THE OUTPUT LOSS DURING DISINFLATION

Martin Bailey*

ABSTRACT

This paper deals with the output losses associated with periods of restrictive monetary and fiscal policy and of declining rates of inflation.

The results using data from several countries for the seventies, tend to support the findings that inflation takes about three years to come down by the number of percentage points of the cutback of monetary expansion. Also it was found that the maximun rate of loss of output comes in the second year after the year of the cutback.

EXTRACTO

Este artículo se refiere a las pérdidas de producto asociadas con períodos de políticas monetarias y fiscales contractivas y con tasas de inflacion decrecientes.

Los resultados, usando información de varios países para la década de los setenta, tiende a confirmar el hecho de que la inflación toma alrededor de tres años para disminuir en un porcentaje similar a la caída de la expansión monetaria. También se encontró que la máxima tasa de caída del producto ocurre en el segundo año después de haberse comenzado la política restrictiva.

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This is the first draft of a larger research that professor Bailey is corrently working on. He presented this version at the "Second Latinoamerican Meeting of the Econometric Society" held in Río de Janeiro (July 1981).

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This paper reports the results of my research on output losses in various countries during periods of restrictive monetary and fiscal policy and of declining rates of inflation. Most of the well documented experience of this type comes from the 1970's, but I have also used some data from earlier decades. In addition, as a preliminary step I review the theories and opinions on this subject most prominently publicized in recent years.

The data are hard to reconcile with any well–known theory, but can be interpreted using plausible ad–hoc additions to the rational expectations view. There has generally been an appreciable but short–lived loss of output connected with restrictive policies, whether pursued persistently or not.

Countries whose rates of inflation persist and accelerate for several years generally experience unfavorable upward shifts of their Phillips curves (or aggregate supply curves), such as occurred in the U.S. Although it is not always enlightening to attempt to use their unemployment statistics to observe this shift, it is clear enough when viewed in terms of aggregate supply using either industrial production or gross domestic product. Inflation could be stopped without any loss of output if the aggregate supply curve could be returned to its previous, pre–inflationary position on the first day of restrictive, disinflationary policy. If, in contract, expectations, contracts and other influences on the position of the aggregate supply curve should refuse to budge, it would follow that a persistent disinflationary policy would produce an aqually persistent loss of output.

The latter possibility virtually dominated discussion of the problem in the mid–70's in the U.S. *The Economic Report of the President* of 1978 estimated the cost substantially reducing U.S. inflation in the hundreds of billions of dollars of lost GNP.[1] (In later years the *Economic Report* has

[1] *Economic Report of the President* (1978 U.S. Government Printing Office.) p. 150

been more optimistic). The estimate, similar to that widely disseminated by Arthur Okun,[2] derived from a belief that the Phillips curve could he shifted downward only very gradually, even after a severe output loss. This belief is most readily rationalized by using adaptive expectations with a rigid formula and slow adaptation.

The possibility of no loss of output is also easily rationalized. In superficial terms all it requires is that the success of a restrictive policy be foreseen on the first day of the policy by all households and firms, and that contracts have been drawn up with enough flexibility to respond to the new policy without real cost (e.g. with complete escalator clauses). With equal superficiality one can claim that rational expectations necessarily imply this result, subject to random error. This result is in fact reasonable whenever it is reasonable to expect that a restrictive policy will persist enough to succeed, as was true in the stopping of the great hyperinflations of the 1920's. There the stabilizing governments usually returned to the gold standard, aided by large foreign loans, and enacted drastic fiscal and monetary reforms.[3]

In the cases of the 1970's, however, no nation went to such dramatic lengths to convince itself that it would stop inflation. In fact, few countries claimed that they would *stop* inflation; most said they would reduce it gradually. Some said it repeatedly, and delivered on the promise rather less often, as has been the ease in the United States. Therefore we may ask, if a government promises to reduce the rate of inflation substantially, what is it rational to expect? Does anyone, inside or outside that government, have any way of knowing whether and to what extent it will persevere enough to reduce inflation substantially? If experience is a good guide, the rational expectations to hold is that there will be best partial success.

Therefore, in cases like those of 1970's (including nearly all cases since World War II), when a government actually succeeds in reducing inflation substantially, we should not be surprised to discover that households and firms in that economy have been surprised. *Ex post* we know that the government succeeded; but *ex ante* they did not know it would. Their surprise will always go in the same direction if there is no reason to consider the possibility that the government will reduce inflation *more* sharply than it promised. Again, experience suggests no reason to expect that. Given ex post that a disinflationary program succeeded, errors of expectations will be asymmetrical. Yet no one can gain from such knowledge unless he knows how to pick the winners in advance.

[2]See, for example, his "Efficient Disinflationary Policies" *AER Papers and Proceedings* v. 68 (may 1978) p. 348.

[3]See Sargent, Thomas J. "The Ends of Four Big Inflations". Federal Reserve Banck of Minnesota working paper, presented at the NBER Conference on Inflation, october, 1980.

Turning now to the data, first let us review them in a rough, descriptive way. The experiences of the 1970's present three fairly clear and straightforward groupings of the countries on which data are available. Group A let their rates of inflation run up to more than twenty percent, and then cut those rates in half or better, maintaining low or falling rates of inflation for at least three years. (I separated this group from those that did not persist so long in their disinflationary episodes in order to see whether persistence resulted in a larger loss of output.) Group B let their rates of inflation run up to ten percent or more, but not more than 18 percent; these countries were otherwise like group A. They cut their inflation rates in half, and persisted for at least three years. Group C fell short by one or the other of these criteria: either their inflations never exceeded nine percent (rounded) or they didn't cut them in half, or they didn't persist for as long as three years. One of these countries, Germany, did cut its inflation rate in half and did persist for three years, but did so from a starting point, i.e. a peak inflation rate, of only seven percent. All of them had peak rates of inflation in 1973, 1974, or 1975, and then reduced rates for at least one year. Of the ten countries in this group, six had declining rates, or rates below the earlier peak, for at least three years. Hence we may call this the group that dithered; it includes the U.S.

Summary data for the three groups appear in Table 1. Group A has eleven countries, group B has six, and group C has ten. Many countries lost some output during the acceleration phase of their inflation; that is, they had a peak in their indices of industrial production prior to the peak in their rates of inflation. However, this type of loss was concentrated among the countries of group A; only three countries among those in the other two groups had such a loss. This point reflects the endogenous nature of the observed rate of inflation: if expectations of inflations outrun aggregate demand, inflation is higher than it otherwise would be, and output is lower. (Alternatively, one could view the observed rate of inflation as a random variable. Either way, for given aggregate demand, the higher it is, the lower real output will be.) The average loss during accelerating inflation was six percent in group A, and only about one percent each in groups B and C.

After the peak of inflation, the group A countries lost an average of 4.3 percent of their industrial production relative to its peak or its value at the time of peak inflation. The group B countries lost an average of 6.0 percent, and those of group C lost an average of 5.5 percent. The lower loss for the group A countries is not surprising in the light of the loss they had already suffered while inflation was accelerating, and follows fairly directly from the interpretations offered in the preceding paragraph. The losses for groups B and C are close to be almost indistinguishable, even though group B brought down its rates of inflation by an average of nine points, from thirteen to four percent, whereas group C brought down its rates by an average of only about five points, from 13.9 to 8.7 percent. These data suggest that the countries of group C gained practically nothing by dithering, compared to group B. (The point is reinforced by comparison with group A, but the comparison is suspect because of the possible reasons, already noted, for the high peak inflation rates in group A.)

Although these comparisons are suggestive, we must remember that production and the rate of inflation are jointly determined at the intersection of aggregate demand and supply. The casual comparison between groups B and C of the preceding paragraph would be acceptable if all the differences between these groups reflected differences in their management of aggregate demand, and nothing else. If it is unsafe to assume so in the comparison of group A and the others, it is also unsafe to assume so in the comparison between groups B and C.

Because output and inflation are jointly determined, and because shifts of aggregate supply (i.e. of the Phillips curve) are likely to have been an importante part of the picture, it is wise to try to separate the influences of various variables in aggregate demand and supply. For a large array of countries data are available on public revenues and spending, as well as on the quantity of money, the price level, industrial production, and gross domestic product (or GNP). Viewing the last two mentioned variables as alternates, all these variables enter into the aggregate demand functions. In as much as the aggregate supply functions represents the same phenomena as does the Phillips curve, its principal variables are output, the rate of inflation, and the expected rate of inflation. (This third variahle used to be controversial, but has now gained very general acceptance; henee I use it without further ado.) The expected rate of inflation may depend on current values of the variables that drive aggregate demand, and, to the extent that expectations are in any sense adaptive, on past values of all observable variables. With accurate specification of the aggregate demand function, the previous period's location of its aggregate supply schedule is indicated by its point of erossing with aggregate demand, i.e. by either the previous period's rate of inflation or its output. Any dependence of aggregate supply on lagged variables should therefore by be sufficiently represented by "lagged variables".

These preliminary thoughts serve as a prelude to the specification of a two—equation system, aggregate demand and supply. In textbook presentations, both are commonly presented with income (output) on the horizontal axis and with the price level on the vertical axis. In the case of aggregate supply, we have already noted in effect that the appropriate variable for the vertical axis is the rate of inflation. In the case of aggregate demand, one can derive the curve in terms of either the price level or the rate inflation. Simplicity and convenience dictate the use of the same variable for both curves, and hence the rate of inflation for aggregate demand as well.

The variables in the IS curve are the following:

output	y
public spending	x
tax revenues	T
autonomous consumption	a
autonomous investment	z_0
the real interest rate	r

The variables in the monetary sector (the LM curve), besides output are the following:

the nominal stock of money	M
the real stock of money	m
the price level	p
the nominal interest rate	i

To obtain a relation involving the rate of inflation, we must first specify the monetary sector more exactly, as follows:

$$m = \frac{M}{P} = L\,(i, y)$$

Although the money stock M has been found to be endogenous in the U.S., and is no doubt endogenous in several other countries, this attribute has not been shown to be of great importance for the estimation of parameters and lags in macromodels of the economy. Where the variations in M are quite large in the data, it is reasonable to suppose that the autonomous parte of the variation greatly outweighs the part dependent on current fluctuations in y and i (in the supply function of money). We will therefore take advantage of the great convenience offered by assuming that M is entirely autonomous.

Using the definition of the real stock of money, we may write the identify in current and lagged values of the monetary and price variables.

$$\frac{m_t}{m_{t-1}} = \frac{M_t}{P_t} \cdot \frac{P_{t-1}}{M_{t-1}}$$

which gives

$$m_t = \frac{M_t/M_{t-1}}{P_t/P_{t-1}} \; m_{t-1} = L\,(i_t, y_t) \qquad (1)$$

The logarithmic form has proved satisfactory in consumption functions, investment functions, and the demand function for money, and has obvious advantages here. For small changes from period to period $\ln (M_t/M_{t-1}) = \mu$ is approximately the proportional rate of change in the nominal money stock, and $\ln (P_t/P_{t-1}) = \mu$ is approximately the rate of inflation.

A problem remains with T, which fluctuates with y when tax rates remain unchanged. However, most countries either have revenues dependent almost entirely on customs and excise or have a mixture of progressive and regressive taxes (as in the U.S.) so that T is approximately proportional to income. Any large variation in the ratio of T to GDP would surely be autonomous. Hence I treat this ratio $g = \frac{T}{GDP}$ as an autonomous variable.

Now, using the definition of the real of interest

$$r = i + \pi^e$$

where π^e is the expected rate of inflation, we can combine the IS curve with the revised LM curve (1) to eliminate the interest rate and obtain a curve relating income to the rate of inflation and to the listed autonomous variables.

$$\ln y_t = a_0 \pi_t + a_1 \ln a_t + a_2 \ln zo_t + a_3 \ln x_t + a_4 \ln g_t + a_5 \mu_t + a_6 \ln m_{t-1} + a_7 \pi_t^e$$

That is besides the rate of inflation and the variables representing autonomus spending, income depends on the rate of monetary expansion, on the lagged value of real cash balances, and on the expected rate of inflation. This equation ignores lagged mulplier effects, in the interest of simplicity. That is, it is written as if all multiplier effects of current autonomous spending worked themselves out fully in the current period. In the actual application, one must allow for the possibility of lags of several years. The same remark applies to the real balance variable, which along with the rate of monetary expansion indicates the position of the LM curve. If expected inflation is measured correctly, there should be no such lagged effects in its case; if there were, there would be a way to change the lag structure of the variables that determine them, until lagged expectations no longer have any effect in the equation. The natural way to define the current expectations variable is as follows: that weighted average of past (and current autonomous) variables such that the lagged expectations variable has no effect.

Aggregate supply has fewer variables; in the long run it is simply full employment real income and nothing more, if one assumes the classical tendency of each economy to return to that level of real income. Modern discussions of aggregate supply generally make it (or the Phillips curve) depend on the difference between the actual and expected rates of inflation, as well, in the short run:

$$y_t = f(\pi_t - \pi^e_t) + y_f$$

where y_f is the full–employment level of real income, which we can safely treat as a constant. This version is the accelerationist version, which by using y_f as shown incorporates the hypothesis of the natural rate of unemployment. For present purposes there is no need to insist on this point; we can instead write the more general form.

$$y_t = f(\pi_t, \pi^e_t, y_f)$$

and for estimation purposes the form

$$\ln y_t = \alpha_8 \pi_t + \alpha_9 \pi^e_t + \alpha_{10} \ln y_f \qquad (3)$$

Equations (2) and (3) form a two–equation system in the jointly determined variables y_t and π_t. By solving them for these two variables, we obtain the reduced forms

$$\ln y_t = \beta_0' + \beta_1' \ln a_t + \beta_2' \ln zo_t + \beta_3' \ln x_t + \beta_4' \ln g_t + \beta_5' \mu_t + \beta_6' \ln m_{t-1} + \beta_7' \pi^e_t \qquad (4)$$

$$\pi_t = \gamma_0' + \gamma_1' \ln a_t + \gamma_2' \ln zo_t + \gamma_3' \ln x_t + \gamma_4' \ln g_t + \gamma_5' \mu_t + \gamma_6' \ln m_{t-1} + \gamma_7' \pi^e_t$$

However, we still need an expression for the expected rate of inflation π_e, which we cannot measure directly. We have no data on nominal and real interest rates that could be used for this purpose; indeed, the real interest rates is just as elusive a concept as is the expected rate of inflation. With rational expectations, the expected rate of inflation would depend simply on the variables in aggregate demand: on the rate or monetary expansion, of course, but also in the short run on autonomous spending and on the level of real balances. With even the slightest lag in the system, for example that connected with two–year wage contracts, it would depend also on the previous year's rate of inflation. In more general terms, it can depend on lagged rates of inflation for several years, lagged real balances, lagged expansion of the money supply, and lagged autonomous spending, as well as on the current autonomous variables. However, there is some redundancy in this list, because lagged inflation, lagged real balances, and lagged nominal monetary expansion are related to each other by definition as in equation

(1). It follows that the list of variables in equations (4) is sufficient, when modified to include lags, to determine expected inflation.

We can present this point another way. Suppose we write a general adaptive expectations formula

$$\pi^e_t = \delta w_t + (1 - \delta)\, \pi^e_{t-1} \tag{5}$$

Where W_t is a weighted sum of the most recent available observations of autonomous and jointly variables. For given values of the autonomous variables, if equations (4) are known one can know the value of the previous period's expected rate of inflation simply by putting in the observed lagged value of output or inflation, lagged values of the other values, and solving for it. Because of the noted difficulty with using lagged inflation, we use the first of the two equations (4) for this purpose, substituted into (5), to give

$$\pi^e_t = \delta w_t + (1-\delta)\, w'_{t-1} \tag{5'}$$

where w'_{t-1} is a distinct and different weighted sum of lagged autonomous variables and lagged output; w'_{t-1} includes all these variables because (5') depends both on aggregate demand and on aggregate supply, through (4).

Accordingly, we obtain the form

$$\ln y_t = \beta_0 + \beta_1 \ln a_t + \beta_2 \ln zo_t + \beta_3 \ln x_t + \beta_4 \ln g_t + \beta_5 \mu_t + \beta_6 \ln m_{t-1} + \beta_7 \ln y_{t-1}$$

$$\pi_t = \gamma_0 + \gamma_1 \ln a_t + \gamma_2 \ln zo_t + \gamma_3 \ln x_t + \gamma_4 \ln g_t + \gamma_5 \mu_t + \gamma_6 \ln m_{t-1} + \gamma_7 \ln y_{t-1} \tag{6}$$

where each of the terms is to he understood as a lag polynominal in the indicated and lagged values of the variable. For example, the term $\beta_1 \ln a_t$ should be interpreted as

$$\beta_{10} \ln a_t + \beta_{11} \ln a_{t-1} + \beta_{12} \ln a_{t-2} + \ldots$$

In the application of equations (6) to data on the experience of various countries since World War II, we have two further problems. One problem is that we do not have data on autonomous consumption spending and and autonomous investment spending. Shifts in these two variables contribute shocks to the system, just as do the monetary and fiscal variables; to omit them is a misspecification. However, this is one instance where in the nature of the case the misspecification can be readily dealt with. Autonomous private spending is uncorrelated with the monetary and fiscal variables because it is autonomous. Hence the coefficients of these variahles remain unbiased. If, as we must suppose, autonomous private spending is serially correlated, its omission will bias the coefficientes of lagged dependent variables towards one, and perhaps increase the number of significant lags of the dependent variables. (Without this effect, our analysis suggests only a single lag for the dependent variable). Hence its effect is to overstate the length of the lags and the persistence of output changes due to the other variables. We take up this effect further below.

The second problem is that the lag structures are likely to differ from country, and there are not enough data to estimate a separate lag structure for each one. (The lag structure may also change from one time to another in each country). This fundamental specification problem means that we cannot take tests of significance quite so seriously as we might in a context in which we feel more sure about the correctness of specification and homogeneity, by countries, of the structure being estimated. We must bear in mind that note of caution, when we proceed to consider what the data show in a descriptive way about the experiences of these countries.

A further point of specification concerns the questions we would like the data to answer for us. Equation (6) as stated permit us to estimate the time lags of the effects of restrictive policy on output and inflation, for a given policy mix. However, with no further non–linearities than those implied by the logarithmie form of the equations, we cannot test hypotheses about alternative specifications. In particular, it is interesting to ask whether twice as restrictive a policy has twiee as big an effect on output (in logarithmic terms), or more or less than twice as big an effect. The simplest way to check on that is to put nonlinear terms in the regressions designed to show scale effects of this kind. Preliminary runs showed that a restrictive monetary policy partly affects real balances and partly effects the rate of inflation in the first year, so that a nonlinearity variable for monetary expansion should be paired with a corresponding nonlinearity variable for real balances. To discriminate symmetricaly between large and small policy changes for both expansionary and restrictive policies, I used the cube root of the change in the rate of monetary expansion and of the growth of real balances. (In the case of the growth of real balances, I took the cube root of deviations around an average rate of growth.) The cube–root variable with a positive coefficient gives a low weight to large changes, relative to the original unretouched variable. Introduction of this type of variable alongside the other permits the data to answer our question about policy scale effects for the countries and years in the sample.

The data permitted using up to three years of lagged values of all variables, plus country dummies and country trends. To allow for possible esoteric lag structures of omitted variables, I included three years of lagged output, even though we had a clear case for only one year in our specifica tion discussion. Inasmuch as I started with ten years of data (the 1970's) for most countries, and have a total of thirty-three countries, even after deleting several years because of the use of lagged variables (and also because of missing data), I have 217 data points in the regressions.

In the course of preparing these regressions I considered the likely possibility that there would be predictable differences in the lag structures and in monetary and fiscal effects among countries. A natural hypothesis that came to mind was that the highly industrial countries would differ from the less developed ones. Indeed, when I did separate regressions for the two groups of countries (using the IMF classification in *International Financial Statistics*) the coefficients appeared notably, perhaps significantly different. Paradoxically (it seemed to me) the less–developed countries had strong Keynesian fiscal effects whereas the developed countries had none. Other coefficients differed as well. However, the Chow test was not only insignificant, but its F–ratio was less than one. This result indirectly points to the high collinearity in the data.

A group of coefficientes with significant individual t ratios can easily fail an F test for the group as a whole. Hence the details of the lag structure are untrustworthily, even apart from the doubts about it mentioned earlier. Of more interest is the question whether the lagged effects of policy implicit in the data are robust with respect to specification; they could be despite the problem of collinearity.

The remaining question to be dealt with is the treatment of serial correlation. Preliminary regressions in the logarithms of production, real balances, and so on produced significant coefficientes for several lagged values of the dependent variables. For this case there is no established method of correcting for serial correlation in the residuals (which was present and, surprisingly, was negative). I would expect autonomous investment and consumption, excluded from the regressions, to have strong positive serial correlation, possibly near one for adjacent values; high serial correlation is commonplace among economic variables. This consideration would suggest taking first differences. In addition, the nonlinear cube root variables just described are easily formulated and applied in the first differences, whereas they would be extremely cumbersome for the original logarithms or for any autoregressive process other than first differences. As it turned out, the residuals of the first difference regressions showed no sign of serial correlation. Therefore, I present the first difference regression as my principal results.

Two measures of production were available: real gross domestic product, and industrial (or manufacturing) production. The disadvantages of real gross product are that its variance around trend is relatively small, and that its variance includes agricultural output and other sectors whose output moves independently of general business conditions. Preliminary regressions suggest that in fact the effects of restrictive policy are marked by these other influences. Therefore, my principal results are those for the first differences of industrial production. However, I plan to check the effect of changes in specification to see whether these change the results for DGP.

The principal regressions apperar in Table 2, showing the coefficients for changes in industrial production and in inflation as funcrions of the indicated independent variables. Coefficients of lagged industrial production in the regression for industrial production are negative and sum to about −0.5. Hence, if production is disturbed by a random shock, in the next three periods it tends to return half way to its original value. (That they do not sum to minus one may reflect positive serial correlation in the first differences of the omitted variables. However, the lack of complete self—correction may simply reflect the basic macroeconomic proposition that the return to equilibrium requires corrective movements of other variables, such as real balances.) The fiscal variables have the expected sign in this regression, giving Keynesian effects on output. The nonlinearity variable for real balances is significant with three lags, although the nonlinearity variables for nominal cah was insignificant for every lag.

These results by themselves do not answer questions about the lagged effects of policy changes. Besides the lagged effects shown directly in the regression equations, there are feedback effects through lagged real balances, which in the current period are endogenous. For our purposes there is no point in estimating structural coefficients of aggregate demand and supply (e.g. by two–stafe least squares). What we must do is use the coefficients to trace through from period to period the effects of a specified policy package, convoluting as needed the interactions between real balances and output. Because the fiscal variables had small effects on inflation, of mixed and partly perverse signs, I concentrated this phase of my analysis on monetary restriction.

The monetary restrictions I considered were a fixed reduction in the rate of growth of the nominal money stock, starting from an initial set of values for all variables that were consistent with "equilibrium", i.e. that according to the coefficients of the regressions could be maintained indefinitly. The regression in Table 2 is nonlinear because of the cube root variable mentioned earlier. Hence for this regression I show the effects of a five percent monetary cutback and a fifteen percent cutback, to bring out the nonlinear effect.

Figure 1 shows the results using the regression in Table 2 convoluted with the corresponding regression for real balances, implied by that for inflation. The lower half of Figure 1, using the regressions from Table 2, shows the biggest gap in production relative to trend in years 3–4 for both policies. Output is about 3.5 percent below trend in those years for the five percent cutback in money growth and over 8 percent below trend for the fifteen percent cutback. The latter effect is just over double the former. Output does not converge readily to the trend line; moreover, the results for years five and six are very sensitive to small changes in the coefficients, and are not shown.

The upper half of Figure 1 shows the reduction in the rate of inflation associated with each of the reductions in money growth. With the five percent cutback inflation falls by more than four percentage points by year three, two years after the cutback, and falls almost one more percentage point the following year. With the fifteen percent cutback inflation falls by about thirteen percent by year three and then overshoots, falling to 15 percentage points below the starting level in year four. This result, which one can see easily in the individual country data, reflects the demanda for real balances. During the monetary squeeze in years one and two, real balances fall appreciably when inflation, though declining, remains higher than the rate of monetary expansion. The cumulative loss of real balaoces is about fifteen percent. After year four a small part of the los real balances is restored. For both cutback inflation eases downward over a period of four years (including the year of the curback), even though the cutback itself is not gradual.

Similar regressions using real gross domestic product produced the coefficients shown in Appendix Tables. The lag structures are similar to those in Table 2, though different in detail. The reference rate of growth of industrial output chosen was five percent annually, but was 3.3 percent for DGP. The discussion of regressions coefficients for monetary effects and fiscal effects is unchanged; the same comments given earlier with respect to other regressions apply also in this case. The corresponding simulated lagged effects of a cutback of monetary expansion are shown in Appendix Figure 2.

It is particularly noteworthy that the time path of ajustment of output depends on whether or not one uses first differences in the regressions. (Compare Figure 2, Appendix, with Figure 1). This aspect of the results suggests that the specification problems discussed earlier are serious in their effects on the issues raised in this paper. The results can be taken as reasonable estimates of what can be expected to happen in economies that have adjusted to rates of inflation in the range from eight percent to fifty percent or so. It is not a reliable way to estimate the continuing effects after the first four years or so, because their is so little experience of that in the data. Also, by then it must be expected that the way people would form expectations, and consequently would write contracts and make other adjustments, would change so that the lag structures would change from those shown in the present data. Therefore I see no point in trying to estimate longer lag structures than the ones I used.

The procedure of using the regression coefficients in the manner indicated tells us something about what happened in those countries that cut back their rates of money growth in our data set.

During the late 1960's and early 1970's inflation accelerated in most countries and then, frequently, had episodes of falling back more or less shaply. Whatever rules or policy formulas governments had relating monetary and fiscal policy to the states of their economies evidently changed during the accelerating phase up to about 1974, and the new formulas involved more volatility of the rate of monetary expansion than before. It would appear that some of the changes in money growth were unpredictable, if expectations were rational.

The results of our procedure have predictive value in the following sense: so long as the lag structures remain the same, the same effects on output will accompany a restrictive policy episode. Those economists who believed in stable lag structures should have had, and mostly have had, their belief somewhat shaken in the past ten years. Recent published papers by Lucas[4] say that the lag structure should change in such a way, when a government's policy rule or formula changes, that there will be no effect on output. However, policy episodes that include an unpredictable elemental will affect output. Supposing their models to be perfectly accurate representation of real economies, we can say nertheless that if government policy rules and formulas remain unchanged, policy episodes similar to those that ocurred in our data set will occur again from time to time, and when they do they will have the same real effects again (plus new random influences from the same probability distributions) that they had in the years covered in our sample. Our procedure shows what to expect in this context.

As a further elaboration of this point, we can usefully follow Sargent's distinetion between the government's policy rule or formula ("regime") and policy innovations. The former is a feedback rule making current monetary and fiscal variables functions of past values of output, unemployment, inflation, and possibly others. For the moment, suppose that such rules

[4]R.E. Lucas, Jr "Econometric Policy Evaluation: A Critique" in Karl Brunner and Allan Meltzer (eds). *The Phillips Curve and Labor Markets* (Amsterdam, 1976).

remained unchanged in the data set. Policy innovations are random changes in the monetary and fiscal variahles, i.e. are uncorrelated with the value of the feedback function, yet do not represent changes in the function. The past values of the main endogenous variables that enter into a feedback rule, such as output and inflation, are express by or implicity included in our regressions. Inasmuch as the regression coefficient of each variable shows the effect of a change in that variable that is independent of all other variables in the regression, including those in the feedback rule, the regression coefficient for a policy variable shows the effect of an innovation in that variable. (There may be variables not included in our regressions that enter into a feedback rules; if so, the regression coefficient for each policy variable shows the effect of a mixture of policy variation driven by the excluded variables and of policy innovation.) The coefficients correctly predict the effects of a given change in a policy variable to the extent that, and for as long, as households and firms perceive no change in the current feekback rule.

Now relax our supposition that policy feedback rules remained unchanged in the data set. The majority of the countries in our sample had sharp, prolonged cutback in money growth and inflation. We shall discuss shortly whether the private sectors in those countries perceived the cutbacks as changes in feedbacks rules. If they did, the regression coefficients of policy variables include private sector reactions to such perceptions in their mixtures of effects. Indirect evidence of perceived rule changes comes from the nonlinear effects, which plausibly suggest that private sectors viewed large changes in money growth as having a larger proportion of change in feedback rules, compared to small changes in money growth. Also, the dampening out after year 3 of effects on real output of both large and small sustained cutbacks in money growth suggests a progressing shift of public pereeption of the feedback rule, or the equivalent. Otherwise there would be no dampening: the aggregate supply curve (or the Phillips curve) would not budge and output would remain on a lower trend line. These indications strongly suggest that there were perceived changes of feedback rules within the data set, in the eountries that had sustained cutback of money growth, dampening out the real effeets of the cutback within five or six years. This delay was presumably shorter than our calculations show because of the bias, mentioned earlier, due to the omission of autonomous private spending. For large cutbacks, the dampening stated within a year after the cutback, in the sense that the output drop was less than proportional, in comparison with a small cutback. For a similar cutbacks, with similar antecedents and fanfare, it is reasonable to expect similar effects, but shorter—lived because of the indicated bias. (This caveat presumes that the effects of sustained changes in autonomous spending on real output are less rapidly damped than are the effects of sustained policy innovations. If the damping —the speed of change of expectations— is the same for both types of changes, there is no bias.)

TABLE 1

SUMMARIES BY COUNTRY GROUPS
AVERAGES

Group	N° of Countries	Years of Disinfl'n	% Loss from Peak Prod'n in Accel'n	% Loss from Peak Prod'n in Disinfl'n	Max. Infl'n	Min. Subseq. Infl'n
A	11	4.1	6.0	4.3	26.5	3.8
B	6	4.3	0.7	6.0	13.0	4.0
C	10	2.9	1.1	5.5	13.9	8.7

TABLE 2

REGRESSION COEFICIENTS FOR INDUSTRIAL PRODUCTION
FIRST DIFFERENCES

Dependent variables		Industrial production		Rate of inflation	
INDEPENDENT VARIABLES					
Δ Industrial Production	(–1)	– .137	(.066)	–	–
" " "	(–2)	– .185	(.062)	–	–
" " "	(–3)	– .116	(.061)	–	–
Δ Real Balances	(–1)	–	–	.803	(.125)
" " "	(–2)	– .239	(.115)	.275	(.058)
" " "	(–3)	.323	(.109)	–	–
(Δ Real Balances) 1/3	(–1)	.539	(.098)	– .377	(.242)
" " "	(–2)	.363	(.214)	–	–
" " "	(–3)	– .384	(.210)	–	–
Δ Money Growth	(Curr.)	.046	(.042)	.383	(.050)
" " "	(–2)	.131	(.056)	– .131	(.050)
Δ Real Public Expend	(Curr.)	.140	(.042)	– .241	(.041)
" " " "	(–1)	–	–	– .061	(.048)
" " " "	(–2)	–	–	– .120	(.038)
Δ Tax Share of GDP	(Curr.)	– .089	(.038)	–	–
" " " " "	(–1)	–	–	.054	(.042)
" " " " "	(–2)	–	–	–	–
" " " " "	(–3)	– .054	(.029)	–	–
Year 73		.034	(.032)	– .087	(.039)
Year 74		– .019	(.012)	.051	(.013)
Year 75		– .062	(.013)	–	–
R^2		.64758		.52346	

APPENDIX

TABLE A – 1

REGRESSION COEFFICIENTS FOR REAL GROSS PRODUCT (EQUATION 6)

Independiente Variables		Regression Coefficient	Standard Error of Coefficient
Real GDP	(–1)	.238	(.068)
" "	(–2)	– .163	(.068)
" "	(–3)	– .131	(.068)
Real Balances	(–1)	.126	(.033)
" "	(–2)	– .163	(.032)
" "	(–3)	–	–
Money Growth	(Curr.)	–	–
" "	(–1)	– .106	(.037)
" "	(–2)	–	–
" "	(–3)	–	–
Real Public Expend.	(Curr.)	.139	(.030)
" " "	(–1)	.083	(.032)
" " "	(–2)	.104	(.020)
" " "	(–3)	.100	(.027)
Tax Share of GDP	(Curr.)	– .101	(.028)
" " " "	(–1)	– .043	(.031)
" " " "	(–2)	– .064	(.026)
" " " "	(–3)	– .106	(.025)
R^2		.99457	

Notes:

[1] All variables are in logarithms. For inflation the variables is $Ln(P_t/P_{t-1})$, and for money growth it is $Ln(M_t/M_{t-1})$.

[2] Numbers in parentheses are standard errors of the coefficients, in the main part of the table.

[3] In the names of the independent variables, numbers in parentheses refer to lags. For example, Real GDP (–2) refers to Real GDP lagged two years.

[4] Each regression also had a country dummy for every country but one, and separate trends for every country, except that every variable whose coefficient was less than its standard error was deleted. The same rule applied to the variables listed above in the table.

TABLE A 2

REGRESSION COEFFICIENTS FOR REAL BALANCES AND INFLATION

Dependent variables:		Real cash balances		Rate of inflation	
Independent variables					
Real GDP	(–1)	– .221	(.089)	.207	(.092)
" "	(–2)	.394	(.094)	– .465	(.091)
" "	(–3)		–		–
Real Balances	(–1)	827	(.074)	.131	(.073)
" "	(–2)	– .462	(.092)	.477	(.092)
" "	(–3)	083	(.067)	– .115	(.066)
Money Growth	(Curr.)	.637	(.048)	.346	(.049)
" "	(–1)	– .225	(.069)	.242	(.069)
" "	(–2)	.198	(.069)	– .210	(.069)
" "	(–3)	.110	(.050)	– .075	(050)
Real Public Expend.	(Curr.)	.249	(.044)	– .227	(.044)
" " "	(–1)		–		–
" " "	(–2)	.090	(.041)	– .066	(.040)
" " "	(–3)	– .052	(.034)	.053	(.034)
Tax Share of GDP	(Curr.)	– .076	(.043)	.054	(.043)
" " " "	(–1)	– .123	(.040)	.122	(.041)
" " " "	(–2)	.059	(.039)	– .070	(.040)
" " " "	(–3)		–		–
R^2		.98743		.85871	

Notes:

[1] See notes to table A–1.

[2] Numbers in parentheses are standard errors of the coefficients, in the main part of the table.

TABLE A – 3

REGRESSION COEFFICIENTS FOR INDUSTRIAL PRODUCTION

Dependent Variable		Industrial production		Rate of inflation	
Independent variables					
Industrial Production	(–1)	.456	(.045)	–	–
" "	(–2)	–	–	– .272	(.071)
" "	(–3)	.200	(.038)	– .181	(.058)
Real Balances	(–1)	.324	(.047)	.120	(.067)
" "	(–2)	– .237	(.043)	.507	(.072)
Money Growth	(Curr.)	–	–	.285	(.050)
" "	(–1)	– .130	(.048)	.187	(.065)
" "	(–2)	–	–	– .248	(.060)
" "	(–3)	–	–	– .156	(.052)
Real Public Expend.	(Curr.)	.059	(.030)	– .140	(.043)
" " "	(–1)	– .057	(.030)	.185	(.040)
Tax Share of GDP	(–2)	–	–	– .114	(.024)
" " " "	(–3)	– .065	(.019)	–	–
R^2		.99537		.84775	

Notes:

[1] All variables are in logarithms. For inflation the variables is Ln (P_t/P_{t-1}), and for money growth it is Ln (M_t/M_{t-1}).

[2] Numbers in parentheses are standard errors of the coefficients, in the main part of the table.

[3] In the names of the independent variables, numbers in parentheses refer to lags. For example, Real GDP (–2) refers to Real GDP lagged two years.

[4] Each regression also had a country dummy for every country but one, and separate trends for every country, excpet that every variable whose coefficient was less than its standard error was deleted. The same rule applied to the variables listed above in the table.

TABLE A – 4

REGRESSION COEFFICIENTS FOR REAL GROSS PRODUCT
FIRST DIFFERENCES

Independent Variables		Real Gross Product		Rate of Inflation	
Δ Real GDP	(–1)	–	–	.220	(.102)
" " "	(–2)	– .231	(.060)	– .221	(.097)
" " "	(–3)	– .312	(.062)	(.184	(.097)
Δ Real Balances	(–1)	–	–	.800	(.124)
" " "	(–2)	– .122	(.046)	.292	(.062)
" " "	(–3)	.070	(.039)	–	
(Δ Real Balances)$^{1/3}$	(–1)	.183	(.083)	– .433	(.242)
Δ Money Growth	(Curr.)	.183	(.060)	.477	(.104)
" " "	(–1)	–	–	–	–
" " "	(–2)	.075	(.038)	– .154	(.050)
(Δ Money Growth $^{1/3}$)	(Curr.)	– .401	(.122)	– .230	(.212)
" " "	(–1)	– .100	(.072)	–	–
Δ Real Public Expend.	Curr.)	.172	(.031)	– .252	(.041)
" " " "	(–1)	.064	(.031)	– .078	(.049)
" " " "	(–2)	.055	(.030)	– .096	(.046)
" " " "	(–3)	.086	(.029)	–	–
Δ Tax Share of GDP	(Curr.)	– .144	(.029)	–	–
" " " " "	(–1)	– .059	(.027)	.085	(.046)
" " " " "	(–2)	– .035	(.026)	– .044	(.042)
" " " " "	(–3)	– .085	(.027)	–	–
Year 1973		–	–	– .074	(.039)
Year 1974		– .015	(.008)	.046	(.013)
Year 1975		– .033	(.009)	–	–
R^2		.56317		.55246	

Notes:

[1] The variable (Δ Real Balances)$^{1/3}$ has the following construction.

a) When the change in the logarithm of real balances is within 0.05 of the value 0.035, the value of the variable equals the change in the logarithm of real balances.

b) When the latter exceeds 0.085 or is less than –0.015, the variable equals the cube root of latter, adjusted by a constant such that the variable equals the latter, adjusted by a constant such that the variable equals the latter when it is precisely either o.085 or –0.015.

[2] The variable (Δ Money Growth)$^{1/3}$ is constructed in a manner parallel to that of (Δ Money Growth)$^{1/3}$, except that is centers on xero instead of 0.035.

[3] All other variables are first differences of those in Table 2.

[4] Country trends in the regression of Table 2 become constants in this one, and country dummies in that regression disapperar.

FIGURE 1

ESTIMATED EFFECTS OF MONETARY RESTRICTION FROM TABLE 2

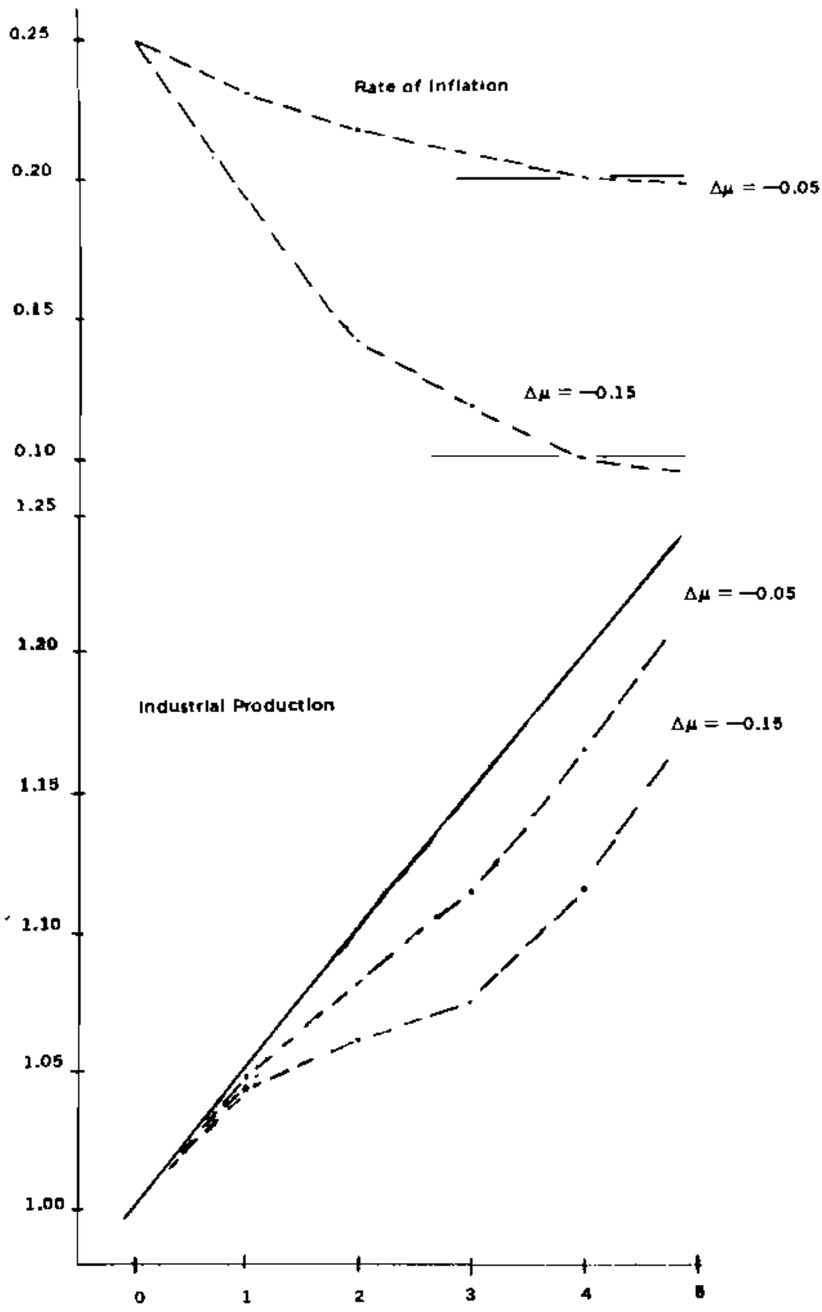

FIGURE 2

ESTIMATED EFFECTS OF MONETARY RESTRICTION FROM TABLE A – 3