

THE CASE FOR GRADUALISM IN POLICIES TO REDUCE INFLATION

Allan H. Meltzer

Inflation is usually defined as a sustained rate of increase in a broadly based index of prices. Whatever meaning one gives to the imprecise term "sustained," the past fifteen years seem to meet the standard. Both the all-item consumer price index and the implicit GNP deflator have increased in every quarter since late 1965, and neither seems likely to reach a zero rate of change in the near future.

Sustained inflation at the rates of recent years is rare, even if not unique, in the histories of developed economies. It seems useful, at a conference summarizing the lessons of the seventies and drawing implications for the eighties to look back on the path we have travelled and to explore the path we might take to restore price stability. I shall use the opportunity to discuss some of what has been learned about monetary policy. The list is a long one, particularly if we include propositions that once were "known" but later forgotten or rejected in the years of Keynesian orthodoxy, so I shall not attempt to be complete.

Any long-term gain from ending inflation depends on a negative relation between inflation and real output. The most common reason for suspecting that a gain will occur is the observed association between inflation and changes in relative prices. See Cukierman (1979). The

Dr. Meltzer is Professor of Economics and Social Sciences at Carnegie-Mellon University. The author is grateful to Alex Cukierman and Jerry L. Jordan for helpful comments on an earlier draft.

principal problem for monetary policy at present is to achieve this gain by ending inflation at minimum transitional loss of output. Every six months, I join with my colleagues on the Shadow Open Market Committee in recommending a policy of pre-announced, gradual, sustained reductions in the growth of money as a means of restoring price stability. A clear statement of the reasons for a policy of this kind -- often called gradualism -- has not been provided. I will try to partially fill that gap and to relate the case for gradualism to some of the lessons we have learned from recent experience with sustained inflation.

The history of recent inflation is surrounded by myths that obscure the origins of the inflation and the reasons for its persistence. I begin with an account of the origin and an explanation of persistence. Much of the case for gradualism depends on the way in which individuals form anticipations of the future. I present one view of rational expectations, in the sense of Muth (1961), and use this model of expectations to show how Federal Reserve policy procedures can convert real shocks into permanent changes in the rate of price change. Then I present the case for gradualism in a world in which persistent and transitory changes in monetary policy cannot be identified quickly.

THE ORIGIN AND PERSISTENCE OF CURRENT INFLATION

The most enduring myth about the origins of the current inflation is that the inflation started during the Vietnam war. According to a standard version of history, President Johnson rejected the recommendations of his advisers by refusing to choose between "guns and butter." The President delayed asking Congress for increased taxes

(or for smaller expenditures for redistribution) and allowed the budget deficit to overstimulate the economy in 1967. Since 1967, inflation has been intractable. According to some estimates, ten or more years of recession would be required to eliminate inflation by monetary and fiscal policies.¹

The facts do not correspond to this capsule history. The rate of increase of consumer prices reached the 3 to 4% range at least a year before the Vietnam deficits. Spending by the federal government in dollars of constant purchasing power remained 3 to 5% below the 1962 level during most of 1965. Budget deficits and government spending did not start the inflation or encourage the Federal Reserve to expand in 1965 or 1966. The budget had a small surplus in 1965, and a small deficit in 1966. The Federal Reserve slowed the growth rate of the monetary base late in 1966 in a sudden burst of concern about rising inflation. The 1967 deficit of more than \$13 billion comes after these first steps to slow inflation and much too late to explain the start of the inflation.

A surtax was added to the income tax in 1968, so the Vietnam deficit proved to be temporary. By late 1968, the budget again was in surplus, and the surplus persisted in 1969. The 1969 surplus of \$8.5 billion is one of the largest of the past thirty years in real as well as in nominal terms.

To sustain the thesis that the Vietnam deficits started the current inflation, one must not only ignore the problem of the timing of

¹See Perry (1978) for a more complete statement of this view and for an extreme form of the argument that inflation is intractable. Perry's Phillips curve implies that it costs \$200 billion dollars of real output for each percentage point reduction in the rate of inflation.

the start of inflation, on which I commented earlier, but must accept the improbable proposition that six quarters of wartime deficit generated anticipations that were irreversible. Credulity is strained further when the 1967 deficit is expressed in constant dollars to compare with the deficits in earlier and later years. The 1967 deficit is almost identical to the 1958 deficit when both are expressed in dollars of the same purchasing power. The 1958 deficit did not initiate years of sustained inflation. On the contrary, inflation fell from the 3 to 4% range of 1956-57 to the 1 to 2% range in 1958-59 and to less than 1% by 1961.

The 1975 nominal budget deficit of \$70 billion is four times larger than the deficits of 1958 and 1967 when the three are expressed in dollars of comparable purchasing power. The 1975 deficit is not followed by a balanced budget or a surplus but by sustained deficits. Yet, most broad measures of the rate of price change declined in 1976. The GNP deflator rose by less than 4.5%, on average, for the first three quarters of the year, and the consumer price index rose by less than 5% for the year as a whole.²

The proximate cause of the start of the current inflation is the monetary policy of the early 1960s. Inflation persists because policy continues to sustain anticipations of future inflation by producing persistent inflation. Bursts of anti-inflation policy, and announcements of firm commitments to reduce inflation, are not followed by policies that reduce money growth.

²The decline in the rate of inflation affected more than just food prices as is sometimes claimed. The wholesale price indexes of consumer finished goods rose by less than 2.5% for the year.

CHART 1

Rate of Growth of the Monetary Base
(3 Year Moving Average)

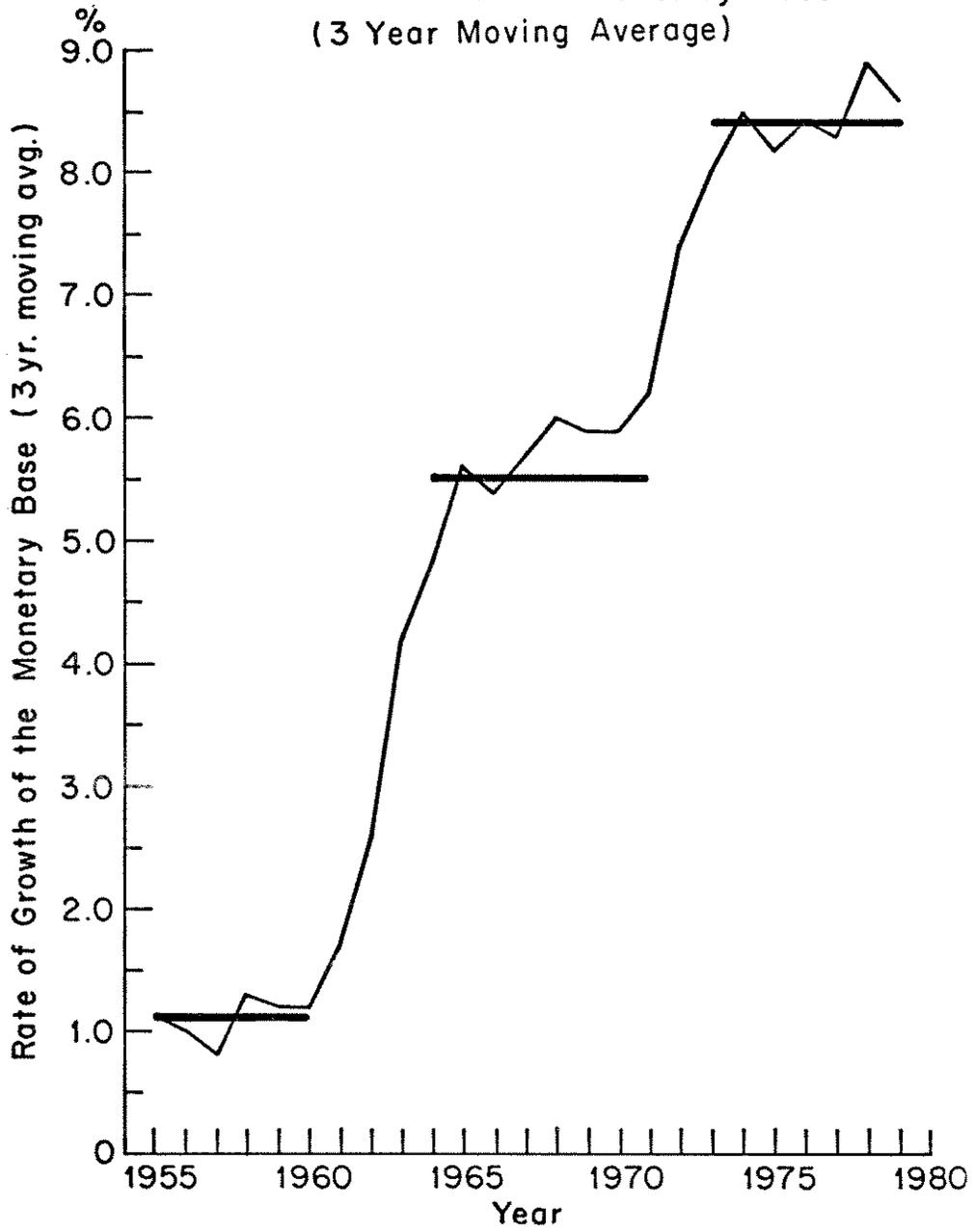


Chart 1 uses a twelve quarter moving average of the growth of the adjusted monetary base as a measure of the long-term effect of monetary policy. Using this measure as an index of the sustained thrust of monetary policy, we can divide the monetary history of the past twenty-five years into five episodes. The first, from 1955 to 1960, has a low average rate of monetary growth, 1.1%. The second is a three-year transition. The twelve quarter moving average rises steadily toward the 5.5% range. In the third period, 1964-71, the growth of the base remains in the neighborhood of 5.5%. The fourth period is a one-year transition, 1972, during which the maintained growth of the base moves from about 5.5% to 8.5%. Since 1973, the moving average of the base has grown at a maintained rate of about 8.5%.

A number of studies, including my own Meltzer (1977), suggest that inflation follows money growth with an average two-year lag. The mean of the three-year moving average ending in year t , shown in Chart 1, is an unweighted average centered in year $t-1$. If we impose a two-year lag, inflation in year $t+1$ is influenced by the twelve quarter rate of growth of the monetary base ending in year t . To measure persistence, I have computed the standard deviation of the percentage rates of change of the consumer price index and the percentage rate of change of money wages for the years 1956-61, 1965-72 and 1974-78 that correspond to the two-year lag of prices behind the maintained growth of the monetary base.³ The data are shown in Table 1.

³The rates of price and wage change are one-year averages of the all-item consumer price index for six-month spans and average hourly earnings over six-month spans from BCD. Wage data are not available before 1965.

TABLE 1

Mean (μ) and Standard Deviations (σ)

Years (t)	Growth of Adjusted Monetary Base in t		Rate of Price Change t+1		Rate of Wage Change t+1	
	μ	σ	μ	σ	μ	σ
1955-60	1.1	.18	1.9	1.00	N.A.	
1964-71	5.7	.44	4.0	1.26	5.9	1.13
1973-78	8.4	.31	7.5	2.42	8.0	.79
Omitting 1974			6.4	.85	7.7	.36

The data show a tendency for the standard deviation of the rates of change of money and wages to fall in recent years. Removing the effects of the oil shock, by omitting 1974, further reduces the standard deviations. The standard deviations of the rates of change of wages and prices are not startlingly different from the standard deviations of the maintained growth of the adjusted base. The persistence of rates of price change from year to year appears to be related to the persistence of maintained rates of money growth.

To examine further the relation between the persistence of money growth and the persistence of inflation, Table 2 compares the two quarter average rates of growth of base money to the quarterly averages of the rates of change of prices and wages used in Table 1. As before, I imposed a two-year lag of rates of price change behind rates of money growth. The data now suggest that the variability of base money growth is of approximately the same magnitude as the variability of the rate of wage change.⁴ The standard deviations of the rate of price change,

⁴The time periods for the base differ from those in Table 1 because Table 1 has a three-year moving average. I have kept the periods for rates of price and wage change the same as in Table 1.

however, are not closely related to the standard deviations of rates of base money growth. Short-term variability of the rate of price change reflects more than the variability of monetary growth.

TABLE 2

Mean (μ) and Standard Deviations (σ)

Period	Two quarter moving average of growth of monetary base		Period	Standard Deviations (σ) quarterly average rate of change over six-month spans			
	μ	σ		Consumer prices	Money wages	μ	σ
t	μ	σ	t+2	μ	σ	μ	σ
1954-59	1.1	0.87	1956-61	1.5	1.61		
1963-70	5.7	1.10	1965-72	4.00	1.34	5.9	1.19
1972-76	8.2	0.91	1974-78	8.2	2.61	8.0	0.90

The data for 1963-70 and 1972-76 include several periods in which inflation was given "highest priority" as a goal of public policy. Careful inspection of the data shows that periods of slower growth of the base coincide with these announcements in 1966, 1969-70 and 1974-75, but none of these periods of slower growth is long enough to have any marked effect on the standard deviation of the growth rate of the base. Table 2 shows that the standard deviation of the two quarter moving growth rates is independent of the rate of growth of the base and not very different in the three sample periods.

The data suggest two reasons for the persistence of inflation and the slow response of inflation to changes in the growth rate of money. First, short-term rates of price change are relatively variable, so people have difficulty separating the effects of money growth from other influences on short-term price changes. This is particularly the

case for recent years, when announced changes in oil prices have had considerable influence on measured rates of price change and their variability. Second, the commitment to anti-inflation policies does not last. People are unwilling to buy long-term contracts based on the assumption that the slower rate of money growth will persist long enough to reduce the trend rate of inflation. In the next section, I offer an explanation of the relation between the variability of money growth and the persistence of inflation.

THE BASIC INFERENCE PROBLEM⁵

Each week the Federal Reserve reports the growth rates of various monetary aggregates. Market participants try to infer the future course of money growth, interest rates, prices and exchange rates from the announcement. Their problem, and ours as economists, is to separate transitory changes in money growth (or other variables) from persistent changes. I call this problem of separating permanent or persistent changes from ephemeral or transitory changes the basic inference problem because it arises for most economic variables and is a major problem for people making decisions.

To illustrate the problem, suppose that in a given week the announced change in money is large relative to past changes. Few observers will use the observation for a single week to predict the growth path, and fewer still will predict an equiproportionate change in the rate of inflation. Let the increased rate of money growth persist, for a month or two, and the balance of opinion will start to

⁵This section owes a large debt to Brunner, Cukierman and Meltzer (1979).

change. More observers will infer that there has been a persistent change in the growth rate of money.

The effect of the first week's observation on market prices, interest rates and exchange rates differs from the effects of a change that is perceived to be permanent. Although the change in money is reported, and therefore is known, the correct inference to be drawn from the information is uncertain because the content of the information is uncertain. A rational investor who uses all available information, must first decide what he knows; that is to say, he must decide how much of the changes he has observed can be expected to persist.

This view of the world in which monetary and other policies operate differs in an important way from the usual model of rational expectations developed by Lucas (1975) and others. There, people are uncertain about whether the changes they observe are the result of shocks that change relative prices or shocks that change the absolute price level; once information becomes available, there is no doubt about its meaning.

Given the speed with which information becomes available, the confusion between aggregative and relative changes cannot be the principal source of confusion. The main aggregates in our models -- money, debt and deficits or GNP, prices and output -- are observed within a month or a quarter. Once they are observed, the confusion between absolute and relative changes disappears.

The permanent-transitory confusion does not disappear when data are published. The principal uncertainty that individuals face arises, in this model, from an inability to properly interpret information, not from lack of information. People observing the price index must decide

whether a reported increase or decrease in an aggregate is a one-time change that will soon be reversed or the start of a higher or lower maintained rate of change. Expectations remain rational, but the use of all available information does not solve the inference problem and does not eliminate error.

A simple model brings out the source of the permanent-transitory confusion. It is, of course, only one of many ways in which the problem can be formulated, but it is the way that has been used in an application to the problem of stagflation where it produces changes in prices and employment that resemble the aftermath of the oil shock.⁶

An observable variable X_t can be divided into two components, a permanent component, X_t^p , and a transitory component X_t^q . X_t^q and ΔX_t^p are normally distributed random variables with mean zero and known, constant variances, σ_{xp}^2 and σ_{xq}^2 . People cannot observe X_t^p or X_t^q but must infer the permanent value by observing current and past values of X_t .

$$X_t = X_t^p + X_t^q,$$

The expectation of X_t , conditional on all information available in period t , is X_t^p .

The inability to separate permanent and transitory components makes the optimal forecast of X a distributed lag of past observations. Contrary to much of the rational expectations literature,⁷ we find that

⁶Brunner, Cukierman and Meltzer (1979). This application considers the effects of real shocks. The role of the permanent-transitory confusion in the transmission of monetary shocks to real variables introduces additional problems.

⁷Benjamin Friedman (1979) is an exception.

using a distributed lag of past observations is an optimal method of forecasting. The reason is that repetitive observation of an aggregate are required to learn whether a permanent change has occurred. If permanent changes are frequent, and transitory changes are infrequent, a change in X is more likely to be treated as permanent soon after it occurs. At the opposite extreme, transitory changes are frequent and permanent changes are rare, so it is optimal to observe a relatively long series of observations before concluding that a permanent change has occurred. In more technical terms, the larger the ratio $\frac{\sigma_{xp}^2}{\sigma_{xq}^2}$ the faster people correctly infer that a permanent change has occurred; the smaller the ratio, the larger is the number of observations required to sustain the inference that a permanent change has occurred.

We can put more content into the terms "frequent" or "infrequent" by using the computed standard deviations for the two quarter and three-year moving averages in Tables 1 and 2 to estimate the relative variance of permanent and transitory components and to find the implied length of the lag in reaching rational judgments about permanent shocks. The permanent variance of the growth rate of the monetary base is set equal to the variance of the three-year growth rates. The two quarter moving average growth rates include both permanent and transitory components. We assume that permanent and transitory variances are independent and compute the transitory variance by subtracting the variance of the twelve quarter average from the variance of the two quarter average. Muth (1960, pp. 302-4) shows that the best (minimum variance) linear estimator of the permanent value of a variable can be computed from past actual values using the variances of the permanent and

transitory components. For the problem at hand, the calculations for the three periods of relatively constant growth of the monetary base show that the relative variances of the growth rates of the base are:

	1955-60	1964-71	1973-78
$\frac{\sigma_p^2}{\sigma_q^2}$.04	.19	.14

These ratios imply very different lags in the adjustment of the expected growth of the base. In 1955-60, only 55% of the adjustment of expectations occurs within three years. The reason is that the very low variance around the three-year average growth of base money obscures the change in the maintained rate of growth, when it occurs. Rational individuals interpret most of the permanent change as transitory and fail to adjust fully for several years. In the two remaining samples, the variance of the permanent component is higher relative to the variance of the transitory component. Expectations adjust more quickly; more than 95% of the full adjustment occurs in the first three years.⁸

Expectations of inflation are related to the growth of money that individuals expect to be maintained. The expected growth of base money can be reduced permanently only if the actual growth of base money is reduced. The speed of adjustment of expected to actual growth can be reduced, also, if the variability of the growth rate of the base is reduced. For example, if the Federal Reserve reduces the variance of the two quarter growth rate to equal the variance of the twelve quarter

⁸"Transitory" variances are computed from two quarter moving averages, so two quarters are used as one period when computing the lags.

growth rate, 85% of the adjustment of expectations about the permanent growth occurs in the first year. Expectations of inflation respond more rapidly to monetary policy; the length of the lag of inflation behind money growth declines.

It is, no doubt, a mistake to use these numbers as precise estimates of the expected length of the lag. Fortunately, the principal implications do not depend on the precision with which we measure the speed of adjustment of expectations. If short-term policies are less variable, the speed of adjustment increases. Faster adjustment of expectations lowers the length of time between changes in the growth rate of the monetary base and changes in the expected growth of the base and, therefore, in the expected rate of inflation. The shorter the lag, the smaller, ceteris paribus, is the persistence of inflation.

A related, but distinct, implication explains why short-term changes in the growth rate of the base have little effect on maintained inflation. The larger the transitory variance of the growth rate of the base, given the long-term or permanent variance, the longer is the lag. Short-term reductions in the growth rate of the base have little effect on long-term expectations if the short-term growth of the base is highly variable. The real costs of reducing inflation are higher, under these circumstances. The costs take the form of recession and rising unemployment. Recession encourages the Federal Reserve to shift to a policy of monetary expansion thereby reinforcing expectations that the maintained average growth rate of the base will not be reduced. Chart 1, above, shows that past periods of anti-inflation policy have, in fact, had little effect on the maintained growth rate of the base.

The calculations in Tables 1 and 2 imply that the lag in the formation of expectations is shorter now than in the fifties. The data suggest, however, that the reason for the shorter lag is the increase in the measured variance of the permanent component, not a reduction in the measured variance of the transitory component.

THE POLICY PROBLEM

The Federal Reserve can reduce the short-term variance of the growth of the monetary base by adopting targets expressed in terms of the base. Reserves and currency, the uses of the base, are approximately equal to the sum of reserve bank credit and international reserves. With floating (or adjustable) exchange rates, the Federal Reserve can control the two quarter growth rate of the base by controlling the stock of Reserve bank credit. To control the base the Federal Reserve need not solve an impossible or even a difficult problem. All they must do is control the asset side of their balance sheet.

As is well-known, the Federal Reserve cannot control both interest rates and the growth rate of the base. By specifying short-term targets in terms of values (or ranges) of the Federal funds rate, the Federal Open Market Committee surrenders control of short-term changes in the base. The problem of separating permanent and transitory changes helps to explain how loss of short-term control of the base contributes to persistent movements of the base even if the dominant shocks in the economy are real, not nominal shocks.

To illustrate the problem, I use the three equation, equilibrium model based on Brunner, Cukierman and Meltzer (1979). All variables

are natural logarithms. Production or output, y_t , is given by a neo-classical production function

$$(1) \quad y_t = u_t + \delta l_t$$

with l_t , the number of man hours of labor and u_t a productivity shock; δ is the elasticity of output with respect to labor. Real aggregate spending is always equal to output, y_t , and depends on expected or permanent income, y_t^p , on the real rate of interest and on shocks to aggregate demand, ε_t . The anticipated rate of inflation is the difference between the logarithms of the price level anticipated for next period (${}_t p_{t+1}$) and today's prices (p_t). The market rate of interest is i_t .

$$(2) \quad y_t = a + b y_t^p + c [i_t - ({}_t p_{t+1} - p_t)] + \varepsilon_t$$

$$b > 0 ; c < 0$$

Equation (3) equates the current stock for base money, $B + \psi_t$, to the demand for base money, where ψ_t is the shock to the level of nominal money balances.⁹ Some part of the shock to spending, ε_t , affects the demand for money; the rest affects the demand for bonds and the supply of labor. Increases in spending are financed by reducing the demand for money so θ is positive and increases in ε reduce the demand for money.

$$(3) \quad B + \psi_t = \alpha + p_t + \beta i_t + y_t^p + \gamma (y_t - y_t^p) - \theta \varepsilon_t$$

$$\beta < 0$$

$$1 > \gamma, \theta > 0$$

⁹The analysis can be cast in terms of growth rates of money by making minor adjustments.

The three equations form an augmented IS-LM model. The principal novelties are the distinction between permanent and current income and the introduction of permanent and transitory shocks. The three shocks, u_t , ϵ_t and ψ_t , have permanent and transitory components, but people are not able to distinguish the permanent and transitory components when observing the shocks. For example, $u_t = u_t^D$ with known variances σ_{up}^2 and σ_{uq}^2 , normal distributions and expected values Eu_t^D and $E\Delta u_t^D$ equal to zero.

Substituting eq. (1) into (2) and (3) and solving for i_t reduces the system to two equilibrium relations. The money market equilibrium or LM, in eq. (4) and the IS curve, eq. (5) relate i_t to the three shocks, to the price level and to other variables. For the current analysis, I treat y_t^D and l_t as given and independent of the shocks.¹⁰

$$(4) \quad \beta i_t = B + \psi_t - p_t - \gamma u_t + \theta \epsilon_t - \gamma \Delta l_t - (1-\gamma)y_t^D - \alpha$$

$$(5) \quad c i_t = c({}_t p_{t+1} - p_t) + u_t - \epsilon_t + \delta l_t - b y_t^D - a$$

During most of its existence, the Federal Reserve used the market interest rate (or some surrogate like the level of free reserves) as the operating target. Suppose the Federal Reserve sets the target interest rate at i_0 and supplies or absorbs base money to keep $i_t = i_0$.

¹⁰A full solution is given in Brunner, Cukierman and Meltzer (1979) by specifying the labor market equations. The additional detail would not alter the conclusions of this discussion. The principal differences that have been neglected are the dependence of y_t^D on the expected values of the real shocks and the dependence of l_t on the actual values of the real shocks. The reader who is disturbed by the partial solutions can substitute permanent and actual values of shocks -- real shocks -- for y_t^D and l_t . For the analysis that follows what matters is that the responses of IS and LM to the shocks cause i_t to differ from i_0 .

The stock of base money $B + \psi_t$ changes only as required to maintain the interest rate at i_0 , which is to say that the stock of money now depends on the real shocks.

$$(6) \quad \psi_t = \psi(\varepsilon_t, u_t)$$

Equations (4) and (5) are shown as solid lines in Figure 1. The slope of LM from eq. (4) is positive in the i, p plane. The slope of IS is -1 . The price level is p_0 . The policy of fixing interest rates, temporarily at i_0 , makes the interest rate pre-determined at i_0 . Monetary policy keeps the interest rate constant by changing money. Whenever there are real shocks to productivity or to spending and the demand for money, the Federal Reserve changes the stock of money enough to hold interest rates fixed until it decides that the shock is permanent.

Consider the effect of a negative productivity shock, $du_t < 0$. From (4) and (5) we compute the elasticities

$$\left. \frac{di_t}{du_t} \right|_{LM} = \frac{-\gamma}{\beta} > 0 \quad \text{and} \quad \left. \frac{di_t}{du_t} \right|_{IS} = \frac{1}{c} < 0.$$

A negative shock shifts both the LM curve and the IS curve to the right in Figure 1. If γ is small, the demand for money changes very little, and interest rates rise. The Federal Reserve offsets the rise in interest rates by increasing the money stock.

$$\frac{di_t}{d\psi_t} = \frac{1}{\beta} < 0$$

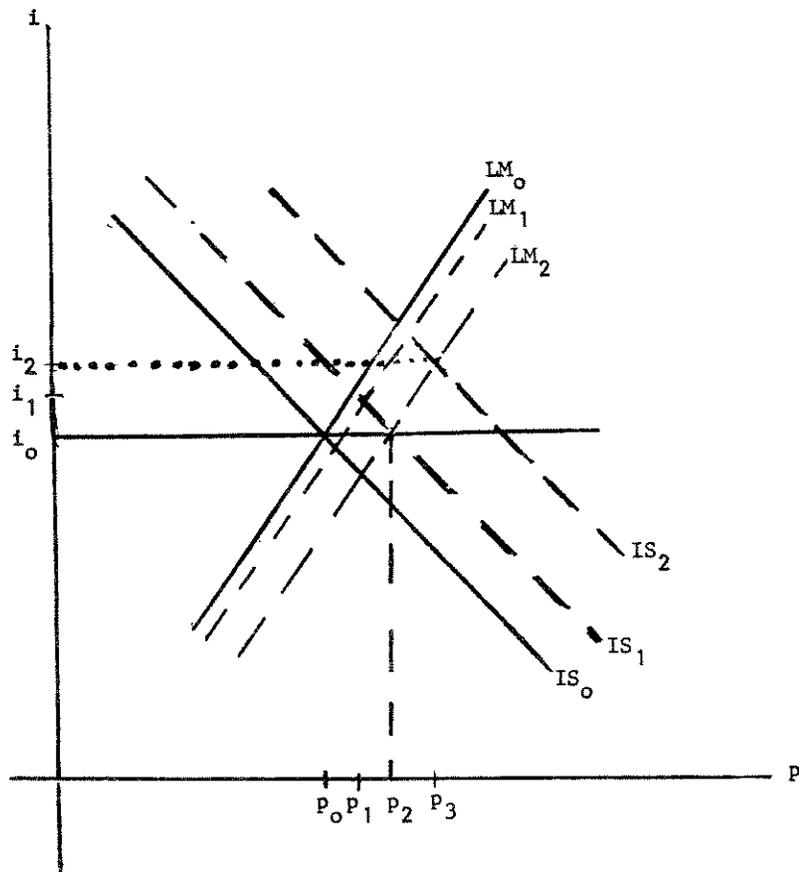


FIGURE 1

If the negative productivity shock is transitory, Federal Reserve policy eliminates any effect on interest rates but increases the price level by more than the increase resulting from the transitory decline in productivity. The dotted lines IS_1 and LM_1 in Figure 1 show the effect of the transitory change in u_t . Prices and interest rates rise; p_1 is the log of the price level at the intersection of IS_1 and LM_1 , and i_1 is the interest rate. Federal Reserve policy shifts the LM curve further to the right, shown by LM_2 , restoring the interest rate i_0 and increasing the price level to p_2 ; $p_2 - p_1$ is the relative rate of change in the price level resulting from Federal Reserve policy, and $p_1 - p_0$ is the rate of price increase caused by the decline in productivity.

The mean values of the transitory shocks are zero so the effect of Federal Reserve's response to transitory shocks is on the variance of rates of price change and not on their average over time. A policy of pegging interest rates increases the variability of the measured rates of price change resulting from transitory shocks. Our earlier finding that the variance of the rate of price change rose during the period in which there were oil shocks is consistent with this implication.¹¹

Suppose, however, that the negative productivity shock is permanent, or persistent, not transitory. In this case, the price level fluctuates around p_2 following the increase in money to LM_2 . Because permanent and transitory shocks cannot be observed separately, or

¹¹There are, of course, other causes of variability including the shocks to spending and the demand for money (ϵ_t) and the Federal Reserve's response to these shocks.

separated reliably, people must decide whether the observed rate of price increase, $p_2 - p_0$, the change in money, ψ_t , and other changes have caused a one-time price change or a persistent change in the rate of price change. If the inferences drawn from available information lead people to believe that some part of the change in the measured rates of price change and money are persistent changes in the rates of change, instead of one-time changes in level, the IS curve shifts further to the right. The size of the shift depends on the degree to which the anticipated rate of inflation, ${}_t p_{t+1} - p_t$, rises.¹²

The Federal Reserve policy of fixing the interest rate at i_0 sustains the inference that the observed changes in prices and money reflect a persistent increase in rates of change, not a one-time change in levels. The reason is that, when IS shifts to the right the policy of fixing interest rates requires the Federal Reserve to again increase the money stock, shifting LM further to the right.

The additional changes in money and prices reinforce beliefs about the persistence of the changes in money and prices. As the perceived and measured rates of inflation rise, anticipated inflation rises, and there is a further rightward shift in IS. Additional increases in money are now required to hold the market interest rate at i_0 .

Each increase in the stock of money reinforces the belief that there has been a persistent change in the rate of money growth. Each increase in the equilibrium price level reinforces the belief that the

¹²A run of transitory, negative shocks to productivity produces a similar result. ${}_t p_{t+1}$ is today's expectation of next period's price. The rational expectation takes the form of a distributed lag, as indicated earlier, so expectations adjust gradually.

rate of price change has increased. The Federal Reserve's policy of maintaining the level of interest rates converts a one-time change in the price level into a series of price changes that strengthen perceptions that there has been a change in the rate of change.

Rational investors "know" the model, so they know that anticipations about the price level adjust slowly because they and others are unable to separate persistent and transitory changes. The policy of holding the interest rates at i_0 implies that the price level will rise as long as the money stock grows. That is, as long as ${}_t p_{t+1} - p_t$ is positive, the policy of fixing interest rates will require the Federal Reserve to let the money stock rise.

The Federal Reserve can eliminate the bulge in the money stock and in the measured rate of price change by raising the target rate of interest. I have drawn a dotted line at the intersection of IS_2 and LM_2 in Figure 1 to show the rise in interest rates required to keep the price level from exceeding p_3 . The dotted line shows that the required interest rate is i_2 ; $i_2 - i_1$ is the additional increase in interest rates resulting from Federal Reserve policy. The increase $i_2 - i_1$ is temporary, not permanent. Once people recognize that the money stock is constant, anticipations of rising prices decay; IS shifts to the left; the market rate of interest falls to i_1 ; and the price level falls between p_2 and p_3 . (The precise level of prices is at the value of i_1 on LM_2 .)

The combination i_1, p_1 is the interest rate and price level combination to which the economy moved following the permanent loss of productivity. It is not an accident that the economy eventually settles at the rate of interest i_1 following the "anti-inflationary" increase in interest rates to i_2 ; it is an implication of the neutrality

of money. Monetary policy, at first, allowed the money stock to rise, then held the money stock constant, eliminated the anticipation of rising prices and allowed the interest rate to decline. The lasting effect of the interest rate policy is a higher price level. The amount of increase depends, of course, on the speed with which the Federal Reserve abandons the interest rate target $i_t = i_0$.

This discussion of policy has neglected many complicating features. The adjustment of prices and interest rates has been analyzed as if these changes occur without real effects. The gradual adjustment of employment when rational individuals cannot distinguish permanent and transitory productivity changes has not been emphasized. The case for fixing the level of interest rates is not strengthened by these omitted effects.

A principal result of the policy of fixing market interest rates is that additional changes in prices (and output) are induced by monetary policy. People are forced to decide how much of the observed change in money is persistent and how much is transitory. The determination of the new permanent price level is made more difficult.

The permanent decline in productivity produces a temporary increase in unemployment and a permanent loss of real income. Unemployment rises because people do not recognize instantly that the shock is permanent. Hence, they do not instantly adjust their real incomes (and real wages) to the level they eventually reach. Monetary policy can reduce this cost of adjustment only if the monetary authority can succeed in reducing real wages to their new, permanent level without setting off anticipations of rising prices. The monetary authority must have superior information on the speed with which people recognize the

permanent loss of real income and the speed with which anticipations of price changes form and decay. There is no reason to believe that monetary authorities have information of this kind or are able to set market interest rates in a way that minimizes the cost of adjusting to real shocks. On the contrary, monetary policy produced persistently higher rates of price change following the productivity shocks of this decade.

THE CASE FOR GRADUALISM

Reliance on market interest rates as the operating target of monetary policy produced high rates of growth of the monetary base and sustained inflation. The low variance of the long-term average growth of the base suggests that the 8.5% growth rate of the base is perceived as a "permanent" rate of change. To end inflation the rate of growth of the base must be reduced.

If expectations form and decay quickly in the presence of new information, the problem of ending inflation is made easier. A credible policy to stop inflation causes prompt revision of expectations. Revised expectations, and slower growth of base money bring inflation to an end. Rational individuals recognize that sunk costs or contracts must be forgotten, so as contracts are revised, they enter into agreements or commitments that reflect their revised expectations. Even in this case, there are benefits to gradualism if costs of adjustment can be reduced by permitting people to learn about the new environment.

The analysis in the preceding section suggests some of the difficulties people face when forming judgments about the persistent rate of change of money. Some of these difficulties can be reduced if policy

makers announce the intended rate of money growth. Announcements are not sufficient to change anticipations permanently. A principal reason is that policymakers statements are not entirely credible. Past promises to slow money growth and reduce inflation have been followed within a few quarters by renewed expansion. Consequently, rational individuals treat any initial reduction in money growth (or budget expenditures) as temporary, not permanent, changes. An announced reduction in the growth of money, initially, will not be interpreted as a reduction in the maintained rate of money growth.

Gradual reduction in money growth can reduce the cost of lowering the rate of inflation in three ways. First, maintaining the growth of the base at a steady rate lowers the variance of the transitory component and reduces the lag in the formation of expectations. Second, the maintained average rate of money growth falls gradually, so people have time to adjust future commitments to reflect revised expectations. Third, if costs of adjusting to a lower rate of inflation are not proportional to the total adjustment but increase with the rate per period, costs of adjustment are reduced by lowering the rate per period.

If the rate of adjustment of money growth is very low, the variance of the permanent component is low, so the lag in adjustment of expectations increases. If the rate of adjustment of money growth is rapid, the variance of the transitory component increases, so costs of adjustment rise. The optimum rate of adjustment is achieved by increasing the variance of the permanent component and reducing the variance of the transitory component of money growth. This is equivalent to finding the minimum lag in the formation of anticipations.

The policy of gradual, pre-announced reductions in money growth advocated by the Shadow Open Market Committee did not emerge as a solution to the problem of finding an optimal lag. The choice of an optimal policy depends on information that is not yet available. Our proposal, like most policies, depends more on empirical judgments about the length of lags and costs of adjustment than on hard evidence. I have no doubt that future research will find a better path.

SOME FINAL SPECULATIONS

The chief difficulty in the policy of gradualism is the length of time required to reach the rate of growth consistent with non-inflationary growth in the economy. If we use the long-run growth of real output as a guide, the rate of base money growth must fall from the current rate of 8% to no more than 3%. If payments technology continues to improve, base velocity will rise in the future as it has for at least the past quarter century. The non-inflationary rate of base money growth is then no more than 1 or 2%.

Is a seven year program of sustained reductions in money growth the best that can be done? I expect not. There is reason to believe that policymakers can increase their credibility by meeting pre-announced targets. Increased credibility permits policymakers to lower the maintained growth rate while lowering the relative variance of the transitory component of money growth. Credible announcements mean that individuals distinguish permanent changes closer to the time they occur by using announcements of proposed changes as a reliable indicator of future money growth.

No one can be very certain about these issues. The evidence on which we rely comes from experience in Germany, Switzerland, the United Kingdom and our own experience in the middle seventies. Each of these experiences suggests that within two to three years at most, the anticipated rate of inflation declines. The rate of price and wage change falls; long-term interest rates decline, and real output rises or accelerates.

Those who desire "incomes policies" to reduce the lag for adjustment might find pre-announced monetary policies more attractive than either the failed incomes policies of the past or present, or complicated, inefficient programs to tax wage and price changes. Instead of announcing the rate of price and wage changes that the government favors, the government can announce the rates of monetary and fiscal expansion that the government intends to maintain. These announcements, if they are credible, help individuals to form expectations about future rates of inflation.

Analysis of the length of the lag in the adjustment of anticipations relates these adjustments to the adjustment of permanent values or maintained rates of change. The evidence we have is neither inconsistent with the theory of expectations that I have sketched nor more consistent with any other explanation I have seen. This is not a strong claim, but it is considerably better founded than the belief that inflation is intractable.

REFERENCES

- Brunner, Karl, Alex Cukierman and Allan H. Meltzer (1979) "Stagflation, Persistent Unemployment and the Permanence of Economic Shocks," multilithed, Carnegie-Mellon University.
- Cukierman, Alex (1979) "Relative Price Variability, Inflation and the Allocative Efficiency of the Price System," multilithed, Carnegie-Mellon University.
- Lucas, Robert E. (1975) "An Equilibrium Model of the Business Cycle," Journal of Political Economy, 83 (December) pp. 1113-44.
- Meltzer, Allan H. (1977) "Anticipated Inflation and Unanticipated Price Change" Journal of Money, Credit, and Banking, 9 pt. 2 (February), pp. 182-205.
- Muth, John F. (1960) "Optimal Properties of Exponentially Weighted Forecasts," Journal of American Statistical Association, 55 (June) pp. 299-306.
- Muth, John F. (1961) "Rational Expectations and the Theory of Price Movements," Econometrica, 23 (July) pp. 315-35.
- Perry, George L. (1978) "Slowing the Wage-Price Spiral: The Macroeconomic View," Chapter 2 in Okun and Perry (eds.) Curing Chronic Inflation, Washington: Brookings Institution.