# Hysteresis in History: Was There Ever a Phillips Curve?

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The persistence of high unemployment in Europe during the late 1980s poses many puzzles for macroeconomic analysis, both theoretical and empirical. While numerous macroeconomic doctrines may be called into question by the European experience, the particular theory addressed in this paper is Milton Friedman's 1968 Natural Rate Hypothesis (NRH), which implies that, because inflation in Europe has stabilized and is no longer decelerating, Europe must today be operating at close to its natural rate of unemployment, often called the "nonaccelerating inflation rate of unemployment" (NAIRU).

Two principal interpretations of the rising European NAIRU have been offered. The "structuralist" view advances specific supply-side impediments (including high real wages and government regulations) as the cause of the rising NAIRU and reaches the pessimistic conclusion that the NAIRU cannot decline until these impediments are removed. A weakness of this interpretation is the absence of convincing quantitative evidence capable of explaining why the European NAIRU should have increased from 2 percent in the 1960s to 10 percent today, or should have increased so much more in some countries than in others. Evidence relating to alternative structural factors contributing to higher unemployment is reviewed critically in my 1988 paper, and by several authors in the volume edited by Robert Lawrence and Charles Schultze (1987).

The more optimistic "hysteresis" approach posits a NAIRU that automatically follows in the path of the actual unemployment rate. In this view, the European NAIRU is high because actual unemployment is high, and the NAIRU can be reduced if actual unemployment declines as the result of expansionary demand policies. The empirical counterpart of the hysteresis framework is a reduced-form relation in which inflation depends on the *change* in unemployment, not on the *level* of unemployment as in the NRH.

Whether the change or level of unemployment matters, a seemingly small matter of shifting one derivative, has profound implications for both economic doctrine and policy. Friedman's NRH became influential two decades ago with its accurate prediction that an attempt to maintain actual unemployment below the NAIRU would lead to accelerating inflation. But the NRH is symmetric, and predicts that, starting from an initial Walrasian structure determining the NAIRU, an increase in the actual unemployment rate leads to decelerating inflation at an accelerating rate, and eventually to an accelerating deflation. Lacking a convincing reason why the Walrasian NAIRU in Europe should have shifted by exactly as much as the actual unemployment rate, the absence of an accelerating deflation may suggest that the symmetric NRH is flawed. And, if the NRH is abandoned, it casts stabilization policy adrift from its previous mooring, the task of steering the economy toward a fixed NAIRU, and open to the central implication of hysteresis that any rate of unemployment, no matter how low or high, is consistent with steady inflation at a rate that depends on the history of both inflation and unemployment.

While "accelerating deflation" may be a familiar phrase in the austere taxonomies of the macroeconomics classroom, it is notably absent in the annals of monetary history. This raises an intriguing set of empirical questions. Was there *ever* in history any evidence to support the symmetric version of the Friedman NRH? Was hysteresis always present in the data, waiting to be discov-

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ered? Can an asymmetric version of the NRH be salvaged, valid in periods of excess demand but not excess supply? This short paper provides preliminary answers over the period since 1870 for five industrial nations: France, Germany, Japan, the United Kingdom, and the United States.

### I. Empirical Implications of Hysteresis and the NRH

I begin with the simplest possible version of the symmetric NRH relating the inflation ($p_t$) and unemployment ($U_t$) rates and then recast it to nest hysteresis as an alternative hypothesis:

$$(1) \qquad p_t = \alpha p_{t-1} + \beta(U_t - U_t^*).$$

If $\alpha = 1$, then the NAIRU ($U_t^*$) corresponds to a steady-state situation where $p_t = p_{t-1}$. As Thomas Sargent (1971) pointed out, Friedman's NRH is consistent with values of $\alpha$ below unity, since with some time-series processes for the price level (for example, mean reversion), rational agents will form expectations with a weight of less than unity on lagged inflation.

Hysteresis can arise when $U_t^*$ depends on the lagged unemployment rate ($U_{t-1}$), in addition to its microeconomic determinants represented by $Z_t$.

$$(2) \qquad U_t^* = \eta U_{t-1} + Z_t.$$

Substituting (2) into (1) results in

$$(3) \qquad p_t = \alpha p_{t-1} + \beta(U_t - \eta U_{t-1} - Z_t).$$

Full hysteresis occurs when $\eta$ equals unity, implying that there is no longer a unique $U_t^*$. By transforming (3), we can see that full hysteresis implies a relation between inflation the change in unemployment, not the level of unemployment:

$$(4) \qquad p_t = \alpha p_{t-1} + \beta(1-\eta)U_t + \beta\eta(U_t - U_{t-1}) - \beta Z_t.$$

Full hysteresis implies that when the actual unemployment rate decreases, inflation increases, but rather than accelerating continuously, the acceleration is finite in an amount depending only on the value of the $\beta$ coefficient. Starting from an initial inflation rate $p_0$, the inflation rate ($p_n$) that occurs after $n$ periods of changing unemployment is

$$(5) \qquad p_n = p_0 + \beta \sum_{i=1}^{n} \Delta U_i.$$

I am interested in this paper in extending the investigation to the era prior to World War I, when unemployment data are absent or of dubious quality for most countries, and data on detrended log output ($\hat{Q}_t = Q_t - T_t$) must be used instead. With appropriate substitutions, (4) can be rewritten in terms of log detrended output, and full hysteresis ($\eta = 1$) has the analogous implication that inflation depends on the log change in detrended output and not its level:[1]

$$(6) \qquad p_t = \alpha p_{t-1} + \beta(1-\eta)\hat{Q}_t + \beta\eta(\hat{Q}_t - \hat{Q}_{t-1}).$$

To capture fully changes in behavior in different historical eras, particularly those involving wars, it is useful to rewrite (6) in a form that indicates the fraction of current nominal GNP changes taking the form of price changes, using the identity $\hat{Q}_t \equiv \hat{Q}_{t-1} + \hat{y}_t - p_t$, where $\hat{y}_t$ is the excess of nominal GNP growth over the growth rate of the output trend ($\hat{y}_t = y_t - T_t + T_{t-1}$):

$$(7) \qquad p_t = [1/(1+\beta)] \times [\alpha p_{t-1} + \beta\hat{y}_t + \beta(1-\eta)\hat{Q}_{t-1}].$$

The key implication of (7) is that with full

[1] The substitutions are as follows: in (1) substitute log output ($Q_t$) and log natural output ($Q_t^*$) for $U_t$ and $U_t^*$. Then in (2) write $Q_t^* = T_t + \eta(Q_{t-1} - T_{t-1})$, where $T_t$ is a time trend.

hysteresis ($\eta = 1$) and with $\alpha = 1$, the acceleration or deceleration of inflation, as well as the change in detrended output, depends only on the difference between $\hat{y}_t$ and $p_{t-1}$, that is, whether or not excess nominal GNP growth "ratifies" the inherited inflation rate:

$$(8) \qquad p_t - p_{t-1} = [\beta/(1+\beta)] \times (\hat{y}_t - p_{t-1});$$

$$(9) \qquad \hat{Q}_t - \hat{Q}_{t-1} = [1/(1+\beta)] \times (\hat{y}_t - p_{t-1})$$

In short, full hysteresis implies that changes in both inflation and output are completely independent of the *level* of detrended output, and that an economy in the depths of a Great Depression can experience an acceleration of inflation, no matter how high the level of unemployment or low the level of detrended output, if excess nominal GNP growth exceeds last period's inflation rate.

While accelerating deflation has rarely if ever been observed, accelerating inflation has occurred periodically. This suggests that (7) may be overly restrictive by forcing the "level effect" to operate with a fixed coefficient. In the empirical section that follows, separate coefficients are estimated for positive and negative values of $\hat{Q}_{t-1}$, thus allowing for an asymmetric version of the NRH. In this version the economy is subject to an error-correction mechanism in periods of excess demand but not in periods of excess supply. Shifts in parameters in response to changes in the variance in aggregate demand are a common feature of both new-classical and new-Keynesian models (Laurence Ball et al., 1988), suggesting that the coefficient on lagged inflation and on nominal demand growth should be allowed to vary during wartime and other volatile periods, as in my earlier paper (1983).

## II. Regression Results

The presence of full hysteresis, and the absence of level effects, would require an estimated coefficient of zero on the level of unemployment in (4) or on the lagged level of detrended log output in (7). The empirical equations summarized in this paper are estimated only for output data (using (7)), with no coverage of unemployment data, in view of limited space, previous research on unemployment data, and data gaps.[2] Postwar data are taken from standard OECD sources, and data prior to World War II are based on Nathan Balke and myself (1989) for the United States, C. H. Feinstein (1972) for the United Kingdom, Kazushi Ohkawa and Mihohei Shinohara (1979) for Japan, and national sources as summarized by Maddison (1982) for France and Germany.[3]

The use of output data in estimating (7) requires a detrending procedure. Significant variations in population and productivity growth over the past century prevent the use of a single trend and require the choice of "benchmark years" to separate multiple piecewise log-linear output trends. To avoid the possible criticism that benchmark years might have been selected to support or refute the hysteresis hypothesis, all are copied from previous research directed at other issues.[4] Inconsistency may result from the use of benchmark years originally selected by varying criteria—peak output in some cases,

[2] Tests with unemployment data have already been carried out, albeit with data on wage changes rather than price changes, by Olivier Blanchard and Laurence Summers (1986) for four of the five countries (excluding Japan) in the postwar period and for the interwar United States. The data review by Angus Maddison (1982, Appendix C) indicates that there are no interwar unemployment data for Japan, and that data for France are sporadic rather than annual.

[3] Data for Japan, the United Kingdom, and the United States measure nominal GNP, real GNP, and the GNP deflator. Data for Germany and France prior to World War II measure real GNP, the CPI, and a hybrid concept of nominal GNP equal to the CPI times real GNP.

[4] For the postwar U.S. benchmark years, see my textbook (1987), and for the other four countries, see my 1988 paper; for the pre-World War II period, U.S. benchmarks are taken from Christina Romer (1989), for France, Germany, and the United Kingdom from Solomos Solomou (1987), and for Japan from my 1983 paper.

TABLE 1—EQUATIONS EXPLAINING THE ANNUAL INFLATION RATE, FIVE COUNTRIES, 1873–1986

| | U.S. | U.K. | France | Germany | Japan[c] |
|---|---|---|---|---|---|
| Years Omitted | None | 1939–59 | 1914–23; 1939–59 | 1914–24; 1939–59 | 1939–59 |
| Lagged Inflation ($p_{t-1}$) | | | | | |
| Basic effect | −0.11 | 0.04 | 0.05 | 0.00 | 0.08 |
| Extra effects: | | | | | |
| 1888–1913 | | | | | −0.66[a] |
| 1950–86 | 0.60[a] | | 0.61[a] | 0.44[a] | |
| Excess Nom. GNP Growth ($\hat{y}_t$) | | | | | |
| Basic effect | 0.47[a] | 0.59[a] | 0.37[a] | 0.42[a] | 0.83[a] |
| Extra effects: | | | | | |
| 1873–93 | 0.20[a] | | | | |
| 1873–1913 | | | | | 0.62[a] |
| 1893–1938 | | | 0.30[a] | | |
| 1915–22 | 0.60[a] | 0.26[a] | | | |
| 1942–49 | 0.24[b] | | | | |
| 1960–86 | | 0.37[a] | | −0.08[b] | |
| Detrended Log Output ($\hat{Q}_{t-1}$) | | | | | |
| Basic effects: | | | | | |
| Positive values | 0.20[a] | 0.33[a] | 0.31[a] | [d] | 0.47[a] |
| Negative values | −0.01 | 0.07[b] | 0.29[a] | 0.13[a] | 0.35[a] |
| Extra effect, negative values: | | | | | |
| 1873–93 | 0.28[a] | | | | |
| $\bar{R}^2$ | 0.90 | 0.96 | 0.93 | 0.81 | 0.88 |
| S.E.E. | 1.60 | 1.35 | 1.69 | 1.49 | 2.33 |
| Durbin-Watson | 2.63 | 1.86 | 2.17 | 1.46 | 2.06 |

*Notes:* Each equation includes one or more dummy variables for episodes of government intervention in the price-setting process, as defined in the longer working-paper version of this article.

[a]Statistically significant at 1 percent level.

[b]Statistically significant at 5 percent level.

[c]Sample period for Japan begins in 1888 rather than 1873, reflecting data availability.

[d]Coefficient wrong-signed and insignificant; equation reestimated with this variable excluded.

average output in others, and the level of output consistent with a particular unemployment rate in still others. To avoid this problem, the log output ratio is redefined to have a mean of zero over the period prior to 1914 in all countries but the United States.

The equations estimated here test for an asymmetric version of the NRH level effect by allowing the coefficients on the output level to differ in periods of high and low output. We also allow the coefficients on $p_{t-1}$, $\hat{y}_t$, and $\hat{Q}_{t-1}$ to vary over time by estimating a single equation for the entire period for which data are available, and then searching for parameter shifts. If additional variables are defined as the product of the individual economic variables of interest ($\hat{y}_t$, $\hat{Q}_{t-1}$, and so on) and "0,1" dummy variables for each subperiod, then the $t$-ratios on the additional variables provide estimates of the statistical significance of parameter shifts. All of the statistically significant parameter shifts are listed separately in Table 1.

The table lists coefficient estimates for a single regression equation for each of the five countries, spanning the 114-year period 1873–1986 for all countries but Japan, where data limitations dictate an initial year of 1888. Selected wartime years are omitted as shown; in each case output was severely depressed as a result of supply constraints rather than depressed demand. The explanatory variables are displayed in three groups corresponding to the three variables included in (7); within each group of explanatory variables are listed several "extra effects," that is, the coefficients on the product of the variable concerned and a 0,1 dummy variable for the period shown. The equations also include a set of dummy variables (differing for each country and not displayed in Table 1 to save space) representing the effects of wartime controls and other episodes of government intervention. Details on the definition of and coefficients on these variables, as well as a full data appendix, are available in the working paper version of this article.

The major implications of the estimated coefficients are as follows:

Inflation "inertia" in the form of large and significantly positive coefficients on lagged inflation is entirely a postwar phenomenon, and then only for the United States, France, and Germany. Negative inertia is found in Japan before World War I, perhaps reflecting noisy data, and no inertia or persistence at all in the United Kingdom over the full century.

The inflation response to nominal GNP growth is almost unity in Japan, and ranges from 0.37 to 0.59 in the other countries. The U.S. and U.K. coefficients, which may seem surprisingly high, indicate the response in the first two years, not just the first year.[5]

[5]There is no reason why only one lag of unemployment or output should appear in the original hysteresis

The impact effect of nominal demand changes on inflation in the United States is much higher during wartime than peacetime in the United States and United Kingdom, and is higher before 1893 in the United States. Significant extra impacts of nominal demand are evident in part or all of the peacetime prewar era in France and Japan. The interpretation of these nominal demand coefficients must be made with care in view of simultaneity. To the extent that there is feedback within the current year between inflation and the determinants of nominal GNP growth, the coefficients on $\hat{y}_t$ combine the pure supply-side coefficient $[\beta/(1+\beta)]$ in (7) with the current-year demand feedback effect.

Recall that the main focus of the paper is on the prediction of the full hysteresis hypothesis that the Phillips curve "level" effect is absent from inflation equations, that is, we want to know whether the division of nominal GNP changes between price and quantity changes depends on $\hat{Q}_{t-1}$. This level effect is highly significant in France and Japan for both positive and negative values. Asymmetry is evident for the United States and United Kingdom, where the coefficient on $\hat{Q}_{t-1}$ is at or near zero, and is significantly smaller for negative than for positive values. Germany is the outlier with the opposite pattern from that of the United States and United Kingdom, with a significant influence of negative values but none for positive values.

### III. Conclusion

This paper interprets hysteresis as implying the absence of a level effect of unemployment or output through which "self-correcting" or "gap-closing" price adjustment automatically occurs, without the need for policy intervention. The NRH emerges from my empirical investigation of a century of data for five countries tattered and frayed, but at least partially intact. A strong and symmetric output level effect is found in France and Japan, and asymmetric effects in the United States, United Kingdom, and Germany. In no country is full hysteresis supported.

The results raise a caution flag for those offering hasty generalizations about the inflation process. Viewed from a century's experience in the largest industrialized nations, almost every conceivable pattern has emerged, from the highly flexible prices that have characterized the Japanese economy since its early industrialization, to the sticky, inertia-prone pattern evident in the postwar United States. While inflation persistence is a purely postwar phenomenon, and is absent altogether in the history of the United Kingdom and Japan, traces of hysteresis are evident throughout the past century in the form of evidence that prolonged economic slumps have exerted little or no downward pressure on prices in the United States and the United Kingdom.

equation (2). With two lags there, equation (7) can be transformed to contain the current and first lagged value of $\hat{y}$ and the second lagged value of $\hat{Q}$. Statistical significance of the first lagged $\hat{y}$ term dictated this form for the U.S. and U.K..

## REFERENCES

**Ball, Laurence, Mankiw, N. Gregory and Romer, David,** "The New Keynesian Economics and the Output-Inflation Trade-off," *Brookings Papers on Economic Activity*, 1:1988, *19*, 1–65.

**Balke, Nathan and Gordon, Robert J.,** "The Estimation of Prewar GNP: Methodology and New Results," *Journal of Political Economy*, February 1989, *97*, 38–92.

**Blanchard, Olivier J. and Summers, Lawrence H.,** "Hysteresis and the European Unemployment Problem," in S. Fischer, ed., *NBER Macroeconomics Annual 1986*, Cambridge: MIT Press, 1986, 15–78.

**Feinstein, C. H.,** *National Income, Expenditure and Output of the United Kingdom, 1855–1965*, Cambridge: Cambridge University Press, 1972.

**Friedman, Milton,** "The Role of Monetary Policy," *American Economic Review*, March 1968, *58*, 1–17.

**Gordon, Robert J.,** "A Century of Evidence on Wage and Price Stickiness in the United States, the United Kingdom, and Japan,"

in James Tobin, ed., *Macroeconomics, Prices, and Quantities*, Washington: Brookings Institution, 1983, 85–120.

_____, "Back to the Future: European Unemployment Today Viewed from America in 1939," *Brookings Papers on Economic Activity* 1:1988, *19*, 271–304.

_____, *Macroeconomics*, 4th ed., Boston: Little Brown, 1987.

**Lawrence, Robert Z. and Schultze, Charles L.,** *Barriers to European Growth: A Transatlantic View*, Washington: Brookings Institution, 1987.

**Maddison, Angus,** Phases of Capitalist Development, Oxford: Oxford University Press, 1982.

**Ohkawa, Kazushi, and Shinohara, Mihohei,** *Patterns of Japanese Economic Development: A Quantitative Appraisal*, New Haven: Yale University Press, 1979.

**Romer, Christina,** "The Prewar Business Cycle Reconsidered: New Estimates of Gross National Product, 1869–1908," *Journal of Political Economy*, February 1989, *97*, 1–37.

**Sargent, Thomas J.,** "A Note on the 'Accelerationist' Controversy," *Journal of Money, Credit and Banking*, August 1971, *3*, 721–25.

**Solomou, Solomos,** *Phases of Economic Growth, 1850–1973*, Cambridge: Cambridge University Press, 1987.