The Lag from Monetary Policy Actions to Inflation: Friedman Revisited

by Nicoletta Batini and Edward Nelson

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Abstract

This paper updates and extends Friedman's (1972) evidence on the lag between monetary policy actions and the response of inflation. Our evidence is based on UK and US data for the period 1953–2001 on money growth rates, inflation, and interest rates, as well as annual data on money growth and inflation. We reaffirm the result that it takes over a year before monetary policy actions have their peak effect on inflation. This result has persisted despite numerous changes in monetary arrangements in both countries. The empirical evaluation of dynamic general equilibrium models need to be extended to include an assessment of these models' ability to account for the monetary transmission lags found in the data.

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I. Introduction

At the Dec. 27–29, 1971, American Economic Association meetings, Milton Friedman (1972) presented a revision of his prior work on the lag in effect of monetary policy (e.g. Friedman, 1961). His new conclusion was that "monetary changes take much longer to affect prices than to affect output;" estimates of the money growth/CPI inflation relationship gave "the highest correlation… [with] money leading twenty months for $M1$, and twenty-three months for $M2$" (p. 15).

In the intervening 30 years, new evidence has emerged in support of Friedman's estimate, so that it is now something of an international rule of thumb for countries that have experienced moderate inflation. Bernanke, Laubach, Mishkin, and Posen (1999, pp. 315–20) describe a two-year lag between policy actions and their main effect on inflation as "a common estimate." They observe that this estimate has been embodied in the forecasting and decision-making of several inflation-targeting central banks, and assume such a lag in their recommendation of an inflation target for the US. Gerlach and Svensson (2001) report that the European Central Bank has documented an approximate 18-month lag between money growth and inflation in the euro area.

A parallel development in recent years has been theoretical and empirical analysis of inflation dynamics. Several studies have modelled inflation behaviour with dynamic stochastic general equilibrium models. This has included empirical work on the New Keynesian Phillips curve (NKPC) (see e.g. Sbordone, 1998; Galí and Gertler, 1999). On the whole, this literature has concluded that postwar inflation in the US and several other countries can be successfully modelled using the NKPC, whose structure does not imply inherent persistence in inflation. In a recent contribution, Erceg and Levin (2001) (EL) support this view by arguing that the persistence in inflation observed in the US during its "Great Inflation" period was not an intrinsic phenomenon; rather, it emerged from the interaction of firms' NKPC-style pricing behaviour and private sector uncertainty about the authorities' underlying inflation target. They argue that "the [US] inflation rate exhibits much less persistence prior to 1965 and after about 1984."[1]

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[1] EL contend that inflation persistence diminished in the 1980s and 1990s because agents adjusted to the stabler Volcker-Greenspan monetary policy regime. See also Cogley and Sargent (2001).

Thus, many countries have moved toward inflation-targeting procedures that take inertia in inflation for granted, but formal modelling is moving toward models in which inflation persistence is not a structural, policy-invariant feature of the data. Can these two trends be reconciled? Or have the additional three decades of data overturned Friedman's finding of a lag between monetary actions and inflation?

II. Three Types of Inflation Persistence

To clarify discussion, it is useful to distinguish between three types of inflation persistence: (1) positive serial correlation in inflation; (2) lags between *systematic* monetary policy actions and their (peak) effect on inflation;[2] and (3) lagged responses of inflation to non-systematic policy actions (i.e. policy shocks).

The recent literature on the NKPC claims success in accounting for type 1 inflation persistence. Yet a model that accounts for this type of persistence could fail to account for type 2 and 3 persistence. For monetary policymaking, accuracy of a model regarding type 2 persistence is clearly most important. The standard NKPC implies virtually no lag in effect of monetary policy actions on inflation, so additional model features must be introduced to account for these lags (such as decision lags for price-setters in Rotemberg and Woodford, 1997). Such features do introduce delays in effect of both the systematic and non-systematic components of policy—types 2 and 3 inflation persistence. But in practice the only empirical evidence consulted is on the effects of the policy-shock component—type 3 persistence.[3] For example, Rotemberg and Woodford set model parameters so as to match output and inflation responses to a policy shock. In fact, there are few theoretical or empirical grounds for believing that policy shocks represent either the most important source of macroeconomic variability, or that their estimated effects can help quantify the impact on inflation of the systematic monetary policy actions. Lucas (1972) provided a rationalization for effects of monetary shocks on output in flexible-price models, but never suggested that policy shocks were the most important source of output

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[2] Systematic policy actions refer to the portion of the monetary policy reaction function that consists of time-invariant responses to private sector shocks. They need not coincide with *anticipated* policy actions if policy responds to contemporaneous non-policy shocks.
[3] See Christiano, Eichenbaum, and Evans (1999) for a review of VAR evidence on the effects of monetary policy shocks.

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variability.[4] Similarly, schools of thought that rely on sticky prices to generate real effects of monetary policy, such as monetarism and New Keynesian economics, make no claim that monetary policy shocks dominate the business cycle. Rather, they maintain that, empirically, most real effects of monetary policy arise from the nonneutrality of policy responses to non-policy shocks (see Woodford, 1998). Importantly, *no* theory asserts that only the nonsystematic component of policy matters for inflation behaviour. In standard models, the monetary policy response governs whether a real shock that affects potential output has persistent effects on the output gap and inflation. The systematic component of policy is, consequently, crucial for inflation behaviour; arguably, monetary accommodation of real shocks was important in producing the "Great Inflation" episode.

Current practice thus does not attach much weight to type 2 persistence in model evaluation, despite its potential importance for policymaking. To aid future modelling, it would be useful to have some relatively model-free quantitative evidence on the extent of type 2 inflation persistence. We attempt to do so in this paper. Neither the selection of policy stance measure, nor the appropriate statistic to calculate, is a straightforward issue. Because the systematic component of policy is inherently endogenous, many of the familiar characteristics seen as desirable properties of measures of policy change, such as exogeneity, are inappropriate.

Friedman, of course, based his analysis on the timing relations between monetary aggregates and inflation. We follow Friedman by using the correlation of inflation with money growth $k \geq 0$ periods earlier, a statistic denoted $r_{\pi\mu}(k)$, as one means of summarising evidence on type 2 inflation persistence. In using monetary aggregates for this purpose, we take no stand on whether money has any special role in the transmission mechanism. Rather, we view money growth rates as "quantity-side" measures of the monetary conditions induced by central bank interest rate policy. For example, open market operations to alter short-term nominal interest rates tend also to change the growth of reserves and the money stock.[5] On the other hand, changes in the opportunity cost of holding money not produced by current monetary policy—

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[4] Indeed, Lucas's position is that for post-war US output fluctuations, "the relative importance of technology and other real shocks is... something like 80%" (in McCallum, 1999, p. 284).
[5] Furthermore, a fall in the "natural" interest rate for a given setting of nominal interest rates tends to reduce money growth, as less money needs to be supplied to implement a given interest rate operating target. Again, in this case the money growth movement accurately reflects the tighter conditions.

such as an increase in the own-rate on M2 after financial liberalisation, or greater incentives for the private sector to hold purchasing power in the form of base money after a disinflation—potentially distort money growth. Our calculation of $r_{\pi\mu}(k)$ across sub-samples allows for changes in steady-state velocity growth due to these factors. Looseness in the money growth/inflation relationship should not be taken to imply the absence of a systematic lead/lag relationship. And as Alvarez, Lucas, and Weber (2001) observe, the looseness of the relationship can be overstated; slower M2 growth in the 1990s *was* followed by lower inflation. But in light of reservations about money growth, we also present correlations of inflation with Δr_t—the first difference of the short-term real Treasury bill rate—a variable chosen to capture the notion that monetary policy can influence the real rate over short periods.[6]

Another concern with estimating dynamic relations between measures of systematic policy and inflation is that, if monetary policy adjusts completely and successfully to offset non-policy shocks, there should be no observed relation between policy measures and inflation. Several considerations, however, suggest that in practice such a relation will be present. Longstanding deviations of policymakers' specification of the economy from the true underlying economic process will tend to produce target misses that are attributable to policy actions.[7] Objectives other than deviations of inflation from target tend to make it optimal to move policy in such a way that persistent but temporary deviations from target occur.[8] And the variability in the precise lag in effect of policy means some target misses will be due to prior policy decisions. For all these reasons, in an inflation-targeting regime, some systematic deviations of inflation from target will be associated with systematic policy actions.

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[6] Use of Δr rather than the level of the real rate has the dual advantages that Δr behaviour is not dominated by the longer-term swings in the mean of r, which are likely determined by non-policy factors; and that cross-correlations with inflation are less affected by the arithmetic link between the real rate and future inflation from the Fisher relation. Our r_t series is the monthly average nominal bill rate minus an average of $E_t\Delta p_{t+1}$, $E_t\Delta p_{t+2}$, and $E_t\Delta p_{t+3}$, where Δp_t is the annualized monthly percent change in the CPI. For both countries we study, the expectations $E_t(\bullet)$ are approximated by OLS projections of Δp_{t+i} on lags 1–12 of Δp_t and HP filtered log industrial production, plus dummies for price controls and indirect-tax changes. More details are provided in our data appendix.

[7] Prior to the 1970s, such specification errors might have included belief in a nonvertical Phillips curve and an overemphasis on "special-factors" theories of inflation. More recently, a candidate for specification error is that the output-gap series used in policymaking is conceptually very different from the output gap that is used in the theory underlying the NKPC.

[8] In Rudebusch and Svensson (1999), for example, the policymakers' objective function penalizes volatility in inflation, the output gap, and interest rates.

III. Empirical Evidence

Table 1 presents, replicates, and updates the US timing evidence contained in Friedman's 1972 paper. He identified the cycles in nominal variables (measured by six-month changes in the CPI and money) associated with each cyclical peak and trough. For 1953–70, we largely confirm his finding of a one to three year lag between money growth and inflation. Most of the differences in our replication stem from our use of the adjusted monetary base and the current M2 definition as the two measures of money, compared with old M1 and M2 in his paper. Note that a clear lead for money over inflation (i.e., type 2 inflation persistence) exists in the pre-Great Inflation years 1953–64, a period that Erceg and Levin characterise as without type 1 inflation persistence. After 1971, the instability of the short-run Phillips curve became more evident and the US economy was hit by several supply shocks, so the link between business cycles and inflation loosened. For example, inflation continued to decline many years into the 1980s and 1990s expansions. Despite this break, for the full updated sample we find that money growth still leads inflation by well over a year; if anything, the lead of money growth over inflation is somewhat longer in recent decades, particularly when we use M2 growth.

Table 2 lists the maximum values of $r_{\pi\mu}(k)$ for 1953–2001 and selected sub-periods, using twelve-month growth rates of money and consumer prices. We report results for both the US and the UK. The results with the interest-rate based measure of policy largely support the timing evidence using money growth.

Both for the period as a whole and for sub-samples, the US evidence suggests money leads inflation by over a year. For 1953–79, the lead is of the order of 12 to 30 months. The 1980–2001 data also suggest a long lead, with a peak of $r_{\pi\mu}(k)$ at $k = 23$ months for the base and 49 months for M2. For this period, however, the correlation coefficient itself is near zero using the base—largely reflecting the break in base velocity behaviour following the end of the Great Inflation and the onset of the Volcker-Greenspan regime. As Erceg and Levin argue, it took several years for agents to adjust to this regime change. The adjustment included a fall in average velocity growth, distorting the relation between inflation and prior monetary change for data that overlap the pre and post-regime change period. This accounts for why the base growth/inflation correlation is near-zero when the 1980–85 observations are

included, but becomes positive and significant for the last fifteen years of data (1986–2001), results for which we also report in the table. For the same reason, we have limited our examination of the relationship in the UK under inflation targeting to the last five years of data, which ensures that data on both money and inflation are generated within the inflation-targeting period.[9]

For the UK, results for the 1953–79 period suggest a lead of money growth of 6 months over inflation—not negligible, but low compared to the values of k in the rest of Table 2. This reflects limitations of base growth as a monetary indicator in the 1970s. The most significant monetary easing in the UK was a cut in reserve requirements in 1971, which presaged the take-off of inflation in 1972–75. Our UK base series is not adjusted for requirement changes and so misses this easing. Excluding the 1970s, Table 2 indicates a lead for UK money of 11 months for the pre-1980 period. Finally, the lead of money growth over UK inflation is found to be two years both for 1980–2001 as a whole and the last five years.

Bryan and Gavin (1994) argue that the lag between base growth and inflation is an artefact of the pre-1979 policy rule, and is absent from US data thereafter. Yet, as the tables show for both countries, while the money growth/inflation relation is looser after 1979, there remains a clear delay in the reaction of inflation. This suggests that, even if inflation persistence of the type 1 form is not invariant to the monetary policy rule, some inflation persistence of the type 2 form is part of the structure of the economy—at least for economies such as the US and the UK that have had moderate inflation—and is not an illusion generated by a particular policy rule.

Table 3 reports evidence using annual monetary and inflation data for the two countries—for 1871–2000 for the US as well as post-war data, and 1835–2000 for the UK. It provides perhaps the most decisive evidence that the appreciable delay in the reaction of inflation to monetary changes is not a side-effect of a particular policy regime. The 1871–2000 period is characterised by a one-year lead of M2 growth over US inflation, and similar results hold for 1948–2000. For the UK since 1835, base money growth leads inflation by one year, and this is robust to excluding the years

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[9] Nevertheless, the relationship between UK money base growth and aggregates such as inflation and nominal GDP growth is quite loose even after 1996, in part because of continued reaction of money-holders to the new UK policy regime, and in part because consumption has risen faster than output, so transactions demand for money has increased decidedly more than nominal GDP or prices.

most affected by wartime price control.[10] Friedman (1961, p. 450) notes that the resilience of timing relationships between money and other variables "under very different monetary arrangements" is evidence that those relationships are structural. Given the drastic changes in monetary arrangements in both the US and the UK since the nineteenth century, we conclude that the existence of a lag of a year or more between monetary policy changes and their peak effect on inflation is a structural feature of both countries' economies.

IV. Conclusions

Recent studies of inflation with dynamic general equilibrium models have emphasised the interaction of policy regime and the pricing behaviour of the private sector in producing empirical inflation persistence. While this may indeed be an important source of persistence that previous, non-optimising models have neglected, we argue that there are strong grounds for believing that at least one type of inflation persistence is present in the data across many different policy regimes. This is the pronounced delay in the reaction of inflation to systematic monetary policy actions —a form of inflation persistence that appears to be very much still with us. It follows that the current methods used for the empirical evaluation of optimisation-based models need to be extended to include an assessment of these models' ability to account for this pervasive feature of the data.

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[10] Table 3 reaffirms Friedman's (1978) observation that "[i]n 1863, [W.S. Jevons] wrote: 'An expansion of the currency occurs one or two years prior to a rise of prices.' His finding has held ever since for both the UK and the US—of course not precisely, but on the average."

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TABLE 1–LEAD OF MONEY GROWTH OVER INFLATION IN POSTWAR US BUSINESS CYCLES

From Friedman (1972, p. 15)			Replication and update			
	Lead in months of				Lead in months of	
Reference date	*M*1	*M*2	Reference date	Inflation trough or peak	Adjusted monetary base	*M*2
Troughs				*Troughs*		
8/54	13	13	5/54	10/54	10	11
4/58	11	31	4/58	6/61	13	30
2/61	17	25	2/61	5/63	38	39
5/67	6	2	5/67	5/67	7	7
11/70	17	17	11/70	8/72	30	28
			3/75	6/76	13	21
			7/80	—	—	—
			11/82	7/86	21	37
			3/91	4/98	26	41
Peaks				*Peaks*		
7/53	19	19	7/53	9/53	9	21
7/57	17	17	8/57	4/58	17	11
5/60	22	26	4/60	10/60	15	16
11/66	4	4	11/66	10/66	10	10
11/69	10	10	12/69	2/70	14	14
			11/73	1/75	22	25
			1/80	3/80	21	38
			7/81	—	—	—
			7/90	11/90	34	51

Note: Following Friedman, this table is based on six-month growth rates of all variables. Some lines are blank because we have treated Jan 80–Nov 82 as one long recession. We have followed Friedman's dating of the 1966–67 mini-recession.

TABLE 2—CORRELATIONS BETWEEN CPI INFLATION AND MEASURES OF SYSTEMATIC POLICY

Sample period	Monetary policy measure: twelve-month money growth Maximum value of $r_{\pi\mu}(k)$		Monetary policy measure: change in short real rate Max. neg. value of $r_{\pi\Delta r}(k)$
	United States		
	Adjusted money base	*M2*	
Feb 1953–Aug 2001	0.304 [a,b] ($k = 23$)	0.680 [a,b] ($k = 35$)	−0.033 ($k = 25$)
Feb 1953–Dec 1979	0.615 [a,b] ($k = 12$)	0.772 [a,b] ($k = 30$)	−0.051 ($k = 17$)
Jan 1980–Aug 2001	0.031 [a,b] ($k = 29$)	0.737 [a,b] ($k = 49$)	−0.036 ($k = 25$)
Sep 1986–Aug 2001	0.426 [a,b] ($k = 29$)	0.706 [a,b] ($k = 49$)	−0.139 [a] ($k = 10$)
	United Kingdom Money base		
Feb 1953–Aug 2001	0.698 [a,b] ($k = 11$)		−0.033 ($k = 13$)
Feb 1953–Dec 1969	0.422 [a,b] ($k = 11$)		−0.154 [a] ($k = 9$)
Feb 1953–Dec 1979	0.769 [a,b] ($k = 6$)		−0.096 [a] ($k = 8$)
Jan 1980–Aug 2001	0.797 [a,b] ($k = 23$)		−0.075 ($k = 13$)
Sep 1996–Aug 2001	0.254 [a] ($k = 24$)		−0.072 ($k = 10$)

Note: Inflation is twelve-month percent increase in CPI (US), RPI/RPIX (UK). Base money series adjusted for millennium bulge by interpolating between Nov 1999 and Feb 2000 observations. US base series is Anderson-Rasche (2000) domestic base series for 1965–99, spliced into St Louis series for pre-1965 and 2000 observations. US M2 series is adjusted for MMDAs introduction in 1983; pre-1959 observations are obtained by splicing in Friedman-Schwartz (1970) old M2 series.
a.   Significantly different from zero using conventional *t*-test.
b.   Significantly different from zero using Newey-West *t*-test.

TABLE 3—EVIDENCE FROM ANNUAL DATA

Sample period	Monetary policy measure: money growth Maximum value of $r_{\pi\mu}(k)$	
	United States	
	Adjusted money base	*M2*
1871–2000, GDP deflator inflation	—	0.542 ($k = 1$ year)
1948–2000, CPI inflation	0.343 ($k = 2$ years)	0.574 ($k = 3$ years)
	United Kingdom Money base	
1835–2000	0.607 ($k = 1$ year)	
1835–2000 excluding WWI and 1940–50	0.692 ($k = 1$ year)	

Note: Inflation and money growth are percent changes in annual averages of price indices and money stocks.
Sources:
US money data: Friedman and Schwartz (1970); Federal Reserve Bank of St. Louis.
US price data: Balke and Gordon (1986); Federal Reserve Bank of St. Louis.
UK money data: Huffman and Lothian (1980); Capie and Webber (1985); Bank of England.
UK price data: Goodhart (1999); Bank of England.