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ABSTRACT

This paper presents a single reduced-form inflation equation that can explain both the variance and acceleration of inflation during the 1970s. Inflation is explained by four sets of factors. Aggregate demand enters through the lagged output ratio and the growth rate of nominal GNP. The adjustment of inflation to changes in aggregate demand is limited by the role of inertia in the inflation process, expressed as the dependence of the rate of change of prices on its own past values. Two types of supply-side elements enter. Government intervention directly altered the price level during the Nixon control era, and in addition the government has aggrevated the inflation problem by what have been called "self-inflicted wounds," including increases in the effective social security tax rate and effective minimum wage. Also there have been external supply shocks that are outside of the immediate control of the government, including changes in the relative prices of food and energy, changes in the growth rate of productivity, and changes in the foreign exchange value of the dollar.

Considerable attention is given to alternative methods of estimating the impact of direct episodes of government intervention in the price-setting process, particularly during the Nixon controls. We find that such episodes have been futile. Because of their futility, these intervention episodes can be regarded as "self-inflicted wounds," like the payroll tax and minimum wage changes that normally are described by this term.

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While the inflation experience of the U. S. between the end of the Korean war and the end of the decade of the 1960s can be explained adequately by a conventional Phillips curve approach, the high variance and continued acceleration of inflation during the decade of the 1970s pose new challenges to the time-series econometrician. Why did inflation continue to speed up from about 5 percent in early 1971 to 10 percent in early 1980, despite an average ratio of actual real GNP to "natural" real GNP (hereafter the "output ratio") that was below its average level of the 1950s and 1960s? And why was inflation so variable, falling from an annual rate of 5.3 percent in the first half of 1971 to 3.0 percent in the middle two quarters of 1972, then rising to 11.7 percent in the last half of 1974, then falling to 4.2 percent in the first half of 1976, and finally rising to 10.1 percent in the first quarter of 1980?[1]

This paper presents a single reduced-form inflation equation that can explain both the variance and acceleration of inflation during the 1970s. It can be regarded as a sequel to an earlier paper that fit a similar inflation equation to a long period of historical annual data for the period 1892-1978.[2] It applies the same basic specification to quarterly data for the 1954-80 period and devotes more attention to supply-side variables that have particular relevance for the recent behavior of inflation. Inflation is explained by four sets of factors. Aggregate demand enters through the same variables as in the earlier study, the lagged output ratio and the growth rate of nominal GNP. The adjustment of inflation to changes in aggregate demand is limited by the role of inertia in the inflation process, expressed as the dependence of the rate of change of prices on its own past values. Two types of supply-side elements enter. Government intervention directly altered the price level during the Nixon control era, and in addition the government has aggravated the inflation problem by what have been called "self inflicted wounds", including increases in the effective social security tax rate and effective minimum wage. Also there have been external supply shocks that are outside of the immediate control of the government, including changes in the relative prices of food and energy, changes in the growth rate of productivity, and changes in the foreign exchange value of the dollar.

Thus the main themes of the paper are that inflation cannot be explained simply as the result of excessive demand stimulation, or of a single type of supply shock, or of inertia by itself. Considerable attention is given to alternative methods of estimating the impact of direct episodes of government intervention in the price-setting process, particularly during the Nixon controls. We find that such episodes have been futile. The Nixon-era controls temporarily held down the price level and then allowed it to bounce back to its "no-controls" level, thus contributing to the instability of both inflation and real output. Other episodes of intervention--the Kennedy-Johnson guidelines and Carter pay standards--had no effect at all on the inflation process.

Because of their futility, these intervention episodes can be regarded as "self-inflicted wounds", like the payroll tax and minimum wage changes that normally are described by this term of opprobrium. Although space limitations prevent us from assessing the full range of policy alternatives that face Washington policymakers, it seems clear that there are enough degrees of freedom in the inflation process to allow creative policies to heal the wounds and to offset the unavoidable impact of external supply shocks.

I BASIC SPECIFICATION OF THE REDUCED-FORM INFLATION EQUATION

We begin from a pair of wage and price equations and combine them to obtain our basic reduced-form equation that is used for estimation below. The rate of wage change depends on the sum of lagged price change and the desired rate of real wage growth, on the level and rate of change of the output ratio, and on supply shifts that affect the wage-setting process. The rate of price change relative to the current rate of wage change depends on the change in "standard" productivity, the level and rate of change of the output ratio, and on supply shifts that affect the price-setting process. When these two equations are combined, we obtain:

$$(1) \quad p_t = \gamma_0 p_{t-1} + \gamma_0(\lambda_t - \sigma_t) + \gamma_1 \hat{Q}_t + \gamma_2 \hat{q}_t + \gamma_3 z_t + \varepsilon_t,$$

where upper-case letters designate logs of levels of variables and lower-case letters designate their proportional rates of change. Equation (1) states that the inflation rate (p_t) depends on past inflation (p_{t-1}), the difference between the desired rate of real wage growth in the wage equation (λ_t) and the rate of "standard" productivity growth relevant for price-setting decisions (σ_t), the level of the output ratio ($\hat{Q}_t$), the rate of change of the output ratio ($\hat{q}_t$), and a vector of supply shift variables (z_t), and an error term (ε_t).[3]

What are the conditions necessary for (1) to generate a constant equilibrium rate of inflation? First, the coefficient on lagged price change (γ_0) must be unity. Second, the real wage term in the wage equation and standard productivity growth in the price equation must be equal ($\lambda_t - \sigma_t = 0$). Third, the level and rate of change of the output ratio, as well as every supply shift variable, must also be equal to zero ($\hat{Q}_t = \hat{q}_t = z_t = 0$). Correspondingly, (1) lays out those events that can cause the inflation rate to accelerate, including an excess of λ_t over σ_t, a level of the log of the output ratio above zero, a positive rate of growth of the output ratio, and any adverse supply shock. Clearly $\hat{Q}_t = 0$ (i.e., $Q_t = Q_t^*$), represents the "natural rate of output" only if all of the other conditions stated in the previous sentence are valid. If there is, for instance, an adverse supply shift ($z_t > 0$), inflation can accelerate even if $\hat{Q}_t = 0$. In other words, an excess of λ_t over σ_t or a positive realization of any z_t variable. pushes the "constant inflation" level of output below the value of Q_t^* from which $\hat{Q}_t$ is calculated. Thus the framework of equation (1) has the potential of explaining why inflation accelerated during the 1970s, despite the fact that our measure of $\hat{Q}_t$ was negative on average during the decade.

There is one rather subtle obstacle to the estimation of (1). We would expect the rate of inflation to respond positively to the speed of economic expansion, $\hat{q}_t$. But there are two reasons why p_t and $\hat{q}_t$ may have a negative correlation that results in a downward bias in the coefficient γ_2. One reason is measurement error; since nominal GNP and prices are measured independently, with real GNP as a residual, any error in the measurement of prices introduces an opposite movement in $\hat{q}_t$. Second, for any given growth rate of nominal GNP, a supply shock ($z_t > 0$) raises p_t and reduces $\hat{q}_t$; any errors in measurement of the z_t variables may introduce a spurious negative correlation between p_t and $\hat{q}_t$. To avoid this problem we use the identity $p_t + \hat{q}_t = \hat{y}_t$, where the latter variable stands for the excess of nominal

GNP growth over the growth in natural real GNP ($\hat{y}_t = y_t - q_t^*$). When this identity is substituted for $\hat{q}_t$ in (1), we can factor out p_t and obtain our final estimating equation:[4]

$$(2)\quad p_t = \frac{1}{1+\gamma_1+\gamma_2}[\gamma_0 p_{t-1} + (\gamma_1+\gamma_2)\hat{y}_t + \gamma_1 \hat{Q}_{t-1} + \gamma_0(\lambda_t - \sigma_t) + \gamma_3 z_t + \varepsilon_t].$$

(2) is the form for which we provide estimates in this paper. We must, of course, specify the productivity term ($\lambda_t - \sigma_t$) and the exact variables to represent the supply shock terms (z_t). We note that the long-run equilibrium properties of (2) differ slightly from those of (1). If the sum of coefficients on lagged prices in (1) is unity ($\gamma_0 = 1$), then in (2) it will be the sum of the coefficients on lagged prices and on $\hat{y}_t$ that equal unity.

II TWO UNICAUSAL APPROACHES

Before the details of the basic inflation equation are discussed and results presented, we first provide estimates of two simpler equations that stress single-cause explanations of inflation. In recent years considerable attention has been given to autoregressive integrated moving average (ARIMA) models, and an early evaluation of the Nixon controls program by Edgar Feige and Douglas Pearce used this technique. A pure ARIMA model explains inflation entirely by its own past values. The ARIMA model thus represents an extreme view that the inflation process is entirely dominated by inertia and is unaffected by changes in current exogenous variables. Nevertheless, an ARIMA price change equation provides an interesting standard of comparison for our more complete specification.

Another unicausal approach is a simple monetarist equation that makes the rate of change of prices depend only on a distributed lag of past changes in the money supply. While this framework is taken more seriously by journalists and laymen than academic economists, a "money only" explanation of inflation is implicit in some recent tests of the classical equilibrium approach to macroeconomics.[5] Like the ARIMA technique, the money-only approach allows for inertia in the inflation process if it allows past changes in money to affect current inflation with a long distributed lag. We use the ARIMA and money-only equations to provide an alternative estimate of the effect of the Nixon price controls.[6] Dummy variables are added to both equations for two separate periods, one when the control effect was "on" between 1971:Q3 and 1972:Q4, and a second between 1974:Q2 and 1975:Q1 when the termination of the controls created an "off" effect.[7] Columns (1) and (2) of Table 1 display the resulting coefficients on the dummy variables and the summary regression statistics. Both the ARIMA and money-only models fit the data for the 1954-80 period with similar standard errors of about one percentage point.[8] The Nixon controls dummy variables are scaled to show the cumulative impact of the controls on the price <u>level</u> during the appropriate period, and thus their coefficients in both columns (1) and (2) indicate that the controls held down the price level by about 3 percent at the end of 1972, while their termination allowed the price level to bounce back to roughly its no-controls level.

An alternative method of assessing the impact of controls is to compute a post-sample dynamic simulation of an equation estimated to the pre-controls period and treat it as an estimate of inflation in the counter-factual state.[9] Line 14a and 14b of Table 1 show the post-sample simulation errors of an equation estimated for 1954:Q2 to 1971:Q2. The post-sample ARIMA extrapolation cannot

TABLE 1

Measures of the Impact of Nixon-era Wage and Price Controls
Using Alternative Models of the Inflation Process
for the Period 1954:Q2-1980:Q2 a/

		ARIMA Model b/	Money-Only Model	Comprehensive Reduced-Form
		(1)	(2)	(3)
1.	Lagged Inflation c/	----	----	0.94 (17.42)
2.	"On" Dummy d/ 1971:Q3-1972:Q4	-3.14 (-2.99)	-3.31 (-4.68)	-1.45 (-3.18)
3.	"Off" Dummy d/ 1974:Q2-1975:Q1	2.46 (3.40)	3.07 (5.07)	1.52 (2.53)
4.	Current and Lagged M1B e/	----	1.46 (21.8)	----
5.	Lagged Output Ratio ($\hat{Q}_{t-1}$)	----	----	0.23 (4.79)
6.	Adjusted Nominal GNP Growth ($\hat{y}_t$)	----	----	0.17 (6.74)
7.	Food and Energy Prices	----	----	0.29 (4.21)
8.	Productivity Deviation f/	----	----	-0.38 (-5.91)
9.	Effective Exchange Rate f/	----	----	-0.09 (-3.33)
10.	Social Security Tax f/	----	----	0.43 (2.19)
11.	Effective Minimum Wage Rate f/	----	----	0.021 (1.47)
12.	Constant	0.16 (1.42)	-1.42 (-5.43)	-0.03 (-0.18)
13.	a. S.E.E.	1.15	1.05	.646
	b. D.W.	2.07	1.60	2.22
14.	Cumulated Errors from Dynamic Simulation within Specified Intervals g/			
	a. "On" 1971:Q3-1972:Q4	-1.93	-3.46	-1.23
	b. "Off" 1974:Q2-1975:Q1	5.28	4.09	3.08

Numbers in parentheses are t statistics.

Notes to Table 1

a. The dependent variable is 400 times the quarterly first difference of the log of the fixed weight GNP deflator.

b. The coefficients in column (1) are estimated in a regression equation in which all variables are pre-filtered as described in the text.

c. The coefficient shown is the sum of 24 distributed lag coefficients constrained to lie along a fourth degree polynomial with a zero end constraint.

d. The dummy variables are constrained to add up to 4.0 (reflecting the conversion of quarterly changes of all variables to annual rates). Thus the "on" dummy is equal to 2/3 for the six quarters listed, and the "off" dummy is equal to 1.0 for the four quarters listed.

e. The coefficient shown is the sum of 28 distributed lag coefficients constrained to lie on a fifth degree polynomial with zero end constraint.

f. The coefficient shown is the sum of a set of unconstrained coefficients on current and lagged values, with four lags included on lines 8, 10 and 11, and two lags included on line 9.

g. The equation represented by each column is re-estimated for the period 1954:Q2-1971:Q2 and dynamically simulated beginning 1971:Q3. In column (3) estimation is subject to the constraint that the sum of coefficients on adjusted nominal GNP growth and lagged inflation equals 1.

explain why inflation in 1974 was so rapid, while the money-only equation yields simulation errors that are roughly similar to the coefficients on the dummy variables. This difference is to be expected, since the post-sample simulations of the money equations use information on the money supply during controls but the ARIMA dynamic simulation uses no information beyond 1971:Q2.

III SPECIFICATION AND RESULTS FOR THE BASIC EQUATION

The third column of Table 1 presents estimates of our basic equation as specified in (2) above. A line by line discussion of our variables and results follows:

1. *Lagged Inflation.* The inertia in the inflation process is captured by a distributed lag on 24 past values of fixed weight GNP deflator inflation. Because the explicitly temporary effects of the controls program should not enter this measure of inertia, the estimated controls effects are removed from the lagged dependent variable, requiring iterative estimation. This procedure reduces the standard error of the equation and increases the estimated impact of both the imposition and removal of controls. The 24 lag coefficients are constrained to lie along a fourth degree polynomial with a zero end constraint, and their sum, 0.94, is reported on Line 1 of Table 1.

2. and 3. *Nixon Control Dummies.* The Nixon controls program is estimated to have held down prices 1.45 percent at the end of 1972, but this effect was more than cancelled by the rebound inflation of 1.52 percent. The estimate of each effect is about half of the corresponding estimate in the unicausal models. This is because the unicausal models must attribute the control period effects of all omitted variables to the control dummies.

But inflation was low in 1971:Q3-1972:Q4 in part because of the productivity gains of this period, and inflation was high in 1974 in part because of a productivity reversal, food and energy price shocks, and the depreciation of the exchange rate of the U. S. dollar.

5. *Lagged Output Ratio.* This variable is the log of the ratio of real output to the natural rate of output, that is $\hat{Q}_{t-1} = Q_{t-1} - Q^*_{t-1}$. The Q^* variable used to obtain the output ratio and, in rate of change form, to adjust nominal GNP growth is from Jeffrey Perloff and Michael Wachter.[10] This traditional Phillips curve variable is highly significant; its coefficient of 0.23 indicates that a one percentage point excess of actual real GNP above natural real GNP causes an acceleration of inflation of 0.23 percentage points at an annual rate per quarter. The total acceleration over the first year of such an excess would be greater than 0.23 percentage points, because after the first quarter the additional inflation would begin to feed through the lagged dependent variable.

6. *Adjusted Nominal GNP Growth.* Just as the demand level variable $\hat{Q}_{t-1}$ is defined such that a value of zero makes no contribution to inflation, the nominal GNP growth variable is defined net of natural real GNP growth. A slowdown in the trend growth rate of productivity will reduce natural real GNP growth and raise $\hat{y}_t$, so that this variable represents the combined effects of demand stimulation and trend productivity growth.

7. *Relative Prices of Food and Energy.* The first of the supply shock variables to be introduced in Table 1 is the contribution to inflation of changes in the relative prices of food and energy. This effect is measured by the difference between the rate of change of the private business deflator and that of an alternative deflator that attempts to "strip out" the impact of the

changing relative prices of food and energy.[11] While this variable makes a significant contribution to the fit of the equation, its coefficient is surprisingly low. This probably reflects errors in the measurement of the food-energy contribution due to differences in coverage and weighting from the dependent variable.

8. *Productivity Deviation.* Suppose desired real wage growth, λ_t, is 2 percent per year but mean productivity gains are fixed at 1 percent. Then equation (2) states that this will add one percentage point to the rate of inflation. Similarly, any difference between λ_t and σ_t is a source of a constant term in a regression fit to (2).[12] If the rate of productivity growth varies, it is reasonable to assume that an average of actual and mean productivity is used in pricing decisions, that is, some fraction of the deviation of productivity from its mean. To capture the recent decline in mean productivity, the productivity deviation variable is the residual series from a regression of the rate of growth nonfarm productivity on a constant and a time trend beginning in 1970.

9. *Effective Exchange Rate.* The depreciation of the dollar during the 1970s has not been included as an explanatory variable in previous studies, mainly because it has been difficult to find a statistically significant effect for changes in the exchange rate. We believe that this previous insignificance of the exchange rate stems from the impact of the Nixon controls in delaying the adjustment of U.S. domestic prices to the dollar depreciation that occurred in two stages between 1971 and 1973. We have created a new variable which is equal to the actual change in the effective exchange rate of the dollar (i.e., the number of units of a market basket of foreign currencies that the dollar can buy each quarter) starting in 1974:Q3, but which is set equal to zero

before 1974 and thus forces the entire 16 percent decline in the effective exchange rate that occurred between 1971:Q3 and 1974:Q2 to occur in two quarters, 1974:Q1 and 1974:Q2.

10. *Social Security Tax.* The coefficient of 0.43 indicates nearly half of all changes in the effective tax rate,[13] which includes both employer and employee shares, is shifted forward into prices.

11. *Effective Minimum Wage Rate.* This variable is defined as the ratio of the statutory minimum wage to average hourly earnings in the nonfarm private economy. Its coefficient of 0.02 means that the cumulative 8 percent increase in the effective minimum wage rate during the four quarters in 1978 accounted for an acceleration of inflation of about 0.16 percentage points.

The comprehensive reduced-form inflation equation of column (3) has a standard error of 0.65, little more than half that of unicausal models. The more complete model substantially improves our ability to explain the 1954-80 inflation experience.

An alternative assessment of the effect of controls is provided by the dynamic simulation beginning 1971:Q3 of our basic equation fit to data through 1971:Q2.[14] The "on" effect estimated by dynamic simulation and reported on line 14a approximates the dummy variable estimate, but the estimated "off" effect is much higher because the pre-1971:Q3 equation does not contain the effective foreign exchange rate. The post-sample simulation incorrectly attributes the inflationary impact of the depreciation of the dollar to the removal of the controls program. To correct for this, we have run two in-sample dynamic simulations of the 1954-80 equation, one of which sets the change in the effective exchange rate to zero. The difference between the two simulations yields the estimate that 1.50 percentage points of the high inflation of the "off" period was contributed by the foreign exchange variable. A more credible estimate of the impact of the termination of controls is therefore 3.08 - 1.50 = 1.58, which approximates the dummy variable estimate of 1.52.

IV SENSITIVITY AND EXTENSIONS OF THE BASIC EQUATION

Another episode of government intervention occurred during the Kennedy and Johnson administration, when there were quasi-voluntary guidelines established for wage increases. These guidelines, first mentioned in the 1962 Economic Report of the President, are generally assumed to have been in effect between early 1963 and mid-1966. Our guidelines variable is assumed to be in effect between 1963:Q1 - 1965:Q4. We enter a separate dummy variable for the three-year period beginning in 1966:Q1 to assess the possibility that part of the 1966-68 acceleration in the inflation rate was due to the end of the guidelines rather than a general state of excess demand in the economy. When these dummy variables are included in our basic equation, the resulting coefficients and t statistics are:

Guidelines dummy I	(1963:Q1-1965:Q4)	0.01	(0.01)
Guidelines dummy II	(1966:Q1-1968:Q4)	0.60	(0.61)

The verdict of these coefficients is that the guidelines program had no significant effect on inflation. The positive influence on inflation of demand growth in the 1963-65 period was offset not by the guidelines program, but by rapid productivity growth. An important implication of this result is that if the guidelines had a significant effect in holding down wage increases, as found by George Perry and others, then the program created a boom in the profit share.

The Carter pay standards may be similarly assessed. We introduced two dummy variables for the periods 1978:Q4-1979:Q4 and 1980:Q1-1980:Q2, respectively. The first dummy can be interpreted as the effect on inflation of the initial year of the pay standards, while the second dummy can be interpreted either as the effect of the second phase of the pay standards or of the "post-controls rebound" following the first stage. The resulting coefficients and t statistics are:

Carter dummy I	(1978:Q4-1979:Q4)	-0.67	(-1.08)
Carter dummy II	(1980:Q1-1980:Q2)	0.05	(0.18)

Both variables are insignificantly different from zero, suggesting that there was nothing unusual about the inflation experience between late 1978 and mid 1980, and that the other variables in the equation are capable of tracking the data.

An alternative method of assessing the Nixon controls introduced by Alan Blinder and William Newton estimates an equation which does not use dummy variables. Rather, a new variable represents the "on" effect that is equal to the fraction of the CPI subject to price controls in each month, based on government records.

The Blinder-Newton approach has two advantages over the dummy variable technique. First, the "off" effect is captured by the change in the "on" variable defined only in those periods when the controlled fraction decreased. There is no need to make arbitrary decisions regarding the dating of dummy variables, since the constructed variable contains its own information. Second, the controls are allowed to have varying effects each quarter rather than the uniform effect imposed by our "on" and "off" dummies.

We substituted the Blinder-Newton "on" variable and current and four lagged values of the "off" variable for our control dummies, and, following Blinder and Newton, assessed the controls effects by two dynamic simulations, one of which had the controls variables set to zero.[15] The implied controls effect (column (a)) may be compared to our own from Table 1 (column (b)).

	(a)	(b)
Standard Error	0.649	0.646
Maximum Restraint of Inflation	-1.48%	-1.45%
Post-Controls Rebound	+1.35%	+1.52%

The Blinder technique--despite the extra research required for construction of the new variable and its lack of applicability to other episodes of government intervention--provides neither a better fit nor an evaluation of the Nixon controls that differs from our simple dummy variable approach.

V Conclusions

An adequate explanation of inflation in the 1970s requires a model that includes effects of aggregate demand, government intervention, external supply shocks, and inertia in the adjustment of prices. Our basic reduced-form inflation equation relies on the contribution of two variables for its aggregate demand effect, the lagged level of the output ratio and the change in nominal GNP adjusted for changes in natural real GNP. Three forms of government intervention influence inflation, the Nixon-era controls, changes in the effective social security tax rate and effective minimum wage. External supply shocks include changes in the relative prices of food and energy, the influence of changes in the effective exchange rate of the dollar, and deviations of productivity from trend. Finally, inertia is represented by the influence of lagged inflation on the current inflation rate.

The central focus of this paper has been on the interaction of the estimated impact of the Nixon-era controls and the other variables. Previous studies have estimated substantial effects of the controls in holding down inflation in 1972 and causing inflation to accelerate in 1974, and in many cases have found that implied impact of the removal of controls in raising inflation in 1974 was greater than the initial impact of the controls in holding down inflation in 1972. Several of the variables that play an important role in our basic equation, especially the productivity deviation and exchange rate, help to explain the actual inflation performance of 1972 and 1974 and thus assign a smaller role to the Nixon controls. In this sense part of the impact of the Nixon controls in some previous studies confound the actual influence of the controls and the influence of left-out variables. In particular, we conclude that ARIMA and money-only models are inadequate for this kind of research because they omit many variables that play an important role in the inflation process, and therefore they yield biased estimates of intervention effects.

Three different methods are used to assess the impact of the Nixon-era controls within the context of our basic reduced-form inflation equation. Post-sample dynamic simulations tend to underpredict inflation in 1974 more than they overpredict inflation in 1972, partly because there was no role of the effective exchange rate before 1971. The inclusion of dummy variables for the imposition and removal of the controls has the advantage of using all of the information available in the full sample period. Dummy variables indicate that the Nixon controls held down the price level by about 1.3 percent between mid-1971 and late 1972, and then allowed a rebound of about 1.4 percent to occur in 1974 and early 1975. A third technique, introduced by Alan Blinder, replaces the dummy variables with a variable that measures the fraction of prices that were actually controlled each quarter. Although this variable seems conceptually superior, it does not alter the conclusions of the dummy variable technique, yielding almost exactly the same standard error of estimate and the same estimated magnitude of the impact of the controls on the price level.

Why was inflation so variable between 1971 and 1980? And why did inflation accelerate from 5 percent in early 1971 to 10 percent in early 1980? Our basic equation explains the high variance of inflation mainly as a result of swings in the effect of Nixon controls, the deviation of productivity from trend, the relative prices of food and energy, and the effective exchange rate, with an additional minor contribution made by the aggregate demand variables and by social security tax changes. The overall acceleration of inflation during the past decade is explained by the adverse contribution of most of the variables.

While the inflation equation developed in this paper identifies the main factors that explain the recent behavior of inflation in the United States, additional research is required before this framework can be used to assess the consequences of alternative aggregate demand policies. Although for the purpose of policy evaluation nominal GNP growth can be treated as exogenous, and the value of the lagged output ratio can be calculated from the behavior of nominal GNP and the inflation rate that the equation predicts, nevertheless there remain two important endogenous explanatory variables that are affected by demand policy and for which auxiliary equations must be developed. The full effect of a restrictive demand policy, for instance, would alter the inflation rate not only through the nominal GNP growth and lagged output ratio variables, but also through the effect of demand policy on the behavior of productivity and the exchange rate.

REFERENCES

R. Barro, and M. Rush, "Unanticipated Money and Economic Activity", in S. Fischer, ed., Rational Expectations and Economic Policy, Chicago: 1980, 23-48.

A. Blinder, Economic Policy and the Great Stagflation, New York, 1979.

__________ and W. Newton, "The 1971-74 Controls Program and the Price Level: An Econometric Post-Mortem", NBER working paper no. 279, 1978.

G.E.P. Box and G. Taio, "Intervention Analysis with Applications to Economic and Environmental Problems", Journal of the American Statistical Association, 1975, 70:70-79.

E. Feige and D. Pearce, "Inflation and Incomes Policy: An Application of Time Series Models", in Karl Brunner and Allan H. Meltzer, eds., Carnegie-Rochester Conference Series on Public Policy, Supplement to Journal of Monetary Economics, Volume 2, New York, 1976.

J. Frye and R.J. Gordon, "The Variance and Acceleration of Inflation in the 1970s: Alternative Explanatory Models and Methods", working paper, Northwestern University, 1980.

R.J. Gordon, "The Responses of Wages and Prices to the First Two Years of Controls", Brookings Papers on Economic Activity, 1973, 4:765-79.

__________, "The Impact of Aggregate Demand on Prices", Brookings Papers on Economic Activity, 1975, 6:613-62.

W. Oi, "On Measuring the Impact of Wage-Price Controls: A Critical Appraisal", in K. Brunner and A. Meltzer, The Economics of Wage and Price Controls, 1976, Carnegie-Rochester Conference Series on Public Policy, Volume 2, Supplementary Series to the Journal of Monetary Economics.

J. Perloff and M. Wachter, "A Production Function-Nonaccelerating Inflation Approach to Potential Output: Is Measured Potential Output Too High?" in K. Brunner and A. Meltzer, eds., Carnegie-Rochester Conference Series on Public Policy, Supplement to Volume 10, New York, 1973.

G. Perry, "Inflation in Theory and Practice", Brookings Papers on Economic Activity, forthcoming.

FOOTNOTES

1. Figures refer to the quarterly change in the fixed-weight GNP deflator expressed at annual rates. This is the dependent variable in all of the equations presented in this paper.
2. See Gordon's 1980 article.
3. A more detailed presentation of this specification is presented by Frye and Gordon.
4. Equation (2) contains productivity and supply shift terms but otherwise is identical to equation (6) in Gordon (1980).
5. See especially the paper by Robert Barro and Mark Rush.
6. The use of dummy variables to assess an intervention in an ARIMA process is discussed by G.E.P. Box and G.C. Taio. We find inflation in non-controls quarters is described by the integrated moving average process $(1-B)p_t = (1-\Theta B)a_t$, where B is the backshift operator $B X_t = X_{t-1}$, and the a_t have independent identical normal distributions. If the imposition and removal of controls affect inflation, we may write $p_t = \frac{1-\Theta B}{1-B} a_t + \alpha_1 ON_t + \alpha_2 OFF_t$. This implies the regression equation $\frac{1-B}{1-\Theta B} p_t = \alpha_1 \frac{1-B}{1-\Theta B} ON_t + \alpha_2 \frac{1-B}{1-\Theta B} OFF_t + a_t$, in which each variable is pre-filtered by subtracting an exponential weighted moving average of its past values.
7. Other choices for the timing of the controls effects are presented in Frye and Gordon.
8. The dependent variable is a quarterly change expressed at an annual rate and varies from roughly zero to 12 percent during 1954-80.
9. For more on the methodology of estimating the impact of controls and other types of government intervention, see Gordon (1973), Alan Blinder, and Walter Oi.

10. Any mismeasurement of Q_t^* is a source of a constant term in a regression fit to (2). For example, if Q_t^* were above the level required for non-accelerating inflation, the output ratio would be too low to explain its share of the inflation which actually occurred.

11. The exact method of performing the "stripping" process is described in Gordon (1975, pp. 656-660). This variable was updated using the methods described in that source to the end of 1976, and has been extrapolated using a regression of the 1954-76 variable on current and lagged values of the deflators of consumer direct expenditures on food and energy.

12. Possible mismeasurement of Q_t^* is the other source.

13. The variable is calculated as the percentage change in $(1/(1-\tau))$, where τ is the ratio of total Federal and state social security contributions to total wage and salary income in the national income accounts.

14. The estimated equation differs from (3) in two respects. First, controls dummies and the effective exchange rate are, of course, omitted. Second, the equation is made dynamically stable by imposing the constraint $\gamma_o = 1$. Our iterative procedure to achieve this stopped just short of convergence, so the coefficient on lagged inflation is estimated at 0.85 and that on adjusted nominal GNP growth is estimated at 0.16. All other coefficient estimates are well within a standard error of those reported in (3), except the constant, which climbs to 0.30.

15. The estimated equation had the effects of controls removed from its lagged dependent variable.