traded are: Copper (CMX), gold (CMX), silver (CMX), barley (WPG), cocoa (CSCE), coffee (CSCE), corn (CBT), cotton (CTN), feeder cattle (CME), hogs (CME), lumber (CME), oats (CBT), soybeans (CBT), soymeal (CBT), soyoil (CBT), world sugar (CSCE), and wheat (CBT).[6] They were provided by the Futures Center of the Columbia University Graduate School of Business and Commodity Systems Inc. of Boca Raton, Florida. The data for cotton are from the data banks of Data Resources, Inc.

The interest rate data are annualized six-month T-bill yields to maturity and come from Data Resources, Inc. but the original source is Bank of America. The dependent variable is the change in the yield from 3:30 p.m. on the announcement day (announcements occurred after 4:00 p.m.), to the next trading day at 3:30 p.m.

Finally, the independent variable is the unanticipated percentage change in M1, M_t, defined as $100[M(t) - M(t-1) - FDM]/M(t-1)$, where $M(t)$ and $M(t-1)$ are the first-announced levels of M1 at t and $t-1$ from the Federal Reserve's H.6 Statistical Release, and FDM is the median forecast of the change in M1 from approximately forty-five Fed watchers whom Money Market Services Inc. of Belmont, California surveys on Tuesday mornings.

B. Tests of Parameter Stability

Before using the Kalman filter, we conduct preliminary Chow tests of the null hypothesis of no temporal change in the response of commodity prices and interest rates to unanticipated money. Ashley (1984) provides Monte Carlo evidence that simple Chow tests are more powerful against most interesting alternative hypotheses than the more complicated tests of Brown, Durbin, and Evans (1975) or a random parameter variation test proposed by Garbade (1977), which we will describe in the following subsection. Following Ashley, we estimate the following equation:

$$DCP_t = a_i + b_i M_t + e_t, \qquad i = 1, 2, \ldots, 12, \tag{1}$$

where the sample is arbitrarily partitioned into twelve approximately equal subperiods. Table 1 presents the F-statistics testing the null hypothesis that $b_1 = b_2 = \ldots = b_{12}$. The hypothesis of parameter stability is rejected for all three series.

[4] The results for cotton and sugar were not included in the earlier working paper and are available from the authors upon request.

[5] The use of nearby futures prices as proxies for spot prices creates a small interest rate bias. This bias should make us cautious in interpreting the figures whenever a change in a commodity price response is in the same direction as a contemporaneous change in the interest rate response. (If the responses are in opposite directions, the evidence is clear.) Among the commodities that we examine, metals carry the smallest bias because for metals there is a delivery date during every month of the year and, therefore, the number of days between the money announcement date and the futures delivery date is the smallest.

[6] CBT ≡ Chicago Board of Trade, CME ≡ Chicago Merchantile Exchange, CMX ≡ New York Commodity Exchange, CSCE ≡ New York Coffee, Sugar & Cocoa Exchange, CTN ≡ New York Cotton Exchange, WPG ≡ Winnipeg Commodity Exchange.

TABLE 1.—TESTS OF PARAMETER STABILITY: RESPONSE TO UNANTICIPATED MONEY
$DCP_t = a_i + b_i M_t + e_t$; $i = 1, 2, \ldots, K$
H_0: $b_1 = b_2 = \ldots = b_K$, $F(K - 1,378 - 2K)$

	Twelve Equal Subperiods Arbitrary Breaks	Twelve Subperiods 2 of 11 Breaks Occur in Oct. '79 & Oct. '82	Three Subperiods Breaks Occur in Oct. '79 & Oct. '82
	$F(11, 354)$	$F(11, 354)$	$F(2, 372)$
All Commodities	2.70[a] [.002]	2.61[a] [.003]	1.44 [.239]
Metals	2.54[a] [.004]	2.88[a] [.001]	0.65 [.521]
Non-metals	2.09[a] [.020]	1.90[a] [.038]	1.49 [.227]
Gold	3.16[a] [.000]	3.17[a] [.000]	1.22 [.298]
T-Bill	2.73[a] [.002]	2.57[a] [.004]	9.51[a] [.000]

Note: Numbers in brackets are significance levels. There are 378 weekly observations from 10/06/77 to 12/28/84. Each of the twelve subperiods of the left column has 32 (first six subperiods) or 31 (last six subperiods) observations. The three subperiods of the right column have 105, 156, and 117 observations each. The twelve subperiods of the middle column have 35, 35, 35, 32, 31, 31, 31, 31, 30, 29, 29, and 29 observations each.
[a]Statistically significant at the 5% level.

Subsequently, we repartition the sample such that October 6, 1979 and October 5, 1982 are two of the eleven break points and we again reject the null hypothesis. However, when we partition the sample into only three subperiods with the break points at October 6, 1979 and October 5, 1982, we are unable to reject the null for the aggregate commodity indices and for gold (we do reject in the case of the T-bill). This suggests that there is variability in Federal Reserve credibility across our sample that cannot be explained solely by the announced changes in monetary policy in October 1979 and October 1982.[7]

C. *The Kalman Filter Model*

Our previous analysis showed that October 1979 and October 1982 are not the only possible break points. Thus we now allow the response of commodity prices to unanticipated money to vary over time without imposing our prior beliefs about specific break points using the following model:

$$DCP_t = a + b_t M_t + u_t, \qquad u_t \sim N(0, \sigma^2) \quad (2)$$

$$b_t = b_{t-1} + v_t, \qquad v_t \sim N(0, \sigma^2 P). \quad (3)$$

The theoretical justification of the random walk model (3) is described in Hardouvelis (1985), but here we choose it primarily for its simplicity because in this part of the paper we are not concerned with estimating a particular stochastic process generating the b_t's, but rather with the stability of the b_t's and with the pattern of their temporal variation. The error terms u_t and v_t are mutually and serially uncorrelated. The parameter P allows the standard deviation of v_t to differ from that of the regression error term u_t. If $P = 0$, then the model collapses to the ordinary stationary coefficient linear regression problem.

TABLE 2.—KALMAN FILTER RESULTS

	$\chi^2(1)$	P
All Commodities	6.74[a]	0.006
Metals	7.20[a]	0.013
Non-metals	3.86[a]	0.003
Gold	11.64[a]	0.013
T-Bill	10.50[a]	0.009

Note: The parameter P is defined in equation (3). The $\chi^2(1)$ statistic tests the null hypothesis of no temporal variability in the response of commodity prices to unanticipated money, i.e., that $P = 0$.
[a]Statistically significant at the 5% level.

Garbade (1977) describes the estimation of model (2)–(3). We utilize thirteen observations from 1977 to initialize the Kalman filter. Thus beginning with the first sample point in 1978, the Kalman filter updates sequentially last period's estimated coefficients and last period's covariance matrix based on the new information contained in M_t. We use a maximum likelihood estimation procedure that searches over the parameter space to obtain estimates of P. These results, and Garbade's test of the null hypothesis that there is no temporal variability in b_t, i.e., that $P = 0$ are contained in table 2. Again, the null hypothesis of parameter stability is rejected.

Figures 1 through 3 display the Kalman filter estimates of the slope coefficients of metals, non-metals, and the six-month T-bill together with their 95% confidence bands. The dashed vertical

[7] We also performed the Cumsum of Squared test of Brown, Durbin, and Evans and rejected the hypothesis of parameter stability.

FIGURE 1.—METALS—RESPONSE TO UNANTICIPATED MONEY

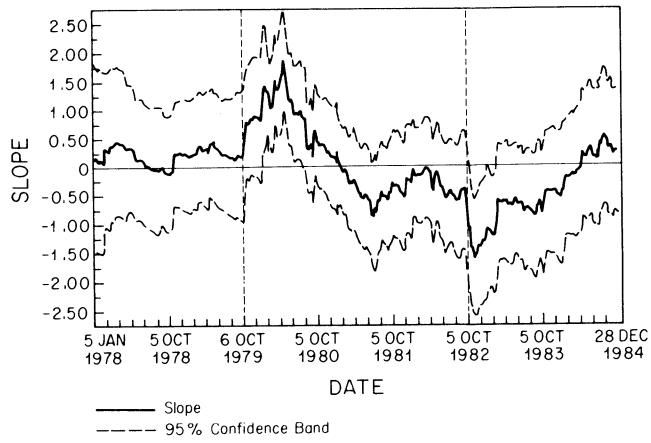


FIGURE 2.—NON-METALS—RESPONSE TO UNANTICIPATED MONEY

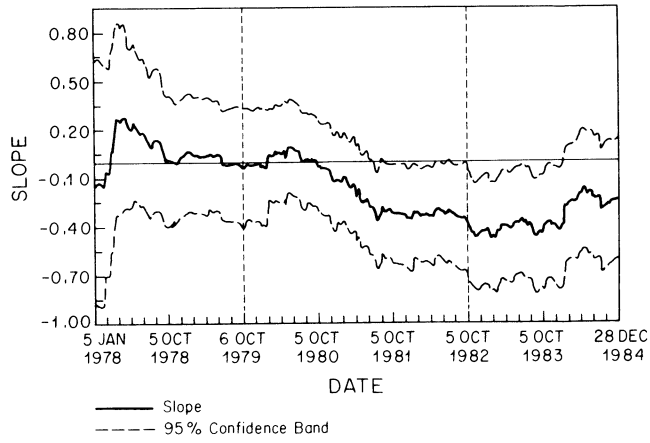
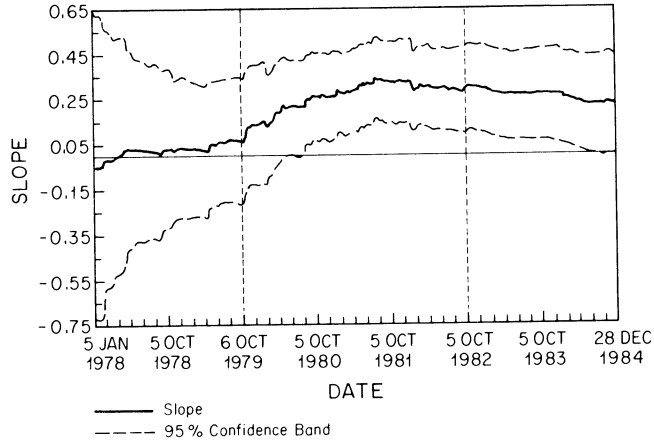


FIGURE 3.—SIX-MONTH TREASURY BILL—RESPONSE TO UNANTICIPATED MONEY



lines in each figure represent the October 1979 and October 1982 announcement dates of a policy change, while the horizontal line is at zero. Metals show the highest variability. They are the most money-like commodities and, consequently, are more sensitive to macroeconomic news than non-metals. Overall, there are so many jumps in the market responses throughout the 1978–1984 period that it would be difficult to identify changes in credibility in October 1979 or October 1982 without prior knowledge about the announced policy changes.

The figures show that the announced policy change in October 1979 did not result in an immediate increase in credibility. On October 6, 1979 there is an abrupt upward jump in the metal reactions as well as a small upward jump in the interest rate reactions. These jumps indicate that perhaps markets became more concerned about inflation, but they could also reflect an increase in the informative content of M1 announcements. The Fed announced it would pay closer attention to M1, and thus the signal to noise ratio in the money announcements increased. The evidence after October 1979 is more interesting. First, the positive interest rate responses grow stronger with the passage of time and peak around the end of 1981. Secondly and surprisingly, the commodity price responses do not immediately turn negative, as we might have expected. Metals show a significant *positive* response until the middle of 1980. One could argue that the metal responses at the end of 1979 are unreliable because of the reported manipulation of the silver market that spilled over to the gold market. Both silver and gold prices rose to unprecedented heights at the end of 1979 and then crashed reaching their lowest levels of 1980 by March of that year. However, figure 1 shows that the metal responses to money announcements not only rose while gold and silver prices were falling in early 1980, but became even more positive after March 1980. The positive metal responses peak at the end of April 1980 and then decline slowly, turning negative at the beginning of 1981. The response of non-metals in figure 2 hovers insignificantly about the zero line showing no clear trend until June 1980 when it starts a three-year decline. The negative response of non-metals becomes statistically significant only around the middle of 1981. Overall, the evidence from both metals and non-metals shows that it took a while before the Fed was able to establish credibility. Perhaps, the Fed became a credible inflation fighter only after markets evaluated the results of its anti-inflation efforts.

Next, observe that the October 1982 de-emphasis of M1 targeting did not result in a decrease in Fed credibility. The October 1982 announcement of a change in monetary policy results in a small increase in the interest rate responses and a downward jump in the commodity responses. The change in the commodity price responses in October 1982 is opposite from what one would expect based on a hypothesis that the Fed should have lost credibility following its announcement of a policy change. Thus it appears that announcements of policy changes do not necessarily affect market perceptions. Yet some loss of credibility may have occurred later. Both metal and non-metal responses reach a trough in February 1983 and then begin an upward movement. The metal responses increase faster turning positive in the middle of 1984. However, the interest rate responses in figure 3 show a smooth downward trend during 1983 and 1984 indicating that the upward trend in commodity price responses may simply be due to a gradual loss in the informative content of the M1 announcement rather than a gradual loss in Fed credibility.

III. Inflation as a State Variable

Our previous analysis reveals that the Federal Reserve earned its credibility as an inflation fighter slowly. Therefore, it is now interesting to examine if the rate of inflation is a state variable that drives the evolution of the slope coefficient b_t over time. Because data on inflation are monthly, our matching of monthly with weekly data cannot be perfect and creates measurement error. Thus for robustness, we examine the effects of inflation on the variability of the slope coefficient using two separate methods, one parametric, the other non-parametric.

In the parametric approach, we model the response of commodity prices to unanticipated money as a function of the economy's rate of inflation. We run the following regression:

$$DCP_t = a + (d_0 + d_1\pi_t)M_t + u_t, \qquad (4)$$

where we match each weekly money surprise with the most recently known monthly inflation mea-

TABLE 3.—INFLATION AND CREDIBILITY
$DCP_t = c + (d_0 + d_1\pi_t)M_t + u_t$

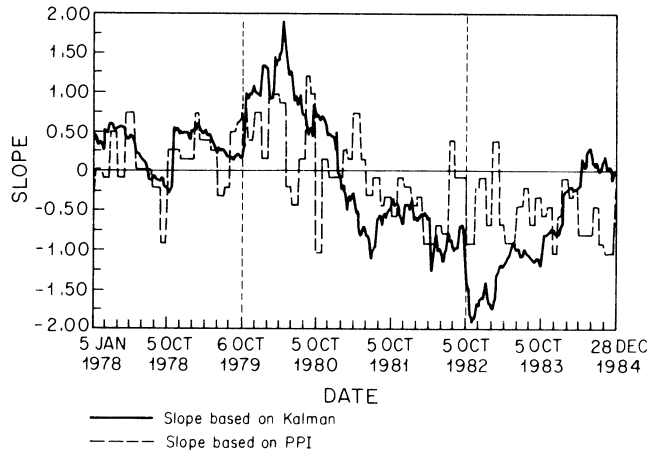
	d_0	d_1	$\bar{R}^2$	DW	SEE	$F(22,342)$
			Producer Price Index			
All Commodities	−0.362[a]	0.310[a]	0.032	2.15	0.56	1.32 [0.152]
	(0.096)	(0.119)				
Metals	−0.505[a]	0.868[a]	0.018	1.99	1.38	1.27 [0.187]
	(0.238)	(0.294)				
Non-metals	−0.345[a]	0.242[a]	0.034	2.12	0.54	1.13 [0.311]
	(0.093)	(0.116)				
Gold	−0.802[a]	1.183[a]	0.030	2.00	1.52	1.29 [0.175]
	(0.262)	(0.324)				
T-Bill	0.153[a]	0.132[a]	0.182	2.15	0.25	2.01[a] [0.005]
	(0.042)	(0.052)				
			Consumer Price Index			
All Commodities	−0.445[a]	0.391[a]	0.033	2.15	0.56	1.42 [0.103]
	(0.121)	(0.148)				
Metals	−0.604[a]	0.905[a]	0.011	1.99	1.39	1.43 [0.096]
	(0.302)	(0.367)				
Non-metals	−0.426[a]	0.328[a]	0.036	2.11	0.54	1.24 [0.213]
	(0.118)	(0.144)				
Gold	−1.003[a]	1.327[a]	0.023	1.97	1.53	1.45 [0.090]
	(0.332)	(0.404)				
T-Bill	0.168[a]	0.096	0.173	2.15	0.25	1.72[a] [0.024]
	(0.054)	(0.066)				
			Unanticipated PPI or CPI			
All Commodities	−0.153[a]	0.496[a]	0.029	2.13	0.56	1.40 [0.113]
	(0.060)	(0.212)				
Metals	0.069	0.974	0.003	1.95	1.39	1.88[a] [0.010]
	(0.150)	(0.528)				
Non-metals	−0.181[a]	0.438[a]	0.034	2.10	0.54	1.10 [0.017]
	(0.058)	(0.206)				
Gold	−0.022	1.253[a]	0.007	1.96	1.54	1.88[a] [0.010]
	(0.166)	(0.583)				
T-Bill	0.236[a]	−0.009	0.168	2.16	0.25	1.79[a] [0.017]
	(0.027)	(0.094)				

Note: The sample consists of 378 weekly observations from 10/06/77 to 12/28/84. Standard errors are in parentheses, and significance levels in brackets. $F(22,342)$ tests the stability of d_0 and d_1 across the twelve equal subperiods of table 1. $\bar{R}^2$ is the coefficient of determination adjusted for degrees of freedom, DW is the Durbin–Watson statistic, and SEE is the regression standard error.

[a]Statistically significant at the 5% level.

sure, π_t. Table 3 presents the results for three alternative inflation measures: the most recently announced actual PPI, the most recently announced actual CPI, and the most recent surprise about either the PPI or the CPI, whichever was the most recently announced. We use a Money Market Services survey measure of inflationary expectations analyzed in Pearce (1987) to construct the surprise about the PPI and the CPI. In all three cases the coefficient d_1 of the commodity regressions is significantly positive. This indicates that a recently announced higher rate of inflation or higher than expected rate of inflation makes the response of commodity prices to money announcements more positive (less negative), that is, makes the Fed less credible. Table 3 presents a test of stability of the coefficients d_0 and d_1 across the twelve equal subperiods of table 1. Observe that for commodities we are unable to reject the null hypothesis of parameter stability (except for metals and gold in the third panel), which implies that the inflation rate is a very important state variable behind the time variability of Fed credibility. Turning to the interest rate results, there is no evidence that the variability of inflation plays a role in the time variability of the

FIGURE 4.—GOLD—RESPONSE TO UNANTICIPATED MONEY



interest rate responses to unanticipated money: d_1 is not different from zero (in two of the three cases), and the hypothesis that d_0 and d_1 are constant is rejected.[8]

Figure 4 plots the time varying response of gold as estimated by the Kalman filter and by the PPI equation (4). Observe that both curves follow a similar overall trend. The figure shows that inflation is an important state variable in the response of gold prices to unanticipated money.

Let us turn now to the non-parametric approach. Here we separate the data into two regimes, one with high inflationary fears and one with low inflationary fears. This method allows us to see if commodity price responses to money announcements are more positive in the regime of high inflationary fears. We define the regime of high (low) inflationary fears as the set of those money announcement weeks in which the surprises about the most recently announced PPI and CPI were both positive (both negative). We discard weeks in which the most recent surprises about the CPI and PPI had opposite algebraic signs (or were zero) because they generate an ambiguity. Our definition is sensible because the PPI and CPI inflation series are positively autocorrelated. Thus if market participants are rational, they ought to revise their expectations of future inflation up (down) whenever past inflation is unexpectedly high (low). Table 4 presents the regression results as well as a test that the slope coefficients are the same across the two regimes. The table confirms the earlier results of table 3. The response of commodity prices to unanticipated money is more positive in the regime of high inflationary fears, but the response of the interest rate is the same across the two regimes.

IV. Conclusions

Contrary to what was implicitly assumed in the previous literature on Fed credibility, we discovered that the October 1979 announcement of a policy change did not provide the Federal Reserve with instant credibility in the market. Although we confirmed the evidence of previous authors that there was an increase in the response of interest rates at that time, we found that commodity price responses did not turn negative immediately. They began a downward trend after mid-1980. It appears that inflationary fears were present for at least one more year and that the Fed established credibility slowly over time, perhaps after markets began verifying that the new Fed policy was successful at reducing the rate of inflation. We also found that the Fed's credibility was not affected by the announced abandonment of strict M1 tar-

[8] Notice that the $\bar{R}^2$'s of the commodity regressions are lower than the $\bar{R}^2$'s of the interest rate regressions. This is an issue of concern but could be justified as follows: When markets are ambivalent about the Fed's future policy, on the one hand commodity prices may show a zero response because the effect of a change in the expected future rate of inflation counteracts the effect of a change in the expected future real rate of interest in commodity prices, yet on the other hand interest rates will respond positively because the two effects move nominal interest rates in the same direction.

TABLE 4.—CHANGES IN INFLATIONARY EXPECTATIONS AND CREDIBILITY
$DCP_t = a_j + b_j M_t + u_{jt}$, $j = H, L$

	b_H	b_L	t-statistic
All	0.101	−0.577[a]	3.43[a]
Commodities	(0.138)	(0.141)	
Metals	0.406	−0.713	2.12[a]
	(0.369)	(0.376)	
Non-metals	0.064	−0.560[a]	3.19[a]
	(0.137)	(0.140)	
Gold	0.794	−1.138[a]	3.07[a]
	(0.440)	(0.449)	
T-Bill	0.249[a]	0.253[a]	0.04
	(0.067)	(0.068)	

Note: The sample contains 124 weekly observations out of the 378. b_H is the estimated slope coefficient during a regime of high inflationary fears (58 observations), and b_L is the estimated slope coefficient during a regime of low inflationary fears (66 observations).

[a]Statistically significant at the 5% level, but under the t-statistic column it denotes significance at the 2.5% level (one-tailed test that $b_H = b_L$).

gets in October 1982 because commodity price responses remained negative for a long period after the announced change. The overall evidence from the Kalman filter estimates shows that one has to have strong priors about the October 1979 and 1982 dates to claim an *immediate* change in credibility.

We also found evidence that inflation is a state variable responsible for the variability in Fed credibility across our sample. First, in a parametric procedure, we found that a higher rate of inflation or higher than expected rate of inflation leads to a more positive response of commodity prices to unanticipated money, indicating lower credibility. Second, in a non-parametric procedure, we separated weeks of upward and downward revisions in inflationary expectations and found that in periods of heightened inflationary fears commodity price responses are more positive (less negative) than in periods of lessened inflationary fears.

Our overall evidence indicates that markets pay attention to policy results, not simply policy announcements.

REFERENCES

Antoncic, Madelyn "High and Volatile Real Interest Rates: Where does the Fed Fit in?" *Journal of Money, Credit and Banking* 18 (Feb. 1986), 18–27.

Ashley, Richard, "A Simple Test for Regression Parameter Stability," *Economic Inquiry* 22 (Apr. 1984), 253–268.

Barnhart, Scott W., "The Effects of Macroeconomic Announcements on Commodity Prices," *American Journal of Agricultural Economics* 71 (May 1989), 389–403.

Belongia, Michael, R. W. Hafer, and Richard Sheehan, "On the Temporal Stability of the Interest Rate–Weekly Money Relationship," this REVIEW 70 (Aug. 1988), 516–520.

Brown, R. L., J. Durbin, and J. M. Evans, "Techniques for Testing the Constancy of Regression Relationships over Time," *Royal Statistical Society Journal*, Series B, 37 (1975), 149–163.

Cornell, Bradford, "The Money Supply Announcements Puzzle: Review and Interpretation," *American Economic Review* 73 (Sept. 1983), 644–657.

Cornell, Bradford, and Kenneth R. French, "Commodity Own Rates, Real Interest Rates, and Money Supply Announcements," *Journal of Monetary Economics* 18 (July 1986), 3–20.

Frankel, Jeffrey, and Gikas A. Hardouvelis, "Commodity Prices, Money Surprises and Fed Credibility," *Journal of Money, Credit and Banking* 17 (Nov. 1985), 425–438.

Garbade, Kenneth, "Two Methods for Examining the Stability of Regression Coefficients," *Journal of the American Statistical Association* 72 (Mar. 1977), 54–63.

Hamilton, James D., "Monetary Factors in the Great Depression," *Journal of Monetary Economics* 19 (Mar. 1987), 145–169.

Hardouvelis, Gikas A., "Market Perceptions of Federal Reserve Policy and the Weekly Monetary Announcements," *Journal of Monetary Economics* 14 (Sept. 1984), 225–240.

———, "Exchange Rates, Interest Rates, and Money Stock Announcements: A Theoretical Exposition," *Journal of International Money and Finance* 4 (Dec. 1985), 443–454.

Hardouvelis, Gikas A., and Scott W. Barnhart, "The Evolution of Federal Reserve Credibility: 1978–1984," Columbia Business School First Boston Working Paper Series #88–16, Nov. 1987.

Huizinga, John, and Frederic S. Mishkin, "Monetary Policy Regime Shifts and the Unusual Behavior of Real Interest Rates," *Carnegie-Rochester Conference on Public Policy* 24 (Spring 1986), 231–274.

Loeys, Jan, "Changing Interest Rate Responses to Money Announcements: 1977–1983," *Journal of Monetary Economics* 15 (May 1985), 323–332.

Mishkin, Frederic S., "Can Futures Market Data be Used to Understand the Behavior of Real Interest Rates?" mimeo, Columbia University, Sept. 1986.

Pearce, Douglas K., "Short-term Inflation Expectations: Evidence from a Monthly Survey," *Journal of Money, Credit and Banking* 19 (Aug. 1987), 388–395.

Quandt, Richard E., "Tests of the Hypothesis that a Linear Regression System Obeys Two Separate Regimes," *Journal of the American Statistical Association* 55 (June 1960), 324–330.

Walsh, Carl E., "Testing for Real Effects of Monetary Policy Regime Shifts," *Journal of Money, Credit and Banking* 20 (Aug. 1988, part 1), 393–401.