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Author(s): Jon Frye and Robert J. Gordon

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Government Intervention in the Inflation Process: The Econometrics of “Self-Inflicted Wounds”

By JON FRYE AND ROBERT J. GORDON*

The high variance and continued acceleration of inflation during the 1970's pose new challenges to the time-series econometrician. The theme of this paper is that inflation in the past decade has depended not only on the level of aggregate demand and the role of inertia—the two explanatory variables stressed in the conventional Phillips curve framework—but also on a number of different supply shocks. Two of these, the increase in the relative price of oil and decline in the rate of productivity growth, have been outside of the direct control of the government, particularly in the short run. But both the variance and acceleration of inflation have been aggravated by three measures within the purview of government policy-makers: increases in the effective Social Security tax, increases in the minimum wage rate, and episodes of direct government intervention in the price-setting process. Because of their futility, these intervention episodes can be regarded as “self-inflicted wounds,” like the tax and minimum wage changes that normally are described by this term.

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 uppercase letters designate *logs* of levels of variables and lowercase 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), a vector of supply shift variables (z_t), and an error term (ε_t).¹

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

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¹A more detailed development of both this specification and of the subsequent empirical results is contained in our earlier paper.

\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:²

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

In long-run equilibrium, inflation (p_t, p_{t-1}) and adjusted nominal *GNP* growth (\hat{y}_t) are equal and all other variables are zero. This implies that the sum of coefficients on lagged inflation and adjusted nominal *GNP* growth must be unity to allow this steady-state equilibrium to be attained.

II. Two Unicausal Approaches

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 which represent an extreme view that the inflation process is entirely dominated by inertia and is unaffected by changes in current exogenous variables (see Edgar Feige and Douglas Pearce). 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.³

We use the *ARIMA* and money-only equations to provide an alternative estimate

²Equation (2) contains productivity and supply shift terms but otherwise is identical to equation (6) in Gordon's 1980 paper.

³See especially the paper by Robert Barro and Mark Rush.

of the effect of the Nixon price controls.⁴ 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. The Nixon controls dummy variables are scaled to show the cumulative impact of the controls on the price level 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 postsample dynamic simulation of an equation estimated to the precontrols period and treat it as an estimate of inflation in the counterfactual state.⁵ Lines 14a and 14b of Table 1 show the postsample simulation errors of an equation estimated for 1954:2 to 1971:2.

III. Specification and Results for the Basic Equation

The third column of Table 1 presents estimates of our basic equation as specified in equation (2) above and exhibits a standard error of 0.68, little more than half that of the unicausal models. 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.

⁴Our use of dummy variables to assess an intervention in an *ARIMA* process follows the procedures suggested by G. E. P. Box and G. C. Tiao.

⁵For more on the methodology of estimating the impact of controls and other types of government intervention, see Gordon (1973), Alan Blinder, and Walter Oi.

TABLE 1—MEASURES OF THE IMPACT OF NIXON-ERA WAGE AND PRICE CONTROLS USING ALTERNATIVE MODELS OF THE INFLATION PROCESS FOR THE PERIOD 1954:2-1980:2^a

	ARIMA Model ^b (1)	Money-Only Model (2)	Comprehensive Reduced Form (3)
1) Lagged Inflation ^c	—	—	0.90 (15.4)
2) "On" Dummy ^d 1971:3-1972:4	-3.14 (-2.99)	-3.31 (-4.68)	-1.30 (-2.65)
3) "Off" Dummy ^d 1974:2-1975:1	2.46 (3.40)	3.07 (5.07)	1.60 (2.30)
4) Current and Lagged $M-1B^e$	—	1.46 (21.8)	—
5) Output Ratio (\hat{Q}_t)	—	—	0.19 (3.55)
6) Adjusted Nominal GNP Growth (\hat{y}_t)	—	—	0.14 (4.56)
7) Food and Energy Prices	—	—	0.29 (4.22)
8) Productivity Deviation ^f	—	—	-0.38 (-5.47)
9) Effective Exchange Rate ^f	—	—	-0.09 (-3.21)
10) Social Security Tax ^f	—	—	0.54 (2.98)
11) Effective Minimum Wage Rate ^f	—	—	0.02 (1.66)
12) Constant	0.16 (1.42)	-1.42 (-5.43)	—
13) a. $S.E.E.$	1.15	1.05	0.68
b. $D.W.$	2.07	1.60	2.19
14) Cumulated Errors from Dynamic Simulation within Specified Intervals ^g			
a. "On" 1971:3-1972:4	-1.93	-3.46	-1.23
b. "Off" 1974:2-1975:1	5.28	4.09	3.08

Note: Numbers in parentheses are t -statistics.

^aThe dependent variable is 400 times the quarterly first difference of the \log of the fixed weight GNP deflator.

^bThe coefficients in column (1) are estimated in a regression equation in which all variables are pre-filtered.

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

^dThe 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.

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

^fThe 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.

^gThe equation represented by each column is reestimated for the period 1954:2-1971:2 and dynamically simulated beginning 1971:3. In column (3) estimation is subject to the constraint that the sum of coefficients on adjusted nominal GNP growth and lagged inflation equals 1.

2); 3) *Nixon Control Dummies*. The Nixon controls program is estimated to have held down prices 1.30 percent at the end of 1972, but this effect was more than cancelled by the rebound inflation of 1.60 percent. The estimate of each effect is about half of the corresponding estimate in the uncausal

models. This is because the uncausal models must attribute the control period effects of all omitted variables to the control dummies. But inflation was low in 1971:3-1972:4 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) *Output Ratio*. This variable is the *log* of the ratio of real output to the natural rate of output, i.e., $\hat{Q}_t = Q_t - Q_t^*$. 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. This traditional Phillips curve variable is highly significant; its coefficient of 0.19 indicates that a one percentage point excess of actual real *GNP* above natural real *GNP* causes an acceleration of inflation of 0.19 percentage points at an annual rate per quarter.

6) *Adjusted Nominal GNP Growth*. 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. The implied parameter estimates are $\gamma_1 = 0.22$ and $\gamma_2 = 0.16$.

7) *Relative Prices of Food and Energy*. The contribution to inflation of changes in the relative prices of food and energy 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. While this variable makes a significant contribution to the fit of the equation, its coefficient indicates that only a fraction of the relative prices changes was incorporated into a permanent acceleration of inflation.

8) *Productivity Deviation*. The variable standing for $\lambda_t - \sigma_t$ is the deviation of actual productivity growth from the productivity trend, estimated to be a constant for 1954–69 and a declining time trend during 1970–80. Its coefficient indicates that the productivity variable used in price setting (σ_t) is an average based 38 percent on actual productivity changes and 62 percent on the productivity trend.

9) *Effective Exchange Rate*. The depreciation of the dollar during the 1970's has been excluded or statistically insignificant in

previous studies. This previous insignificance 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 starting in 1974:3, which is set equal to zero before 1974, and which in 1974:1 and 1974:2 equals the cumulative depreciation that occurred between 1971:3 and 1974:2. Its coefficient indicates that a 10 percent dollar depreciation raises the inflation rate by 0.9 percentage points in the first three quarters.

10) *Social Security Tax*. The coefficient of 0.54 indicates that half of all changes in the effective tax rate,⁶ 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.

An alternative assessment of the effect of controls is provided by the dynamic simulation beginning 1971:3 of our basic equation fit to data through 1971:2. 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-1971:3 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 simu-

⁶The 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.

lations 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 1.60.

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 assumed to be in effect between 1963:1–1965:4. We enter a separate dummy variable for the three-year period beginning in 1966:1 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 (1963:1–1965:4)	0.01	(0.01)
Guidelines dummy II (1966:1–1968:4)	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 1964–65 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, then the program created a boom in the profit share.

The Carter pay standards may be similarly assessed. We introduce two dummy variables for the periods 1978:4–1979:4 and 1980:1–1980:2, respectively. The resulting coefficients and *t* statistics are:

Carter dummy I (1978:4–1979:4)	-0.67	(-1.08)
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Carter dummy II (1980:1–1980:2)	0.05	(0.18)
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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 that represents the on effect is equal to the fraction of the *CPI* subject to price controls in each month, based on government records. We substitute the Blinder-Newton on variables and current and four lagged values of the off variable for our control dummies, and, following Blinder and Newton, assess the controls effects by two dynamic simulations, one of which has the controls variables set to zero. The implied controls effect (column (a)) may be compared to our own from Table 1 (column (b)).

	(a)	(b)
Standard Error	0.68	0.68
Maximum Restraint of Inflation	-1.48%	-1.30%
Postcontrols Rebound	+1.35%	+1.60%

The Blinder-Newton 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 1970's requires a model that includes inertia in the adjustment of prices and the effects of aggregate demand, external supply shocks, and government intervention. Our basic reduced-form inflation equation relies on the contribution of two variables for its aggregate demand effect, the level of the output ratio, and the change in nominal

GNP adjusted for changes in natural real GNP. 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. Three forms of government intervention influence inflation, the Nixon-era controls, as well as changes in the effective Social Security tax rate and effective minimum wage.

Three different methods are used to assess the impact of the Nixon-era controls within the context of our basic reduced-form inflation equation. Postsample 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 1.6 percent to occur in 1974 and early 1975. A third technique, introduced by Blinder, seems conceptually superior, but it does not alter the conclusions of the dummy variable technique.

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. A restrictive de-

mand policy, for instance, would alter the inflation rate not only through the nominal GNP growth and output ratio variables, but also through the effect of demand policy on the behavior of productivity and the exchange rate, requiring that auxiliary equations be estimated to capture these indirect channels of influence.

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