Is “High” Capacity Utilization Inflationary?

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Capacity utilization in U.S. industry features prominently in discussions of inflation. This prominence derives from the widely held viewpoint that “high” rates of capacity utilization are tantamount to resource-shortage conditions or “bottlenecks” that inevitably erupt into price inflation. For instance, an article in Citicorp’s *Economic Week* (January 18, 1994) argues: “In the past, a utilization rate swinging up toward the 84%–85% range was a source of much anxiety. Usually when the rate got that high, production bottlenecks started to appear. . . . Shortages developed. And soon, key price indexes were shooting up.” In the *American Banker* (January 12, 1994), Stephen Davies points out: “Economists say that, historically, there has been a connection between a healthier industrial sector and rising prices. That’s because factories start to run into bottlenecks in which supplies and labor are short” (p. 1). And in an article in *Barron’s* (June 20, 1994), Gene Epstein states, “Capacity utilization should remain below 85%, the assumed inflationary danger zone” (p. 48). A concomitant viewpoint is that when capacity utilization is “low,” the economy is in the inflationary *safe* zone. The threshold defining “high” and “low” rates of capacity utilization is often 85 percent, as the above quotations exemplify.

The purpose of the present study is to outline the theory underlying these popular views and to evaluate it in terms of its ability to explain the facts about the U.S. economy. To accomplish this task, the article proceeds as follows. Section 1 isolates and discusses the core features of the theory. Section 2 presents the evidence on the relationship between capacity utilization and inflation and related evidence on the linkage between cyclical GDP and inflation. Section 3 assesses the theory in terms of its ability to explain the evidence. Finally, Section 4 concludes with a summary and suggestions for future research.

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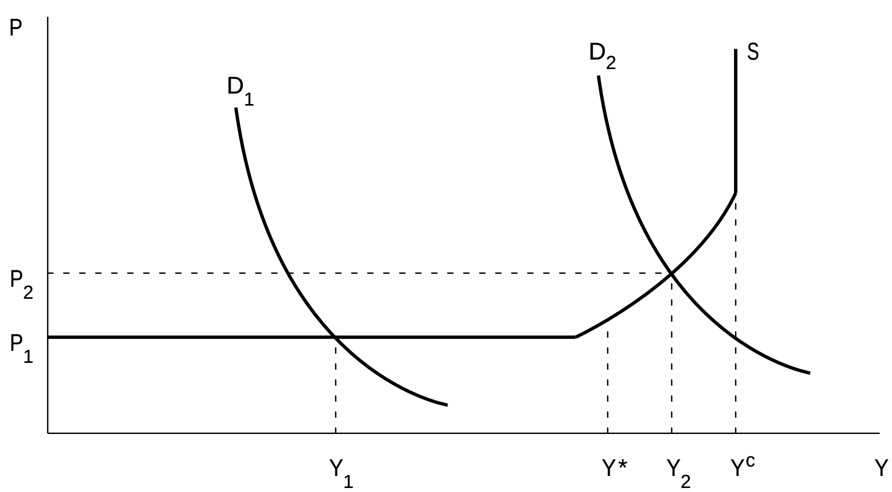
1. THE THEORY

The theory supporting the view that high rates of capacity utilization are inflationary has not been fully articulated. Yet, it seems to be a variant of traditional Keynesian theory. Figure 1 illustrates the key elements of this theory. In this figure, P is the general price level, Y is aggregate real output, Y^* is the full-employment level of output, Y^c is the capacity level of output, D_1 and D_2 denote alternative aggregate demand curves, and S is the aggregate supply curve.

Figure 1 shows that the intersection between aggregate demand and supply determines the price level and output. It is a snapshot of the economy over the time horizon relevant for the study of business cycles, the short run. For this horizon, the fixed capacity output level, Y^c, provides the effective "lid" on the economy. Cyclical fluctuations in output correspond to deviations of actual output, Y, from the constant full-employment output level, Y^*. Resources are less than fully employed when $Y < Y^*$, while they are more than fully employed when $Y > Y^*$—that is, people and capital work overtime. The cyclical fluctuations in output are driven by shifts in the aggregate demand curve, stemming from changes in consumption, investment and government expenditures or in the stock of money. The figure abstracts from economic growth, a long-run phenomenon, which can be imagined as increasing Y^* and Y^c gradually over time and also shifting the demand and supply curves outward slowly over time. Such growth is due to improvements in technology and increases in the stock of capital and the work force.

In this theory, the aggregate supply curve is nonlinear. This nonlinearity implies that the relationship between the price and output responses to demand

Figure 1 A Keynesian Theory



shifts depends on the *level* of real output or, alternatively, the *level* of overall resource use in the economy. At low levels of output, say $Y = Y_1$, resources such as labor and capital are underemployed. Firms can obtain as much of these resources as they wish at constant wages and rents. Therefore, firms are willing to supply whatever amount of final goods is demanded at the existing price level, P_1. When output is high, say $Y = Y_2$, the story is different. Now resources are more than fully employed—capital and labor are working overtime. If firms want to increase resource usage, they must offer higher wages and rents. Consequently, firms are willing to accommodate demand expansions only if they can pass along the resource price increases to consumers in the form of higher final goods prices. Moreover, these price increases occur at an increasing rate as Y^c is approached and resources become increasingly overworked. In short, at low output levels, a rise in demand causes a rise in output with little or no accompanying price inflation. When output is high, demand expansions cause both output increases and rising inflation.[1]

The Federal Reserve’s capacity utilization rate for total U.S. industry is the ratio of actual to capacity industrial production. The capacity industrial production index attempts “to capture the concept of sustainable practical capacity, which is defined as the greatest level of output that a plant can maintain within the framework of a realistic work schedule, . . . assuming sufficient availability of inputs to operate the machinery and equipment in place” (Federal Reserve Statistical Release G.17, March 15, 1994, p. 18). Thus, the capacity utilization rate intends to measure Y/Y^c. The above theory explains the attention devoted to tracking the capacity utilization rate in discussions of inflation.

The isolation of the central features of the theory immediately invites some criticism and questions. First, the concept of capacity output relies on the *impossibility* of quickly expanding the work force, capital stock and technological knowledge. But the work force *is* elastic *even* in the short run—for example, retired workers and young adults acquiring education *can* be induced to enter the work force. New investments and bringing back “on line” previously obsolete capital *can* rapidly increase the stock of capital. Improvements in technology, leading to more efficient production techniques and labor-saving capital equipment, *can* quickly occur as well. These points are emphasized in recent discussions in *The Wall Street Journal* (Harper and Myers, June 6, 1994) about “companies forced to buy equipment to keep up with technological improvements” (p. A6) and in *The New York Times* (Uchitelle, April 24, 1994): “Labor-saving machinery permits the extra production with fewer workers” (p. 24).

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[1] Notice that there is an ambiguity in the theory. It is not clear how the theory develops the relationship between the *level* of output and the *rate of change* of prices. A strict interpretation of the theory’s underlying arguments points to a relationship between the *levels* of output and prices.

Second, the short-run changes in the work force, capital stock and technology will impact on deviations of Y from Y^*, since they shift the aggregate supply curve. Therefore, cyclical output fluctuations may not always be demand driven. Indeed, quantitative real business cycle theory shows that between 54 and 70 percent of the postwar output fluctuations in the United States can be explained by short-run changes in technology (see Kydland and Prescott [1991] and Aiyagari [1994]).

Third, the possible variation in the relationship between price and output responses to demand shocks rests on the presumed existence of a critical level, or levels, of output at which underemployment of resources sets in and prices no longer adjust so as to clear the goods and factor markets. It is difficult to see why such critical levels should exist. The theory is silent on this issue.

Thus, there are some good reasons for wondering whether the theory connecting high capacity utilization with inflation provides a useful guide in explaining the real world. Therefore, the questions arise: What are the facts on the relationship between capacity utilization and inflation? Is the Keynesian theory consistent with these facts?

2. THE EVIDENCE

The Empirical Data

The evidence examined here involves seasonally adjusted, quarterly data for the United States over the period 1953:1–1994:1. A complete description of the data is in the appendix. The individual series will be gradually introduced into the discussion.

Regarding the above theory, two *theoretical* variables measure the overall degree of resource utilization: Y/Y^c and Y/Y^*. Trend output growth does not affect these variables since it affects the numerators and denominators to the same extent. Consequently, movements in these variables are purely cyclical in nature. Furthermore, they bear a perfect positive relationship to one another—stemming from the common cyclical variation in Y. Also notice that the average values of Y/Y^c and Y/Y^*, when taken over the long run, are Y^*/Y^c and Y^*/Y^* respectively—since in the long run the temporary cyclical deviations of Y from Y^* do not, by definition, occur.

The closest *empirical* counterparts to Y/Y^c and Y/Y^* are the capacity utilization rate and cyclical per-capita GDP (henceforth referred to as cyclical GDP), respectively. The former measure was described earlier. Cyclical GDP is the percentage deviation of per-capita GDP from its smoothly evolving time trend.[2] Both empirical variables exhibit purely cyclical variations. The mean

[2] This trend is derived by using the Hodrick-Prescott filtering method (with the "smoothing" parameter value set equal to 1600). See Kydland and Prescott (1990) for a description of the method.

value of utilization provides an estimate of Y^*/Y^c; the mean value of cyclical GDP is zero (i.e., it is an estimate of the logarithm of Y^*/Y^*). In contrast to the perfect sychronization between movements in the theoretical variables, Y/Y^c and Y/Y^*, movements in the utilization rate and cyclical GDP may diverge for at least two reasons.[3,4] First, the underlying output measures are different—the utilization rate uses industrial production, while cyclical GDP uses the more comprehensive production measure, GDP. Second, cyclical GDP captures output relative to its smoothly evolving trend, while capacity utilization is output relative to its capacity level. Even though the theory assumes that the trend growth in Y^* and Y^c is the same, there is no reason why this has to hold in the data.

Figure 2 shows the capacity utilization rate and cyclical GDP. The two series move together closely but not perfectly. The contemporaneous correlation between the series is 0.74.[5] Movements in the two variables are sufficiently different that both merit attention as alternative measures of resource utilization from the point of view of the Keynesian theory.

The capacity utilization rate is shown with the inflation rate in Figure 3. Inflation is measured by the quarter-to-quarter annualized percentage change in the CPI. Notice that there are time periods when the utilization rate is both high (in excess of 85 percent) and rising and inflation is also rising—for example, during 1964 and 1972. This is consistent with the theory. But, there are also periods of high utilization when utilization and inflation move in opposite directions. For example, early in 1955 and 1965, *rising* utilization simultaneously occurs with *falling* inflation, and during most of 1973–74 and 1979, *falling* utilization coincides with *rising* inflation. Furthermore, during much of the time when utilization is low and variable, inflation exhibits substantial variation. These episodes are inconsistent with the theory. A similar story emerges regarding cyclical GDP and inflation. It is depicted in Figure 4. The upshot is that the linkage between high utilization or high cyclical GDP and inflation is not immutable; neither is the linkage between low utilization or low cyclical GDP and inflation.

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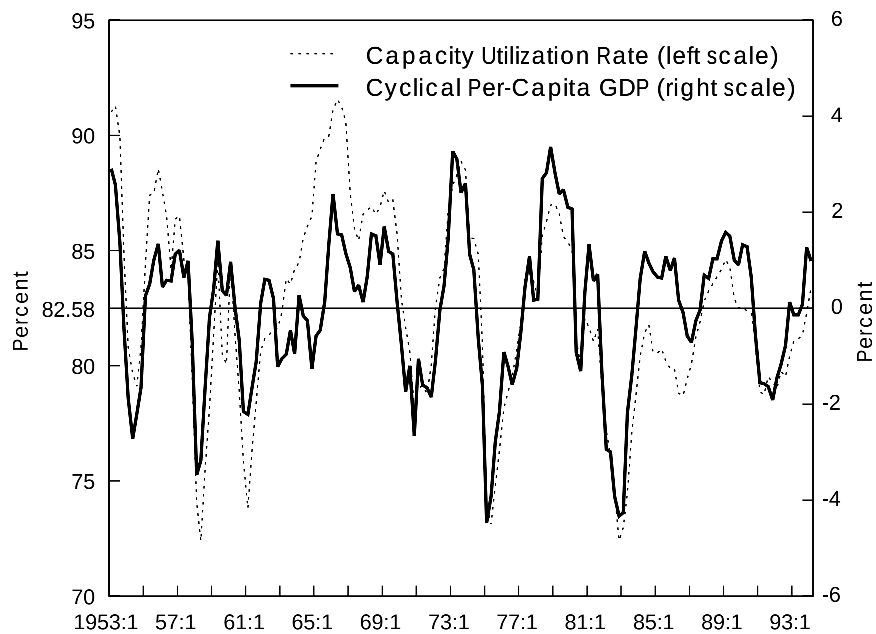
[3] Notice that cyclical GDP measures $\log(Y/Y^*)$. The exponential of cyclical GDP gives a measure of Y/Y^*, which is in comparable units to the utilization rate. This exponential transformation makes no substantive difference to the quantitative analysis, a reflection of the transformation being close to a linear one (at least for the underlying range of variation in cyclical GDP). It is not undertaken for the quantitative analysis discussed in the article since it is common practice to measure cyclical GDP as a percentage *deviation,* not a *ratio* (again see Kydland and Prescott [1990]).

[4] See Shapiro (1989) for a detailed description and discussion of the capacity utilization rate.

[5] The correlation between capacity utilization and cyclical per-capita industrial production is higher. It is 0.82. This shows that the second reason explaining the difference between utilization and cyclical per-capita GDP is the more important of the two reasons.

Figure 2 Capacity Utilization Rate and Cyclical Per-Capita GDP



Notes: (1) Cyclical per-capita GDP is the percentage deviation of per-capita GDP from its Hodrick-Prescott trend component. (2) The horizontal line is drawn at the mean of both variables.

Regression Analysis

Here regression analysis quantifies the *average* historical relationships between inflation and each of the two real economic activity variables. The analysis also tests the significance and possible asymmetries in those relationships.

The regression equation with capacity utilization is

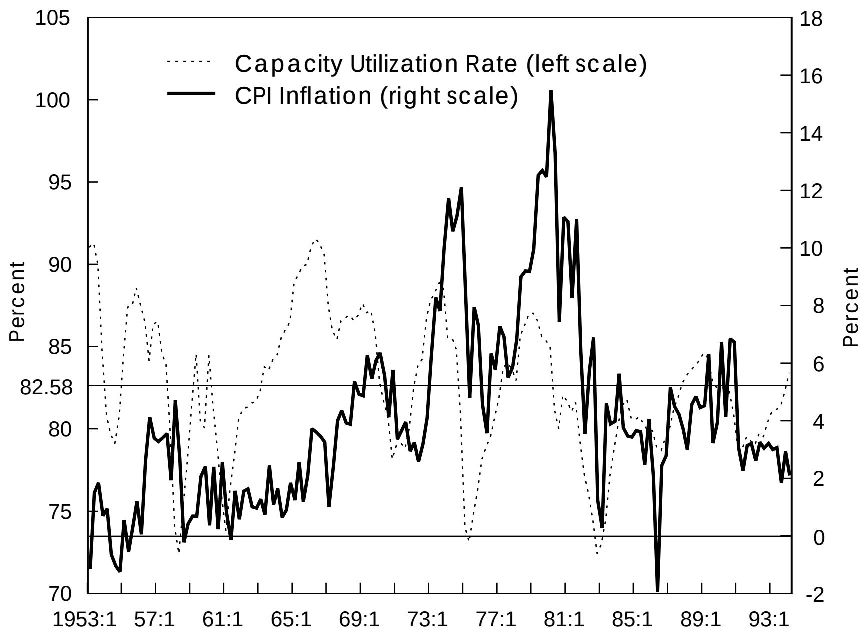
$$\pi_t = \alpha_0 + \alpha_1 \pi_{t-1} + \alpha_2 \pi_{t-2} + \alpha_3 \pi_{t-3} + \beta_h u_t^h + \beta_l u_t^l + \epsilon_t. \qquad (1)$$

Including cyclical GDP, the regression equation is

$$\pi_t = \alpha_0 + \alpha_1 \pi_{t-1} + \alpha_2 \pi_{t-2} + \alpha_3 \pi_{t-3} + \gamma_h y_t^h + \gamma_l y_t^l + v_t. \qquad (2)$$

π_t is the time t inflation rate, $u_t^h (u_t^l)$ is the time t utilization rate series pertaining to high (low) utilization rates and $y_t^h (y_t^l)$ is the time t cyclical GDP series corresponding to high (low) cyclical GDP. These high and low series are explained more fully below. ϵ_t and v_t are disturbance terms at time t. The α_i $(i = 0,\ 1,\ 2,\ 3)$, β_i $(i = h,\ l)$ and γ_i $(i = h,\ l)$ are parameters.

Figure 3 Capacity Utilization Rate and CPI Inflation



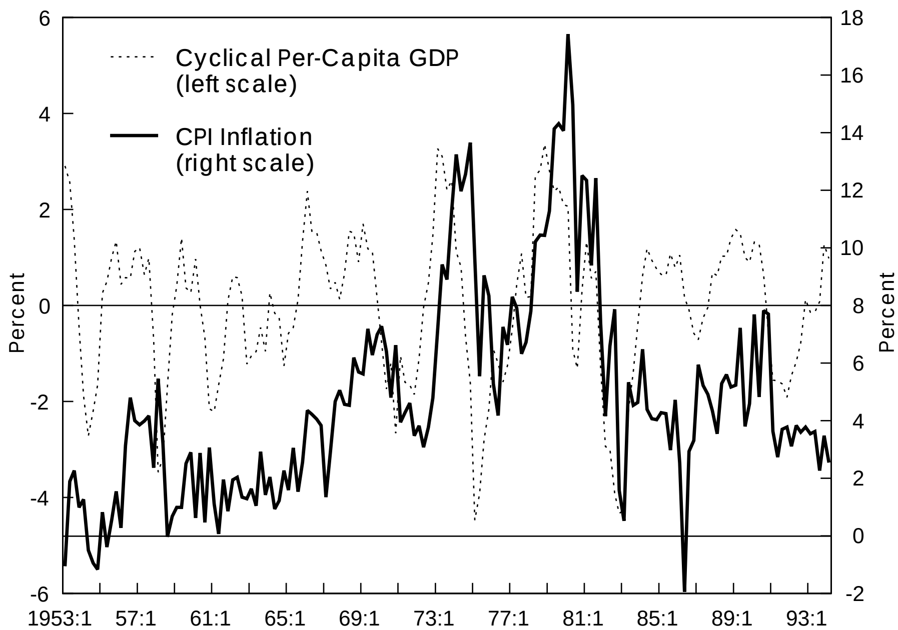
Notes: (1) CPI inflation is measured quarter to quarter at an annualized rate. (2) The horizontal lines are drawn at the mean of the utilization rate and zero CPI inflation.

The equations include three lagged values of the inflation series. Their inclusion is essential to ensure an adequate specification—omitting lagged inflation results in equations with almost no explanatory power. The choice of lag length is predicated on a sequence of F-tests, which establish that additional lagged values of the inflation series are statistically insignificant. Allowing inflation to depend on its lagged values constitutes a generalization of the simple, static Keynesian theory to admit persistence in the inflation process.

In line with the theory, it is the *contemporaneous* values of the real economic activity variables that enter into the regression equations. Their coefficients indicate the magnitude of the average, contemporaneous relationship obtaining between them and inflation, given the past path of inflation. A sequence of F-tests establishes that lagged values of the real economic activity series are insignificant once the contemporaneous values are accounted for in the regression equations.

To test for possible asymmetry in the relationship between utilization and inflation, one must first specify a threshold value defining high and low

Figure 4 Cyclical Per-Capita GDP and CPI Inflation



Notes: (1) Cyclical per-capita GDP is the percentage deviation of per-capita GDP from its Hodrick-Prescott trend component. CPI inflation is measured quarter to quarter at an annualized rate. (2) The horizontal lines are drawn at the mean of cyclical per-capita GDP and zero CPI inflation.

utilization rates and then create corresponding high and low utilization rate series. This exercise is accomplished as follows. Initially the utilization rate is expressed in terms of deviations from its mean. If r_t denotes the time t utilization rate and $\overline{r}$ its mean (equaling 82.58 percent), then $u_t = r_t - \overline{r}$ is the time t deviation of utilization from its mean. The threshold value is set at 85 percent since that value is the one most often used in media discussions. Two new variables, u_t^h and u_t^l, are then derived as follows:

$$u_t^h = u_t \text{ if } r_t \ \geq \ 85 \text{ percent and zero otherwise;}$$
$$u_t^l = u_t \text{ if } r_t \ < \ 85 \text{ percent and zero otherwise.}$$

Should a difference exist between the coefficients of u_t^h and u_t^l, it signifies a difference in the relationship between inflation and each of high and low rates of utilization.[6]

[6] It is important to express the utilization rate, r_t, as a deviation from its mean before deriving the u_t^h and u_t^l series. Not doing so results in series, say $\overline{u}_t^h$ and $\overline{u}_t^l$, that have a correlation equaling -0.99, causing extreme multicollinearity problems in the regression equation. By contrast, u_t^h and u_t^l are mildly correlated (with correlation 0.32), so multicollinearity problems do not arise.

A similar procedure is followed regarding cyclical GDP, the time t value of which is denoted by y_t. By construction, y_t has a zero mean. Using a threshold value equal to one standard deviation above the mean of y_t (equaling 0.0175), one can derive the two variables, y_t^h and y_t^l:

$$y_t^h = y_t \text{ if } y_t \geq 0.0175 \text{ and zero otherwise;}$$
$$y_t^l = y_t \text{ if } y_t < 0.0175 \text{ and zero otherwise.}$$

A difference between the coefficients of y_t^h and y_t^l would mean a difference in the relationship between inflation and each of high and low cyclical GDP.[7]

The regression results for equation (1) are presented in the top panel of Table 1. The coefficients of u_t^h and u_t^l are $\beta_h = 0.10$ and $\beta_l = 0.19$. They are individually significant (that is, significant at the 5 percent level). An F-test of the hypothesis $\beta_h = \beta_l$ strongly indicates nonrejection at significance level 0.28. In other words, the evidence suggests that the relationship between inflation and utilization is the *same* regardless of whether or not the utilization rate is high.

Setting $\beta_h = \beta_l = \beta$ improves the precision of the estimation and therefore leads to the preferred regression equation:

$$\pi_t = \alpha_0 + \alpha_1\pi_{t-1} + \alpha_2\pi_{t-2} + \alpha_3\pi_{t-3} + \beta u_t + \epsilon_t. \quad (3)$$

The findings for this equation are displayed in the lower panel of Table 1. The coefficient of u_t is $\beta = 0.15$, which is significant. The relationship between capacity utilization and inflation is a significantly positive one—with a one percentage point increase in utilization being associated, on average, with a 0.15 percentage point increase in inflation.

The top panel of Table 2 gives the regression results for equation (2). The coefficients of y_t^h and y_t^l are found to be $\gamma_h = 0.58$ and $\gamma_l = 0.36$, respectively. Both are individually significant. The hypothesis $\gamma_h = \gamma_l$ cannot be rejected, using an F-test, at a fairly high significance level of 0.38. Once again, the evidence reveals no important asymmetry.

Setting $\gamma_h = \gamma_l = \gamma$ yields a more precise estimation, leading to the preferred specification:

$$\pi_t = \alpha_0 + \alpha_1\pi_{t-1} + \alpha_2\pi_{t-2} + \alpha_3\pi_{t-3} + \gamma y_t + v_t. \quad (4)$$

The lower panel of Table 2 shows the findings for this equation. The coefficient of y_t is $\gamma = 0.45$. It is significant. A one percentage point increase in the deviation of per-capita GDP from its trend path has been linked with a 0.45 percentage point increase in inflation, on average.

[7] The findings, to be discussed below, are robust to alternative choices of thresholds. More exactly, for utilization threshold values equaling 82.58 percent and 80 percent, and for cyclical GDP threshold values equal to zero and one standard deviation *below* the mean of y_t (-0.0175), similar findings obtain.

Table 1 Regression Results for Inflation-Utilization Relationship, 1953:1–1994:1

Regression Equation (with utilization threshold value = 85%)

$$\pi_t = \alpha_0 + \alpha_1\pi_{t-1} + \alpha_2\pi_{t-2} + \alpha_3\pi_{t-3} + \beta_h u_t^h + \beta_l u_t^l + \epsilon_t$$

$\alpha_0 = 0.38$	$\alpha_1 = 0.58$	$\alpha_2 = -0.05$	$\alpha_3 = 0.41$	$\beta_h = 0.10$	$\beta_l = 0.19$
(1.70)	(8.20)	(−0.61)	(5.77)	(2.07)	(4.04)

$\overline{R}^2 = 0.80$ DW = 1.94

For test of hypothesis $\beta_h = \beta_l$, F(1, 159) = 1.19 (0.28)

Regression Equation (imposing $\beta_h = \beta_l$)

$$\pi_t = \alpha_0 + \alpha_1\pi_{t-1} + \alpha_2\pi_{t-2} + \alpha_3\pi_{t-3} + \beta u_t + \epsilon_t$$

$\alpha_0 = 0.25$	$\alpha_1 = 0.58$	$\alpha_2 = -0.05$	$\alpha_3 = 0.41$	$\beta = 0.15$
(1.32)	(8.25)	(−0.62)	(5.73)	(5.12)

$\overline{R}^2 = 0.80$ DW = 1.94

Notes: (1) The number of observations is 165. (2) t-statistics are in parentheses below the corresponding coefficient values. (3) $\overline{R}^2$ is the regression goodness-of-fit statistic. DW is the Durbin-Watson statistic. (4) The F-statistic with the relevant degrees of freedom is denoted by F (. , .); its significance level follows in parentheses.

Table 2 Regression Results for Inflation-Cyclical GDP Relationship, 1953:1–1994:1

Regression Equation

(with cyclical GDP threshold value = one standard deviation above its mean)

$$\pi_t = \alpha_0 + \alpha_1\pi_{t-1} + \alpha_2\pi_{t-2} + \alpha_3\pi_{t-3} + \gamma_h y_t^h + \gamma_l y_t^l + v_t$$

$\alpha_0 = 0.26$	$\alpha_1 = 0.55$	$\alpha_2 = -0.05$	$\alpha_3 = 0.40$	$\gamma_h = 0.58$	$\gamma_l = 0.36$
(1.21)	(7.94)	(−0.58)	(5.88)	(3.59)	(2.78)

$\overline{R}^2 = 0.81$ DW = 1.99

For test of hypothesis $\gamma_h = \gamma_l$, F(1, 159) = 0.78 (0.38)

Regression Equation (imposing $\gamma_h = \gamma_l$)

$$\pi_t = \alpha_0 + \alpha_1\pi_{t-1} + \alpha_2\pi_{t-2} + \alpha_3\pi_{t-3} + \gamma y_t + v_t$$

$\alpha_0 = 0.36$	$\alpha_1 = 0.55$	$\alpha_2 = -0.04$	$\alpha_3 = 0.41$	$\gamma = 0.45$
(1.94)	(8.02)	(−0.54)	(5.94)	(6.23)

$\overline{R}^2 = 0.81$ DW = 1.99

Notes: See notes for Table 1.

Forecasting Analysis

Another way of gauging the linkages between inflation and each of the two real economic activity variables is to assess the marginal predictive content of the latter variables for inflation. This assessment is done as follows. First, u_{t-1} and y_{t-1} replace u_t and y_t, respectively, in equations (3) and (4) to give the forecasting equations:

$$\pi_t = \alpha_0 + \alpha_1\pi_{t-1} + \alpha_2\pi_{t-2} + \alpha_3\pi_{t-3} + \beta u_{t-1} + \epsilon_t \tag{5}$$

and

$$\pi_t = \alpha_0 + \alpha_1\pi_{t-1} + \alpha_2\pi_{t-2} + \alpha_3\pi_{t-3} + \gamma y_{t-1} + v_t. \tag{6}$$

Omitting the real variables gives the univariate forecasting equation:

$$\pi_t = \alpha_0 + \alpha_1\pi_{t-1} + \alpha_2\pi_{t-2} + \alpha_3\pi_{t-3} + d_t, \tag{7}$$

where d_t is the time t disturbance term. All right-hand-side variables in these equations are in the time $t-1$ information set. Consequently, the disturbance terms ϵ_t, v_t and d_t are the one-period-ahead forecasting errors.

The estimation results for equations (5)–(7), over the period 1953:1–1994:1, are presented in Table 3. The findings for equations (5) and (6) are similar to those for equations (3) and (4), respectively—a reflection of u_t and y_t being highly autocorrelated.

By sequentially estimating (5), (6) and (7) over the 17 sample periods that start in 1953:1–1990:1, increasing by one quarter at a time and ending with 1953:1–1994:1, one can generate a sequence of 17 one-period-ahead forecasting errors for each equation.[8] Computing and then comparing the mean squared forecast errors (MSE) of the equations allows one to assess the marginal predictive content of utilization and cyclical GDP for inflation. Ireland (1995) introduces this measure of predictive contribution.

Table 4 lists the MSE for each forecasting equation. The ratio of the MSE for the utilization-inflation equation to the MSE for the univariate equation is 0.87. In the case of the cyclical GDP-inflation equation, the ratio of MSE is 0.82. These findings highlight that both utilization and cyclical GDP have substantial predictive power for inflation, over and above that stemming from the accounting for past inflation behavior. Also cyclical GDP has the edge on the utilization rate in this respect.

The forecasting results naturally lead to the question: Does utilization have predictive content for inflation once account is taken of past inflation *and* cyclical GDP? To answer this, Table 3 gives the estimation findings (1953:1–1994:1) for the forecasting equation that includes *both* utilization and cyclical GDP:

$$\pi_t = \alpha_0 + \alpha_1\pi_{t-1} + \alpha_2\pi_{t-2} + \alpha_3\pi_{t-3} + \beta u_{t-1} + \gamma y_{t-1} + b_t, \tag{8}$$

[8] Each forecasting equation is stable over various forecasting periods.

Table 3 Regression Results for the Forecasting Equations, 1953:1–1994:1

Forecasting Equation with Utilization

$$\pi_t = \alpha_0 + \alpha_1\pi_{t-1} + \alpha_2\pi_{t-2} + \alpha_3\pi_{t-3} + \beta u_{t-1} + \epsilon_t$$

$\alpha_0 = 0.34$ (1.73)	$\alpha_1 = 0.58$ (8.02)	$\alpha_2 = -0.06$ (−0.66)	$\alpha_3 = 0.40$ (5.45)	$\beta = 0.13$ (4.47)	
$\overline{R}^2 = 0.79$	DW = 1.88				

Forecasting Equation with Cyclical GDP

$$\pi_t = \alpha_0 + \alpha_1\pi_{t-1} + \alpha_2\pi_{t-2} + \alpha_3\pi_{t-3} + \gamma y_{t-1} + v_t$$

$\alpha_0 = 0.45$ (2.37)	$\alpha_1 = 0.54$ (7.36)	$\alpha_2 = -0.05$ (−0.62)	$\alpha_3 = 0.41$ (5.78)	$\gamma = 0.41$ (5.34)	
$\overline{R}^2 = 0.80$	DW = 1.90				

Univariate Forecasting Equation

$$\pi_t = \alpha_0 + \alpha_1\pi_{t-1} + \alpha_2\pi_{t-2} + \alpha_3\pi_{t-3} + d_t$$

$\alpha_0 = 0.36$ (1.73)	$\alpha_1 = 0.66$ (8.89)	$\alpha_2 = -0.06$ (−0.64)	$\alpha_3 = 0.31$ (4.21)		
$\overline{R}^2 = 0.77$	DW = 1.88				

Forecasting Equation with Utilization and Cyclical GDP

$$\pi_t = \alpha_0 + \alpha_1\pi_{t-1} + \alpha_2\pi_{t-2} + \alpha_3\pi_{t-3} + \beta u_{t-1} + \gamma y_{t-1} + b_t$$

$\alpha_0 = 0.43$ (2.23)	$\alpha_1 = 0.54$ (7.36)	$\alpha_2 = -0.05$ (−0.63)	$\alpha_3 = 0.42$ (5.81)	$\beta = 0.03$ (0.69)	$\gamma = 0.34$ (2.83)
$\overline{R}^2 = 0.80$	DW = 1.90				

Notes: See notes for Table 1.

where b_t is the one-period-ahead forecast error. The coefficient of u_{t-1}, $\beta = 0.03$, is insignificant, while that of y_{t-1}, $\gamma = 0.34$, is significant.

This finding suggests that utilization does not have independent predictive content for inflation. But this conclusion, based on the relative significance of β and γ, must be tempered by the recognition that the high collinearity between u_{t-1} and y_{t-1}, noted earlier, makes it difficult to disentangle the relative predictive contributions of u_{t-1} and y_{t-1}. What *is* revealing is that the predictive relationship between inflation and cyclical output, specified by equation (6), is sufficiently stronger than that between inflation and utilization, given by equation (5), so that y_{t-1} is still significant even when u_{t-1} is included in the forecasting equation for inflation.

Table 4 Forecasting Results for Inflation, 1990:1–1994:1

Forecasting Equation with Utilization, Equation (5)

$$\pi_t = \alpha_0 + \alpha_1\pi_{t-1} + \alpha_2\pi_{t-2} + \alpha_3\pi_{t-3} + \beta u_{t-1}$$

$$MSE^5 = 1.4599$$

Forecasting Equation with Cyclical GDP, Equation (6)

$$\pi_t = \alpha_0 + \alpha_1\pi_{t-1} + \alpha_2\pi_{t-2} + \alpha_3\pi_{t-3} + \gamma y_{t-1}$$

$$MSE^6 = 1.3723$$

Univariate Forecasting Equation, Equation (7)

$$\pi_t = \alpha_0 + \alpha_1\pi_{t-1} + \alpha_2\pi_{t-2} + \alpha_3\pi_{t-3}$$

$$MSE^7 = 1.6818$$

Mean Squared Error Ratios

$MSE^5/MSE^7 = 0.8681$ $MSE^6/MSE^7 = 0.8159$

Notes: (1) Forecasts are one-period-ahead forecasts. The number of forecasts is 17. (2) MSE^i is the mean squared forecasting error for forecasting equation i ($i = 5, 6, 7$).

3. ASSESSING THE THEORY

The empirical evidence, presented above, on the relationship between inflation and either capacity utilization or cyclical GDP provides a basis for evaluating the Keynesian theory that connects high resource usage with inflationary conditions.

Analysis of the time profiles of the data establishes that utilization or cyclical GDP does not always move together with the inflation rate. There are several episodes during which inflation and utilization or cyclical GDP move in the opposite direction. For example, during 1973–74 and 1979, *falling* utilization rates and cyclical GDP coincided with *rising* inflation rates. The theory cannot account for episodes such as these. Thus, the theory’s assumption that the aggregate supply curve and associated capacity output level are constant over the business cycle is called into question. For if the supply curve were fixed, inflation and utilization or cyclical GDP would always move in the same direction.

The empirical regression analysis confirms, on average, the theory’s prediction of a positive relationship between utilization or cyclical GDP and inflation. A one percentage point increase in the utilization rate (cyclical GDP) is associated, on average, with a 0.15 (0.45) percentage point increase in the rate of inflation. But, the regressions also indicate that the asymmetries predicted by the theory are not present in the data. That is, the utilization-inflation relationship is the same regardless of whether the utilization rate is high or low, and the stage of the cycle is immaterial to the cyclical GDP-inflation relationship. This casts doubt on the theory's joint assumption of a fixed and nonlinear supply curve. Alternatively expressed, there is no evidence of the existence of immutable threshold levels of utilization or cyclical GDP, levels at which underemployment of resources sets in and prices become relatively unresponsive to market conditions, as asserted by the theory.

The forecasting exercise lends support to the Keynesian theory by showing that both capacity utilization and cyclical GDP have substantial marginal predictive content for inflation. The alternative inclusion of utilization and cyclical GDP in an otherwise univariate forecasting equation for inflation reduces the mean squared one-period-ahead forecast error by 13 and 18 percentage points, respectively. Of the two measures of real economic activity, cyclical GDP exhibits the stronger predictive relationship with inflation, presumably because it is the broader measure of real economic activity. This finding, together with the high degree of correlation between utilization and cyclical GDP, suggests that there is nothing special about the capacity utilization rate relative to cyclical GDP in predicting price inflation. In other words, the empirical linkage between utilization and inflation evidently obtains only in so far as utilization is highly correlated with cyclical GDP.

4. CONCLUSION

Media discussions of inflation inextricably link high capacity utilization with inflationary conditions. The present study outlines the Keynesian theory underlying this viewpoint and then evaluates it in terms of its ability to explain the facts about the U.S. economy over the period 1953:1–1994:1. The outcome is summarized as follows.

First, capacity utilization has often moved in the opposite direction to that of inflation. Of particular note are the oil-price shock periods, 1973–1974 and 1979, when capacity utilization plummeted while inflation soared. The theory cannot explain such occurrences. Second, the relationship between utilization and inflation is, on average, a positive one as asserted by the theory; however, it is the same regardless of whether utilization is high or low, which conflicts with the theory. Third, the theory derives support from the facts that utilization helps predict future price inflation and that the broader measure of economic activity, cyclical GDP, works better than utilization as an inflation predictor.

The upshot of this evaluation is that problems for the Keynesian theory include not only misspecification of the channels through which shocks impact on the economy but also its ignoring of shocks to the supply side of the economy. More exactly, the evidence is not supportive of the theory's assumption of a nonlinear aggregate supply curve that remains constant over the business cycle. An alternative theory that drops the assumption of a nonlinear relationship between inflation and real economic activity and that incorporates both demand and supply shocks is called for. In particular, by including supply shocks the alternative theory has the potential to explain why inflation and real economic activity sometimes move in opposite directions.

One such alternative theory is that of Greenwood and Huffman (1987) and Coleman (1994). This theory emphasizes technology shocks as the main source of cyclical output fluctuations. It also stresses the endogenous responsiveness of the money supply to those shocks. Other alternative theories are advanced by Lucas (1975), Cho and Cooley (1992) and Ireland (1994). These theories feature significant sources of monetary nonneutralities, thereby allowing not only technology shocks but also money supply shocks to play an important role in driving cyclical output fluctuations. All of these theories offer explanations of the empirical relationship between inflation and cyclical output. They all show a relationship that is positive, but only on average, since opposite movements sometimes occur. Further research will reveal which of these theories or alternative theories provides the best explanation.

DATA APPENDIX

The data are quarterly, seasonally adjusted (unless otherwise indicated) and for the United States over the period 1952:1–1994:1. The 1952 data are used only in forming lagged variables for the regression analysis. The source for all data is the FAME database. A description of the individual series follows.

Inflation Rate:	CPI inflation measured quarter to quarter at an annualized rate. The average value of the underlying CPI index is 100 over the period 1982–1984.
Utilization Rate:	Total industry (consisting of manufacturing, mining and utilities) utilization rate for the period 1967:1–1994:1. Manufacturing industry utilization rate for the period 1952:1–1966:4.
Industrial Production:	Total industry output index, 1987 = 100.
Gross Domestic Product:	Gross domestic product measured at constant 1987 prices and in billions of dollars.
Population:	Civilian, noninstitutionalized, aged 16 and above, measured in thousands. This series is not seasonally adjusted.

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