NBER WORKING PAPER SERIES

INFLATION AND THE GROWTH RATE OF OUTPUT

Christina D. Romer

Working Paper 5575

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
May 1996

I am grateful to Robert Gordon, David Romer and, especially, Mark Watson for extremely helpful comments and suggestions, and to the National Science Foundation for financial support. This paper is part of NBER's research programs in Monetary Economics and Economic Fluctuations and Growth. Any opinions expressed are those of the author and not those of the National Bureau of Economic Research.

NBER Working Paper 5575
May 1996

INFLATION AND THE GROWTH RATE OF OUTPUT

ABSTRACT

This paper shows that inflation has depended strongly on the growth rate of output for most of the twentieth century. Only in recent years has the deviation of output from trend become the predominant determinant of price behavior. The paper also shows that the growth rate effect works primarily through materials prices, and that the declining importance of materials can explain why the growth rate effect has weakened over time. Finally, the paper shows that the growth rate effect can explain why prices rose in the mid- and late-1930s despite the fact that output was substantially below trend.

Christina D. Romer
Department of Economics
549 Evans Hall, #3880
University of California
Berkeley, CA 94720-3880
and NBER

INFLATION AND THE GROWTH RATE OF OUTPUT

I. INTRODUCTION

The behavior of prices in the mid-1930s is puzzling. Traditional Phillips curve specifications of the price-output relationship posit that prices respond positively to the deviation of real output from trend. And yet, between 1933 and 1937 the GDP implicit price deflator rose nearly 16% despite the fact that real GDP during these years was, on average, more than 30% below trend.

Economists have attempted to rescue the textbook formulations of aggregate supply for this period by arguing that an aggregate supply shock related to the National Industrial Recovery Act caused the rise in prices.[1] While the NIRA and other New Deal Programs may have affected prices some during the mid-1930s, this paper argues that the more fundamental explanation for the inflation during the recovery from the Great Depression lies in an alternative specification of the general relationship between prices and output. In particular, I suggest that inflation during this period depended more strongly on the growth rate of output than on the deviation of output from trend. Prices rose between 1933 and 1937 despite continued depression simply because output grew at the astronomical rate of 8.3% per year.

This possible relationship between inflation and output growth, first noted in a series of studies by Robert Gordon, is analyzed in detail in this paper.[2] I show that the growth rate effect is not just a characteristic of the 1930s and early 1940s, but rather a general feature of the American macroeconomy before 1973. More importantly, I also provide an explanation for why the effect existed for much of the late 19th and 20th centuries, and for why it may have declined in recent decades.

The paper begins with simple instrumental variables estimation of the price-output relationship for the United States for 1884-1994. The regressions reported in Section II show clearly that inflation is strongly correlated with the growth rate of output. Indeed, for the era before World War II, this growth rate effect thoroughly dominates any effect of the deviation of output from trend. These simple regressions also show that the growth rate effect appears to have declined over time. Indeed, for the period after 1973 it has largely disappeared.

The paper then analyzes the source of the relationship between inflation and output growth. The explanation presented is that the aggregate relationship is due primarily to the behavior of raw materials prices. For reasons described more fully in Section III, the supply of many raw materials is relatively inelastic in the short run. As a result, it is plausible that raw materials prices respond strongly to the growth rate of output. Since raw materials are an important input into the production of manufactured goods, this response of materials prices to output growth eventually appears, though to a lesser degree, in manufactured goods prices.

I test this explanation in two ways. First, I collect disaggregate data on the wholesale prices of raw materials and finished goods. I find that raw materials prices respond more strongly and more consistently to the growth rate of output than do finished goods prices. More importantly, controlling for the rate of change of materials prices eliminates nearly all of the effect of the growth rate of output on finished goods prices. In contrast, controlling for the behavior of finished goods prices does not eliminate the growth rate effect for materials prices. A more stringent test of the materials hypothesis asks whether the declining importance of raw materials in the U.S. economy can explain the measured decline in the growth rate effect. Using the fraction of GDP originating in agriculture, mining, forestry, and fisheries, I construct a series on the trend importance of raw materials. I find that when the growth rate effect is allowed to vary with this trend, the interaction is positive and highly significant. This implies that the growth rate effect has indeed weakened as the importance of materials has declined.

Section IV returns to the puzzling behavior of prices in the 1930s. I use simple simulations to show that the growth rate effect can account for much of the inflation that we observe in the United States between 1933 and the start of World War II. Furthermore, I show that material prices played exactly the driving role for inflation in this period that is predicted by the analysis in Section III.

II. EVIDENCE OF THE GROWTH RATE EFFECT

The first step in the analysis is to show that the growth rate of output has been an important determinant of inflation over much of the last century. To do this, I consider a straightforward extension of a standard Phillips curve regression, estimated in a somewhat non-standard way.

A. Specification

In its simplest form, a Phillips curve specification of the price-output relationship states that:

(1) $$\pi_t = \beta_0 + \beta_1 (y_t - \bar{y}_t) + \beta_3 \pi_{t-1} + \varepsilon_t ,$$

where π_t is the rate of inflation, y_t is the logarithm of real output, $\bar{y}_t$ is some measure of trend output, π_{t-1} reflects inflation inertia, and ε_t captures supply shocks. To test whether the growth rate of output also affects inflation, one could just add the percentage change in real output to the regression specification. That is, one could estimate:

$$(2) \qquad \pi_t = \beta_0 + \beta_1 (y_t - \bar{y}_t) + \beta_2 \Delta y_t + \beta_3 \pi_{t-1} + \varepsilon_t .$$

While specifying such an effect is trivial, actually estimating it is complicated because prices and real output are determined simultaneously. A negative shock to aggregate supply will cause inflation to rise and both the deviation of output from trend and the growth rate of real output to fall. Because of this likely correlation between the output variables and the error term, β_1 and β_2 are likely to be biased downward.

The most common way of dealing with this bias is to include proxies for supply shocks, such as the change in the relative price of oil or dummy variables for certain periods. But since it is not possible to control for all supply shocks, this approach can only partly solve the problem. An alternative approach is to use instrumental variables. If one can find variables that are correlated with the deviation of output from trend and the growth rate of output and are uncorrelated with the error term, it is possible to obtain consistent estimates of β_1 and β_2 .

A sensible instrument for the contemporaneous deviation of output from trend is the just the lagged deviation from trend. The lagged value is almost surely highly correlated with the contemporaneous value. Also, in annual data, the error term (representing supply shocks) is not likely to be strongly serially correlated. Therefore, there should be no important correlation between the lagged deviation from trend and the error term.

A possible instrument for the percentage change in real GDP is some weighted sum of inflation and the growth rate of real output. To see this, consider the following specification for aggregate demand:

(3) $$\Delta y_t = -\alpha \pi_t + \mu_t ,$$

where the μ_t's are shocks to aggregate demand. In the case where α is equal to one, the growth rate of nominal GDP ($\Delta y_t + \pi_t$) is constant along a given aggregate demand curve. Thus, a shift in the aggregate supply curve will have no effect on the growth rate of nominal GDP, and so there will be no correlation between supply shocks and nominal GDP growth. Since the growth rate of nominal GDP is likely to be highly correlated with the growth rate of real GDP, it follows that, if $\alpha = 1$, nominal GDP growth is an excellent instrument for real output growth.

The obvious problem with the approach is that we do not know the slope of the aggregate demand curve. Minus one is a plausible estimate, but other values are also possible. For example, the results reported in Hall and Mankiw (1994) imply that a slope of -1.5 or -2.0 might be more realistic. For any given value of α in equation (2), the variable that is uncorrelated with supply shocks is $\Delta y_t + \alpha\pi_t$. Therefore, it makes sense to try a variety of instruments for the growth rate of real GDP. In the estimation that follows, I try values of α of 0.5, 1, 1.5, and 2.0.

B. Data

The data used to estimate equation (1) and various permutations are annual observations on real GDP and the GDP implicit price deflator.[3] The data after 1947 are from the most recent update of the National Income and Product Accounts.[4] The data before 1929 are from Romer (1989, Table 2, pp. 22-23). Because the early data were constructed to connect with the NIPA GNP data on a 1982 base, I continue with these series for 1929-1946.[5] The two 1982-based series are then ratio spliced to the modern GDP data (which are on a 1987 base) in 1947.

Trend real output is calculated using a piecewise linear trend. The benchmark dates used to construct this trend are 1873, 1884, 1891, 1900, 1910, 1924, 1951, 1962, 1972, 1985, and 1994. These dates are chosen because they correspond to points of mid-expansion. The trend values for 1925-1942 are calculated by carrying the 1910-1924 trend forward in time. Because I exclude the period of World War II price controls (1942-1947) from the analysis, I do not attempt to construct trend values for this period. Also, because output grew so rapidly in the late 1940s and the very early 1950s, it is virtually impossible to derive plausible trend values for this period. Therefore, I exclude the entire war and reconversion period (1942-1951) from the analysis.[6]

C. Results

The estimates of the relationship between inflation and output for the period 1884-1994 (excluding 1942-1951) are shown in Table 1.[7] The table shows the results of both OLS and IV estimation. As described above, I consider four different sets of instruments for the IV estimation. The instrument lists differ in the value of α used to compute the weighted sum of real GDP growth and inflation ($\Delta y_t + \alpha\pi_t$). All of the instrument lists also include the lagged deviation of real output from trend.[8]

The instrumental variables regressions show the expected positive correlation between inflation and the deviation of real output from trend. For example, using the estimates from line 3 (where the weighted sum used in the instrument list is just nominal GDP growth), a one percentage point rise in the deviation of output from trend is associated with a 0.10 percentage point rise in inflation. This relationship is significant at the 95% level.

The more striking finding from Table 1 is that the growth rate effect appears to be substantially stronger and more important than the deviation from trend effect. Using either OLS or IV, the growth rate of output is strongly associated with inflation. For example, again using the results in line 3, a one percentage point increase in the growth rate of GDP is associated with a 0.86 percentage point increase in inflation; the accompanying t-statistic is 6.5. The estimated importance of the growth rate effect over this long sample does not vary much with the instruments used. The growth rate is large and positive when no instruments are used and when all the different weighted sums of inflation and real growth are considered.[9]

Table 2 shows the results separately for various subperiods of the last century. The main division is between the pre-World War II period, 1884-1942, and the post-World War II period, 1952-1994.[10] Within each era I also consider two obvious subperiods: for the prewar era I look separately at the years before and after World War I, and for the postwar era I look separately at the years before and after the supply shocks of the 1970s. I show the results using the two most plausible weighted sums of output growth and inflation as instruments: panel (a) shows the results when the change in nominal GDP is used; panel (b) shows the results when the sum of the change in real GDP and 1.5 times the change in the deflator is used. In both cases, the lagged deviation of output from trend is also included as an instrument.

The main result is that there is substantial variation in the size of the growth rate effect over time, and in the precision with which it can be estimated. The growth rate effect is quite large in the period before 1922, though only marginally significant. For the interwar era, the effect is smaller, but measured very precisely. In the early postwar era, the growth rate effect is smaller still and at most marginally significant. And after 1974, the growth rate effect essentially vanishes.[11]

Paralleling this decline in the growth rate effect is a rise in the size and significance of the deviation from trend effect. While the deviation from trend effect is small relative to the growth rate effect in the prewar era, by the end of the postwar era it is clearly predominant.

D. The Great Depression

That the growth rate effect is so much more important than the deviation from trend effect during the interwar era and measured so precisely is not surprising when one considers a graph of the relevant series. Figure 1 shows the inflation rate and two instruments for the output series included in the regressions, the lagged deviation of output from trend and the growth rate of nominal GDP, for the period 1922-1942. This graph shows that there is a much stronger correlation between inflation and nominal output growth than between inflation and the lagged deviation of output from trend. Even in the relatively uneventful 1920s, the variation in the lagged deviation of output from trend bears little relation to the variation in inflation. In contrast, the growth rate of output has a very strong correlation with inflation in most years of the interwar period.

The fact that the growth rate effect is measured much more precisely in the interwar era than in any other period raises the concern that the estimated effect for the full sample period 1884-1994 may be driven by the Great Depression. To make sure that this is not the case, I re-estimate the regressions reported in Table 1 excluding the years 1930-1942. The estimated equation (using the growth rate of nominal GDP in the instrument list) is:

$$(4) \qquad \underset{}{\pi_t} = \underset{(-1.74)}{-3.28} + \underset{(3.61)}{1.00}\,(y_t - \bar{y}_t) + \underset{(3.47)}{1.18}\,\Delta y_t + \underset{(3.88)}{0.60}\,\pi_{t-1}\,.$$

These results indicate that, while the observations in the 1930s matter some, they are not the sole or even the primary source of the estimated growth rate effect over the last century. Even excluding the Great Depression and the recovery period, the growth rate of real GDP is as important as the deviation of output from trend to the behavior of inflation.

III. THE SOURCE OF THE GROWTH RATE EFFECT

While there has been much research on why inflation depends on the gap between real output and its trend level, there has been essentially no study of why the growth rate of output affects inflation. Indeed, most existing models of price behavior imply that the growth rate of output should not affect inflation.[12] Since the growth rate effect is clearly present in the data, in this section I present and test an explanation for its existence.

A. Explanation

The proposed explanation of the growth rate effect centers on the behavior of raw materials prices. It is well known that materials prices are very cyclically volatile.[13] However, it is possible that this sensitivity takes a particular form: raw material prices may depend particularly closely on the growth rate of output. As a result, rapid rises and falls in output could generate large rises and falls in raw materials prices.

At a conceptual level it is not hard to understand why certain raw materials prices might depend particularly on the growth rate of output. For goods that have an obvious growing cycle, such as crops and livestock, it is difficult to increase supply quickly. It typically takes at least a year to increase the production of agricultural products substantially; if new land must be cleared or improved, the length of time until output increases is even longer. The growing cycle for livestock can be several years. As a result, rapid increases in total output, which increase the demand for these raw materials, could tend to increase their prices substantially in the short run.

For nonrenewable materials such as minerals, the link between rapid output growth and prices is perhaps less obvious. At one level, it seems as though an increase in demand for some mineral should have no more effect on its price than an increase in demand for some manufactured product should have on its price; there is nothing like a growing season to limit increases in mineral output. However, an increase in the demand for a non-renewable mineral resource will tend to increase the mineral's asset value. This rise in the asset value of the mineral will lower the optimal rate of exploitation at the initial price, and hence will shift back the supply curve for the mineral. As a result, it seems likely that a rapid increase in aggregate output that increases the demand for minerals will have a particularly large effect on their prices.

Raw forest products share characteristics with both minerals and crops. While trees used for lumber are renewable resources in the very long run, in the short run one can think of them in the same way as mineral products. A rapid increase in demand will increase the asset value of the existing stock of trees, and hence will increase the price of forest products substantially. Some forest products, such as crude rubber, are more like crops with a growing season: to increase the supply of rubber one has to plant more rubber trees and wait the seven or eight years it takes for them to begin to bear. For these products it is likely that a rapid increase in demand will have a large effect on price because output is inherently inelastic in the short run.[14]

If the prices of raw materials are particularly affected by the growth rate of output, there are several ways that this effect could generate a growth rate effect for the aggregate inflation rate. Most obviously, because materials are a piece of any overall price measure, if materials prices are affected by the growth rate of output the overall price index will be as well, though presumably to a lesser extent.

A less mechanical link might be a simple story of mark-up pricing. Many textbook models of aggregate supply posit that the overall price level is determined by the behavior of wages (which depend on the deviation of output from trend) and the price of raw materials.[15] This simple formulation captures the stylized fact that rapid changes in the price of crucial materials, such as oil, appear to affect the prices of most goods. In this framework, one can think of rapid output growth as leading endogenously to an adverse supply shock: the output growth pushes up materials prices, which then feed through to finished goods prices. Because of this feed-through, one would expect a general growth rate effect, even if it is working largely or solely through materials prices.

B. Data

The natural test of this explanation involves examining the behavior of raw materials and finished goods prices separately. For the postwar era such "stage of processing" data are readily available. The Bureau of Labor Statistics (BLS) creates a producer price index for crude materials for further processing and another for finished goods. Both series are available on a reasonably consistent basis for the entire period 1947-1994.[16]

For the prewar era consistent stage of processing data are much harder to find. The BLS has series for 1913-1951 for raw materials and manufactured products.[17] For 1890-1927 the BLS has also constructed price indexes based on the same goods in their raw and manufactured states.[18] While the two sets of pre-1947 series are quite different in their method of construction, their behavior is remarkably similar in the period when both sets of indexes exist (1913-1927).[19] For this reason it is possible to join the earlier prewar series to the later prewar series with ratio splices in 1913 to create annual stage of processing data for the entire period 1890-1942.

Whether the resulting prewar and postwar stage-of-processing series are consistent with one another is difficult to test because there are only four years of overlap between the series.[20] According to the Bureau of Labor Statistics, the main change incorporated in the postwar revision was a substantial increase in the number of commodities for which price quotes were gathered.[21] There were also some changes in the classification of goods and in the weights used to construct the indexes (BLS, 1952, pp. 180-187). While the BLS does not view the prewar and postwar indexes as strictly consistent, they report that "the new economic group, 'finished goods,' is generally comparable with the former series, 'manufactured products,'" and "crude materials for further processing' is approximately the same as the former 'raw materials' series" (BLS, 1955a, p. 1). The BLS also views the series as comparable enough that they publish series in which the 1926-base data are spliced on to the revised series in January 1947 (BLS, 1957, p. 26).

Because the series appear to be fairly consistent over time, I too splice the annual prewar series to the most recent revision of the postwar series using the observation for 1947. In what follows, I run some regressions over the full sample and discuss some changes over time. However, because of possible inconsistencies I also always consider the behavior of the raw materials and finished goods price series just within the subperiods for which I am confident that the data are consistent.

C. Disaggregate Regressions

Using the stage of processing price data, one can run the same regressions as in Section II. In particular, one can regress both the percentage change in raw materials prices and the percentage change in finished goods prices on the contemporaneous deviation of real GDP from trend, the growth rate of real GDP, and the first lag of the dependent variable. The results are shown in Table 3. For convenience, I focus on the estimates that use the two most plausible values of α , $\alpha = 1.0$ and $\alpha = 1.5$, in computing the weighted sum of output growth and inflation to be used as an instrument; using other values of α does not change the results substantially. The results are reported for both the full sample and for the pre-World War II and post-World War II samples separately.

One fact that is hard to miss from these regressions is that there is relatively little effect of the deviation of output from trend on either materials or finished goods prices. Only for finished goods prices in the post-World War II period is there a significant positive effect. This finding is somewhat more dramatic than that in Table 1. When the GDP deflator is used as the dependent variable, there is typically a weak and marginally significant deviation from trend effect. Together the results in Tables 1 and 3 suggest that conventional Phillips curve specifications may have overemphasized the impact of the deviation of output from trend on inflation.

Another striking feature of the regressions in Table 3 is that there is a uniformly large and highly significant relationship between the percentage change in raw materials prices and the growth rate of GDP. There is no question that materials prices are strongly correlated with the growth rate of output. The estimates for the prewar and postwar sample periods suggest that the growth rate effect on materials is present in both eras and has only weakened a small amount over time.[22]

The results in Table 3 show that for much of the last century, finished goods prices have also depended strongly on the growth rate of output. The coefficient estimate for the entire sample period, while smaller than that for materials prices, is substantial and highly significant. There is, however, evidence of a noticeable change over time. The coefficient estimate for the prewar era is dramatically higher than that for the postwar era. Indeed, for the postwar era the growth rate effect is essentially zero.[23]

The fact that materials prices depend particularly strongly on the growth rate of output is certainly consistent with the hypothesis that the growth rate effect works mainly through materials prices. Similarly, the fact that finished goods prices also depend on the growth rate of output is not evidence against the materials hypothesis; as described before, one would expect some pass-through of the behavior of materials prices. However, a more definitive test is needed of the hypothesis.

A simple extension of the previous analysis that is very telling is to include the contemporaneous change in materials prices in the regressions for finished goods inflation. If the growth rate effect is working through materials prices, then controlling for materials inflation should greatly reduce or eliminate any direct effect of the growth rate of output on the change in finished goods prices. As a check on the results for finished goods prices, one can perform the somewhat peculiar experiment of controlling for finished goods prices in the regressions for materials prices. The results of both these experiments are given in Table 4.

The most obvious finding from Table 4 is that controlling for materials prices essentially eliminates the growth rate effect for finished goods prices in all sample periods. For the full sample period, controlling for materials inflation lowers the coefficient on the growth rate of output from 1.26 to 0.12. It also reduces the significance level from well over 99% to less than 80%.

The opposite experiment, controlling for finished goods inflation in the materials regressions, yields quite different results. Including the additional control variable does reduce the size of the growth rate effect for materials prices substantially, usually by about 75%. However, for most of the sample periods the estimated growth rate effect remains substantial. For the prewar era, the effect is highly significant; for the postwar era, the effect is actually larger than in the earlier period, but less precisely estimated. The fact that controlling for materials prices eliminates the growth rate effect for finished goods prices, while controlling for finished goods prices does not eliminate the growth rate effect for materials prices, is certainly suggestive that the growth rate effect is working mainly through materials prices.

D. Trend-Varying Aggregate Regressions

While the preceding evidence is consistent with the existence of a structural link between output growth, materials prices, and aggregate inflation, it is not conclusive. In particular, it could be that including materials inflation eliminates the growth rate effect for finished goods prices not because the growth rate effect works through materials prices, but simply because materials prices are an excellent leading indicator for inflation. If materials prices are more flexible than finished goods prices, for example, information about future inflation will be reflected in materials prices more rapidly than in finished goods prices. In this case, materials prices could have important predictive power for finished goods prices even if they have no direct impact on them. Therefore, it is useful to consider another test of the materials hypothesis.

One way to see if the link through materials prices is genuine is to see if it is consistent with the variation in the estimated growth rate effect over time. When either the GDP deflator or the wholesale price index for finished goods is used, the growth rate effect appears to shrink substantially over time. This decline could be due to the fact that raw materials have shrunk as a fraction of total output over time. The aggregation and supply shock stories of the link between materials and finished goods prices both imply that a reduction in the importance of materials should lead to a decline in the growth rate effect. In contrast, the view that materials prices help to explain finished good prices simply because they embody new information more rapidly, implies that the predictive power of materials prices for finished goods prices should not be related to the importance of materials in the economy. Therefore, a further test of the materials hypothesis is to see if the growth rate effect varies with the trend importance of materials in the U.S. economy.

To conduct this test, one needs a measure of the trend importance of materials. I derive this series using data on the fraction of GDP accounted for by agriculture, mining, forestry, and fisheries. For the period after 1929 these data are available from the National Income and Product Accounts. Before 1929 they are available for overlapping decades from studies by Martin (1939) and Kuznets (1941).[24] To make the various ratios roughly consistent, I convert the modern estimates to overlapping decadal averages and then ratio splice the various series.[25] I then connect the midpoint for each overlapping decadal average to construct an annual trend series for the importance of materials in the U.S. economy.

The resulting trend series is shown in Figure 2. As can be readily seen, the importance of materials has indeed fallen over time (from over 19% of GDP around the turn of the century, to less than 3% today). However, the decline has been far from smooth: the importance of materials actually increased slightly before World War I, plummeted during the 1920s, was quite steady during the Depression, and then plummeted again during World War II and the early postwar era.

Armed with this series, one can then test whether the growth rate effect has varied systematically with the trend importance of materials. Specifically, equation (2) can be altered to allow the coefficient on the growth rate of output to vary with the trend ratio (TR). That is:

$$(5) \quad \pi_t = \beta_0 + \beta_1 (y_t - \bar{y}_t) + (\alpha_0 + \alpha_1 TR_t) \Delta y_t + \beta_3 \pi_{t-1} + \epsilon_t$$

$$= \beta_0 + \beta_1 (y_t - \bar{y}_t) + \alpha_0 \Delta y_t + \alpha_1 (TR_t \Delta y_t) + \beta_3 \pi_{t-1} + \epsilon_t .$$

If the link between inflation and output growth operates only through materials prices, α_0 would be zero and α_1 would be positive. To estimate equation (5), it is again important to instrument for the output variables, including ($TR_t \Delta y_t$). I use the same instruments as before, with the addition of the trend ratio times the change in nominal output (or one of the other weighted sums).

The results of this estimation are shown in Table 5. Panel (a) shows the results using the percentage change in the GDP deflator as the measure of inflation; panel (b) shows the results using the change in finished goods prices. In each case I only report the results using the two most plausible weighted sums of real growth and inflation in the instrument list. The results, however, are robust to all the instruments considered (and even to no instrumentation at all).

The coefficient estimate on the interaction term is positive and highly significant in both cases. This suggests that the estimated growth rate effect does vary systematically with the trend importance of materials in the economy. This is certainly consistent with the view that the overall growth rate effect is being driven largely by the behavior of materials prices. As materials have become less important to the U.S. economy, the growth rate effect has declined.

The only peculiar feature of these results is that the non-trend-varying piece of the growth rate coefficient comes in quite large and negative. As a result, the estimated overall coefficient actually becomes negative fairly early in the postwar era. This anomalous result appears to be related to the extremity of the Great Depression. As shown in Table 2, while the growth rate effect is very significant during the Great Depression and the recovery period, its estimated magnitude is substantially less than in the era before World War I. This is true simply because the deflation in the early 1930s, while large, did not keep pace with the huge fall in output. This feature of the Depression makes the estimated growth rate effect decline very rapidly. To make the estimates sensible for the pre-Depression era, the regression fits the non-trend-varying piece of the growth rate effect as large and negative.

This speculation is borne out by estimating the trend-varying regression excluding the years 1930-1942. The estimated equation for the GDP deflator (using nominal GDP growth as an instrument) is:

$$(6)\ \pi_t = \underset{(-2.43)}{-5.93} + \underset{(3.74)}{1.00}\,(y_t - \bar{y}_t) - \underset{(-0.39)}{0.34}\,\Delta y_t + \underset{(1.77)}{0.10}\,(TR\ \Delta y_t) + \underset{(3.36)}{0.52}\,\pi_{t-1}\,.$$

When the extreme observations of the 1930s are eliminated, the non-varying piece of the growth rate effect is much smaller, and not at all significant. The time-varying component, in contrast, remains large and is close to significantly different from zero. As a result, with this specification the estimated growth rate effect does not reach zero until the mid-1980s.

IV. INFLATION IN THE 1930S

Armed with the evidence of a growth rate effect for most of the 20th century and a plausible explanation for its existence, we can finally return to the puzzling behavior of prices in the mid- and late-1930s. And, in light of the new evidence, the fact that prices rose almost continuously from 1934 on really is not very puzzling at all. While output was severely below trend during the mid- and late-1930s, it was also growing by leaps and bounds: average real growth in the period 1934-1942 was 8.6%. Since the estimated growth rate effect is larger than the estimated deviation from trend effect in the pre-World War II era, it is not surprising that the forces leading to inflation dominated the forces leading to deflation.

A. Simulation

One way to see the important role of output growth in generating inflation in the 1930s is to simulate what inflation after 1933 would have been if output growth had been more normal. To do this, I use the trend-varying regression for the GDP deflator excluding the Great Depression reported in equation (6) to compute estimates of the growth rate effect in the mid- and late-1930s. I then subtract from actual inflation the difference between actual and normal real growth, multiplied by the trend-varying coefficient. For normal growth I use average growth in the period 1924-1927, the most normal years of the 1920s.[26]

The results of this simulation are shown in Figure 3. Panel (a) shows the actual and simulated inflation rates for the period 1934-1942. Panel (b) shows the actual and simulated values for the log price level. Figure 3 shows that inflation would have been substantially lower in the second half of the 1930s and the early 1940s if output growth had been more normal. Average inflation in the period 1934-1942 would have been -0.9% per year had output grown at its normal rate, rather than its actual rate of 3.0% per year. The cumulative importance of this difference is evident in panel (b). Had output growth between 1933 and 1942 been equal to its 1920s average, the price level in 1942 would have been 36% lower than it actually was.

This simulation clearly suggests that the growth rate effect is an important part of the explanation for inflation in the mid-1930s. At the same time, the simulation also shows that the growth rate effect was not the only factor affecting inflation in the 1930s. Most obviously, in 1934 the growth rate effect only explains about a third of the inflation we observe. This suggests that more conventional explanations, such as the devaluation in 1934 or adverse supply shocks related to the National Industrial Recovery Act or the Agricultural Adjustment Act, may also play a role in explaining inflation in the mid-1930s.[27]

B. The Role of Materials

Not only is it the case that rapid output growth appears to be fueling much of the inflation of the second half of the 1930s and the early 1940s, there is also evidence that the effect was working through materials prices, as suggested in Section III. One way to see the importance of materials prices is simply to look at a graph of the behavior of materials prices, finished goods prices, and the wholesale price index for all commodities for the period 1933-1942. These three series are shown in Figure 4.[28]

One thing that is obvious from Figure 4 is that the rise in materials prices was enormous in most years of the mid-1930s and the early-1940s. Furthermore, to the degree that there is variation in materials inflation, it is highly correlated with nominal output growth, my typical instrument for real growth. Nominal GDP grew at over 15% in 1934, 1941, and 1942. These were all years when materials inflation was particularly high. In contrast, nominal GDP grew at less that 10% in 1937, 1938, 1939, and 1940. These were all years of low materials inflation. Only 1936 appears to be substantially at odds with the usual pattern: nominal GDP growth was relatively large (13%) and yet materials prices rose only a small amount.

It is also the case that the rise in materials prices was not limited to agricultural products. While the rise in farm prices was quite dramatic during the early recovery period, the prices of many non-farm materials included in the BLS materials index also rose substantially. Between 1933 and 1937 farm prices rose 52%. In the same period, the price of steel scrap rose 76%, the price of bituminous coal rose 17%, the price of crude petroleum rose 71%, and the price of crude rubber rose 120%.[29] This suggests that the behavior of the BLS materials price index in the mid-1930s genuinely reflects the behavior of all materials, not just the behavior of farm products.

The fact that prices for all materials rose dramatically in the mid-1930s and early 1940s is certainly consistent with the hypothesis that there is a link between output growth and overall inflation working through materials prices. It is also inconsistent with some alternative explanations for interwar inflation. For example, explanations that stress the importance of rigid or rising wages will have trouble explaining the behavior of materials prices because employee compensation is typically a small fraction of costs for materials producers.[30] Similarly, the fact that all materials prices rose, not just those of agricultural prices, suggests that sector-specific New Deal programs, such as the Agricultural Adjustment Act, cannot be the full explanation for the inflation during the recovery.

Figure 4 also shows that finished good prices rose at the same time that materials prices did, though not as much. This is consistent with the hypothesis that materials inflation fed through to finished goods inflation. It is inconsistent with the notion that the rise in the overall price index could have been the result of a rise in just the materials component. Furthermore, this apparent pass-through is not limited to the effect of farm prices on food prices. While the BLS did not calculate an index for finished goods prices excluding foods during this period, it does have a special index for all commodities excluding farm products and foods. Since farm products are by far the largest component of raw materials, this index is close proxy for the desired series. This index excluding foods also rises substantially between 1933 and 1935 and again between 1936 and 1937. Thus, there appears to be a genuine pass-through of material prices to a wide range of finished goods prices.

V. CONCLUSION

This study has shown that the relationship between prices and output in the United States is more complicated than is conventionally thought. In particular, for most of the last century the rate of inflation has depended not just on the deviation of output from trend, but even more strongly on the growth rate of output. Furthermore, the strength of the growth rate effect appears to vary with the importance of materials in the economy. Because materials prices are particularly sensitive to the growth rate of output, the growth rate effect was stronger in the late 1800s and early 1900s, when the U.S. economy was still based heavily on agriculture and mining, and weaker in the postwar era, when advanced manufacturing and services have become the dominant sectors.

The existence of a growth rate effect can explain much of the puzzling behavior of prices in the prewar era. Most obviously, as just discussed, the rapid growth of output in the mid- and late-1930s can help account for the moderate inflation during the recovery from the Great Depression. The growth rate effect was strong enough and the rate of output growth was high enough that prices rose during this period even though output was substantially below trend. The growth rate effect can explain a similar puzzle in the late 1890s (1897-1900), when prices rose nearly 3% per year despite the fact that output was on average 1% below trend. Just as in the 1930s, the solution to the puzzle is the fact that real output, while substantially below trend, was rising rapidly in this period (around 4.5% per year). This rapid growth pushed up materials prices and fed through to general inflation.

More generally, the growth rate effect can explain why prices rose at the start of most prewar recoveries. Judging from the actual turning points in real GDP, there were six troughs in the period 1884-1929.[31] In the year following these troughs, inflation averaged 2.6% despite the fact that the average deviation from trend was -2.7%. The explanation for this puzzling behavior is that prewar recoveries were typically quite sharp. In the years following these six troughs, average real growth was 5.9%. This rapid growth pushed up prices in most of these recoveries well before the economy was back to its trend level.

Because the growth rate effect has declined over time in the United States, it has more implications for our historical experience than for current policy analysis. However, this is not necessarily true for less developed countries. Since the growth rate effect works largely through materials prices, it is likely to still be important for countries that are major producers of raw materials. Thus, many of the highly agricultural countries of Latin American and Africa need to consider the implications of the growth rate effect even today.

Simply realizing that the growth rate effect is present may help materials-dependent countries to better understand the source of price fluctuations. In this way it could improve their ability to forecast and plan. The existence of the growth rate effect may also suggest improvements to stabilization policy. Many of the studies of the costs of inflation suggest that inflation variability is more damaging than the level of inflation. Since the growth rate of output is an important determinant of inflation, this view of the costs of inflation implies that policy should attempt to keep output growth steady. Indeed, depending on the relative sizes of the deviation from trend and the growth rate effects, it is possible that materials-dependent countries should respond to aggregate demand shocks gradually, rather than by attempting to bring output rapidly back to normal. In this way, a better understanding of the price-output relationship could lead to important changes in how countries manage aggregate demand.

NOTES

1. See, for example, Weinstein (1981).

2. The growth rate effect is discussed in Gordon (1980, 1982, and 1990) and Gordon and Wilcox (1981).

3. Both inflation and real growth are calculated as the annual change in the logarithm of the base series.

4. The data are from Citibase, December 1995 update.

5. The NIPA GNP data on a 1982 base are available in The National Income and Product Accounts (U.S. Bureau of Economic Analysis, 1986, Tables 1.1, 1.2, and 7.4, pp. 1-2, 6-7, and 327-328).

6. Other methods of detrending, including a simple linear trend, were also tried. The method of detrending has little impact on the prewar regressions. For the postwar era, the changes in growth rates in the 1960s and 1970s are large enough that a simple linear trend yields implausible measures of the deviations from trend, and hence somewhat suspicious regression results.

7. I start the sample with the benchmark year 1884 because the data for the late 1860s and early 1870s are more speculative than those after 1879.

8. All of the regressions also include a constant and a linear trend, which are not reported. The trend term is typically positive but not statistically significant.

9. It is useful to note that the instruments used appear to be good instruments in the sense that the are highly correlated with the variables of interest. As a check, I regress the deviation of output from trend on its lagged value and all of the other instruments. The lagged value (in the case where the weighted sum in the instrument list is the growth rate of nominal output) enters with a coefficient of .95 and a t-statistic of 40.5. The growth rate of nominal output also enters significantly. When the same regression is run with the growth rate of real output as the dependent variable, the growth rate of nominal output enters with a coefficient of 0.53 and a t-statistic of 14.6. No other variable is a significant predictor of the real growth rate.

10. The sample periods are chosen to exclude World War II because extreme price controls during the war surely disrupted the usual price-output relationship. The years of World War I (1917-1918) and the Korean War (1952-1953) are included in the analysis because price controls were much less extensive in those periods. The results are robust to the exclusion of these years.

11. Hanes (1994) argues that one should be cautious in interpreting such changes in cyclical sensitivity over time because of possible biases in the data. He shows that early wholesale price series are biased toward materials. As a result, some of the decline in cyclical sensitivity could be due to changes in how the data are constructed. However, Hanes does not analyze whether the same materials bias exists in the GDP deflator used in these regressions. Also, Section III shows that the decline in the growth rate effect can be largely explained by a variable uncorrelated with changes in the data.

12. Gordon (1990) argues forcefully that New Keynesian models of price behavior fail to deal with the growth rate effect.

13. Gordon (1990) provides a cogent summary of the literature on the greater flexibility of materials prices.

14. An study by the National Recovery Administration (NRA) discusses the effect of demand changes on rubber prices in the interwar era. It states: "An increase in demand is attended by a delayed response in supply, while nature makes the adjustments; and, in reverse, a superfluous supply can only slowly and painstakingly be whittled down to the reduced demand for rubber. In consequence, ... the market fluctuates between glut and scarcity; and price may rise from a given base to its multiple and presently fall back again" (NRA, 1937, p. 19).

15. See, for example, Dornbusch and Fischer (1994, p. 232).

16. The postwar data (on a 1982 base) are from Citibase, December 1995 update.

17. This series is available from the BLS (1957, Table 7, p. 34).

18. For example, the raw commodities index includes wheat and pig iron, while the manufactured commodities index includes wheat flour and steel rails. This series is on a 1913 base and is available through 1927 from the Bureau of Labor Statistics (1928, p. 22).

19. Indeed, a regression of the percentage change in the relatively modern wholesale price index for raw materials (on a 1926 base) on a constant and the percentage change in the earlier, more limited series (on a 1913 base) has an R^2 of 0.99; the coefficient estimate is 0.94 with a t-statistic of 31.0. The same regression for the finished goods series has an R^2 of 0.96, and a coefficient estimate of 0.85 with a t-statistic of 16.9.

20. The 1926-base series were discontinued in 1952; the new stage-of-processing series were not released until late 1955, but were calculated back to 1947 (see BLS, 1952, p. 185, and 1955b, p. 1448).

21. This change was particularly large for the finished goods category: the prices of many types of machinery were only collected after 1947 (BLS, 1955b, p. 1448).

22. The relationship between materials inflation and output growth was well understood by economists in the 1920s and 1930s. The Harvard Economic Society, for example, constructed what they called their "sensitive price index." This series was based on 13 industrial materials, including tallow, wheat, shellac, zinc, and steel scrap, and was thought to respond closely to "changes in the industrial situation" (Hubbard, 1934, p. 162). Indeed, materials inflation was considered such a good indicator of changes in demand conditions that the sensitive price index was used as a predictor of industrial output.

23. How much emphasis one wants to place on this change over time depends on how comparable one believes the disaggregate price data are over time. The major change in the finished goods series, a large increase in the number of commodities included, seems more likely to have reduced random noise in the series than to have reduced the growth rate effect in particular. Also, because the finished goods index explicitly excludes materials, it is implausible that the change in the measured growth rate effect is due to the over-representation of materials in the early aggregate wholesale price index described in Hanes (1994).

24. The Martin, Kuznets, and NIPA series before 1947 are available in Historical Statistics (U.S. Bureau of the Census, 1975, series F216, F217, and F218, p. 238). The NIPA data after 1947 are from Citibase.

25. Specifically, the early NIPA series is spliced on to the modern NIPA series using the 1949-1958 observation. The Kuznets series is then spliced on to the NIPA ratio in the decade 1929-1938. Finally, the Martin series is spliced on to the adjusted Kuznets series using the observation for 1919-

1928.

26. Average real growth from 1924-1927 was 3.15% per year. This is quite similar to average growth over the whole pre-Depression sample of 1884-1929, which was 3.35% per year.

27. This supposition can be tested empirically. For example, one can include a dummy variable for the NIRA in the trend-varying regressions for GDP (including the 1930s) given in Table 4. When this is done, the NIRA dummy enters positively and significantly, indicating that the NIRA was a factor causing inflation between when it was passed in mid-1933 and when it was declared unconstitutional in mid-1935. It is useful to note, however, that inclusion of other factors has essentially no impact on the point estimates or the significance of the growth rate effect.

28. The data that I use are the materials and finished goods price series described in Section III. In this picture, I have left the series on the 1926 base; that is, I have not spliced them to the modern series. For consistency I use the overall WPI, also on a 1926 base, from the same sources as the disaggregate series.

29. The annual data on the prices of particular commodities are taken from the December issues of the Bureau of Labor Statistics publication Wholesale Prices, for 1933-1937.

30. For example, using NIPA data on compensation of employees and national income by industry, the fraction of national income accounted for by compensation in 1929 was just 17% for agriculture, forestry, and fisheries, but 74% for manufacturing. The data used in this calculation are from the Bureau of Economic Analysis (1986, Tables 6.4a and 6.3a, p. 256 and p. 260).

31. The dates of the troughs are 1888, 1894, 1907, 1914, 1917, and 1921.

REFERENCES

Dornbusch, Rudiger, and Stanley Fischer. Macroeconomics. Sixth edition. New York: McGraw- Hill, 1994

Gordon, Robert J. "A Consistent Characterization of a Near-Century of Price Behavior." American Economic Review 70 (May 1980): 243-249.

Gordon, Robert J. "Price Inertia and Policy Ineffectiveness in the United States, 1890-1980." Journal of Political Economy 90 (December 1982): 1087-1117.

Gordon, Robert J. "What Is New-Keynesian Economics?" Journal of Economic Literature 28 (September 1990): 1115-1171.

Gordon, Robert J. and James A. Wilcox. "Monetarist Interpretations of the Great Depression: An Evaluation and Critique." In The Great Depression Revisited, edited by Karl Brunner. Boston: Martinus Nijoff, 1981, pp. 49-107.

Hall, Robert and N. Gregory Mankiw. "Nominal Income Targeting." In Monetary Policy, edited by N. Gregory Mankiw. Chicago: University of Chicago Press for NBER, 1994, pp. 71-93.

Hanes, Christopher. "Changes in the Cyclical Behavior of Nominal Prices, 1869-1990. Unpublished manuscript, University of Pennsylvania, 1994.

Hubbard, Joseph B. "Review of the Second Quarter of 1934." Review of Economic Statistics 16 (1934): 160-167.

Kuznets, Simon. National Income and Its Composition, 1919-1938. New York: National Bureau of Economic Research, 1941.

Martin, Robert F. National Income in the United States, 1799-1938. New York: National Industrial Conference Board, 1939.

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

U.S. Bureau of the Census. Historical Statistics of the United States: Colonial Times to 1970. Washington, D.C.: USGPO, 1975.

U. S. Bureau of Economic Analysis. National Income and Product Accounts of the United States, 1929-82. Washington, D.C.: USGPO, 1986.

U.S. Bureau of Labor Statistics. Index Numbers of Wholesale Prices on Prewar Base, 1890-1927. Washington, D.C.: USGPO, 1928.

U.S. Bureau of Labor Statistics. Wholesale Prices. Washington, D.C.: USGPO, Dec. 1933, Dec. 1934, Dec. 1935, Dec. 1936, and Dec. 1937.

U.S. Bureau of Labor Statistics. "A Description of the Revised Wholesale Price Index." Monthly Labor Review 74 (February 1952): 180-187.

U.S. Bureau of Labor Statistics. "Economic Sector Indexes January 1947-July 1955." Washington, D.C.: USGPO, 1955. (a)

U.S. Bureau of Labor Statistics. "New BLS Economic Sector Indexes of Wholesale Prices." Monthly Labor Review 78 (December 1955): 1448-1453. (b)

U.S. Bureau of Labor Statistics. Wholesale Prices and Price Indexes, 1957. Bulletin No. 1235. Washington, D.C.: USGPO, July 1958.

U.S. National Recovery Administration, Consumers Division. The Price of Automobile Tires by Albert Abrahamson. Report No. 2. Washington, D.C.: USGPO, 1937.

Weinstein, Michael M. "Some Macroeconomic Impacts of the National Industrial Recovery Act." In The Great Depression Revisited, edited by Karl Brunner. Boston: Martinus Nijoff, 1981, pp. 262-285.

TABLE 1

PRICE-OUTPUT RELATIONSHIP FOR 1884-1994

Instrument	Deviation of GDP from Trend	Growth Rate of GDP	Lagged Inflation Rate
	Coefficient Estimates (t-statistics in parentheses)		
a. OLS	0.04 (1.09)	0.29 (3.23)	0.41 (4.56)
b. IV, $\alpha = 0.5$	0.07 (1.74)	0.61 (5.85)	0.38 (3.92)
c. IV, $\alpha = 1.0$	0.10 (2.04)	0.86 (6.52)	0.35 (3.25)
d. IV, $\alpha = 1.5$	0.12 (2.16)	1.04 (6.45)	0.34 (2.76)
e. IV, $\alpha = 2.0$	0.13 (2.21)	1.19 (6.21)	0.32 (2.41)

Notes: The dependent variable is the percentage change in the GDP deflator. A constant and a linear trend are also included in each regression.

TABLE 2

PRICE-OUTPUT RELATIONSHIP BY SUBPERIOD

Instrument and Sample	Coefficient Estimates (t-statistics in parentheses): Deviation of GDP from Trend	Growth Rate of GDP	Lagged Inflation Rate
a. <u>IV, α = 1.0</u>			
1884-1942	0.14 (1.65)	0.86 (4.85)	0.24 (1.63)
1884-1921	1.48 (2.64)	1.11 (1.69)	0.27 (0.83)
1922-1942	-0.02 (-0.32)	0.51 (4.68)	0.18 (1.15)
1952-1994	0.37 (3.43)	0.19 (1.37)	1.00 (8.93)
1952-1973	0.14 (1.07)	0.24 (1.37)	0.49 (2.21)
1974-1994	0.49 (3.91)	-0.16 (-1.20)	0.74 (3.78)
b. <u>IV, α = 1.5</u>			
1884-1942	0.16 (1.74)	1.02 (4.84)	0.21 (1.29)
1884-1921	1.67 (2.52)	1.43 (1.77)	0.31 (0.81)
1922-1942	-0.02 (-0.27)	0.54 (4.75)	0.17 (1.04)
1952-1994	0.42 (3.42)	0.29 (1.81)	1.05 (8.32)
1952-1973	0.17 (1.19)	0.33 (1.62)	0.55 (2.24)
1974-1994	0.55 (3.79)	-0.10 (-0.63)	0.82 (3.67)

<u>Notes</u>: The dependent variable is the percentage change in the GDP deflator. A constant and a linear trend are included in each regression.

TABLE 3

PRICE-OUTPUT RELATIONSHIP BY STAGE OF PROCESSING

Instrument, Sample, and Variable	Coefficient Estimates (t-statistics in parentheses): Deviation of GDP from Trend	Growth Rate of GDP	Lagged Inflation Rate
a. IV, $\alpha = 1.0$			
1892-1994			
Raw Materials	0.14 (1.28)	2.02 (6.56)	0.09 (0.79)
Finished Goods	0.12 (1.57)	1.26 (5.89)	0.23 (1.95)
1892-1942			
Raw Materials	0.18 (0.89)	2.13 (5.12)	-0.07 (-0.42)
Finished Goods	0.16 (1.08)	1.31 (4.41)	0.11 (0.68)
1952-1994			
Raw Materials	0.95 (1.68)	1.47 (1.90)	0.51 (3.12)
Finished Goods	0.69 (3.35)	0.04 (0.16)	0.81 (6.41)
b. IV, $\alpha = 1.5$			
1892-1994			
Raw Materials	0.18 (1.48)	2.39 (6.45)	0.06 (0.46)
Finished Goods	0.15 (1.72)	1.53 (5.95)	0.22 (1.69)
1892-1942			
Raw Materials	0.23 (1.05)	2.49 (4.99)	-0.12 (-0.66)
Finished Goods	0.19 (1.19)	1.55 (4.44)	0.09 (0.50)
1952- 1994			
Raw Materials	1.13 (1.77)	2.01 (2.04)	0.56 (3.03)
Finished Goods	0.76 (3.34)	0.22 (0.72)	0.86 (6.12)

Notes: The dependent variable is the percentage change in either raw material prices or finished goods prices. A constant and a linear trend are also included in each regression.

TABLE 4

STAGE OF PROCESSING REGRESSIONS, INCLUDING OTHER STAGE

Instrument, Sample, and Variable	Deviation of GDP from Trend	Growth Rate of GDP	Lagged Inflation Rate	Other Stage Inflation Rate
	Coefficient Estimates (t-statistics in parentheses)			
a. IV, α = 1.0				
1892-1994				
Raw Materials	-0.02 (-0.40)	0.41 (3.59)	-0.15 (-3.13)	1.36 (18.54)
Finished Goods	0.04 (1.22)	0.12 (1.25)	0.19 (3.94)	0.55 (15.44)
1892-1942				
Raw Materials	-0.03 (-0.54)	0.44 (3.82)	-0.16 (-3.31)	1.32 (18.58)
Finished Goods	0.05 (1.08)	-0.02 (-0.24)	0.14 (2.81)	0.64 (15.53)
1952-1994				
Raw Materials	0.14 (0.38)	0.72 (1.56)	-0.25 (-1.68)	1.92 (6.11)
Finished Goods	0.33 (2.69)	-0.25 (-1.69)	0.58 (7.59)	0.26 (7.18)
b. IV, α = 1.5				
1892-1994				
Raw Materials	-0.02 (-0.45)	0.38 (3.21)	-0.15 (-3.10)	1.37 (18.50)
Finished Goods	0.05 (1.46)	0.26 (2.29)	0.19 (3.56)	0.52 (12.95)
1892-1942				
Raw Materials	-0.03 (-0.55)	0.44 (3.63)	-0.16 (-3.30)	1.32 (18.48)
Finished Goods	0.06 (1.22)	0.08 (0.63)	0.14 (2.50)	0.61 (13.39)
1952-1994				
Raw Materials	0.09 (0.24)	0.55 (1.12)	-0.25 (-1.70)	1.90 (5.90)
Finished Goods	0.39 (2.79)	-0.15 (-0.87)	0.61 (7.19)	0.25 (6.25)

Notes: The dependent variable is the percentage change in either raw material prices or finished goods prices. A constant and a linear trend are included in each regression.

TABLE 5

TREND-VARYING PRICE-OUTPUT RELATIONSHIP FOR 1884-1994

	Coefficient Estimates (t-statistics in parentheses)			
Variable and Instrument	Deviation of GDP from Trend	Growth Rate of GDP	Growth Rate x Materials Trend	Lagged Inflation Rate
a. GDP Deflator				
$\alpha = 1.0$	0.08 (1.48)	-1.32 (-2.24)	0.18 (3.57)	0.34 (2.83)
$\alpha = 1.5$	0.09 (1.42)	-1.87 (-2.15)	0.23 (3.20)	0.31 (2.28)
b. WPI for Finished Goods				
$\alpha = 1.0$	0.07 (0.82)	-2.59 (-2.52)	0.31 (3.63)	0.23 (1.85)
$\alpha = 1.5$	0.07 (0.72)	-3.69 (-2.34)	0.42 (3.17)	0.23 (1.54)

Notes: A constant and a linear trend are included in each regression.

FIGURE 1

INFLATION AND OUTPUT IN THE INTERWAR ERA

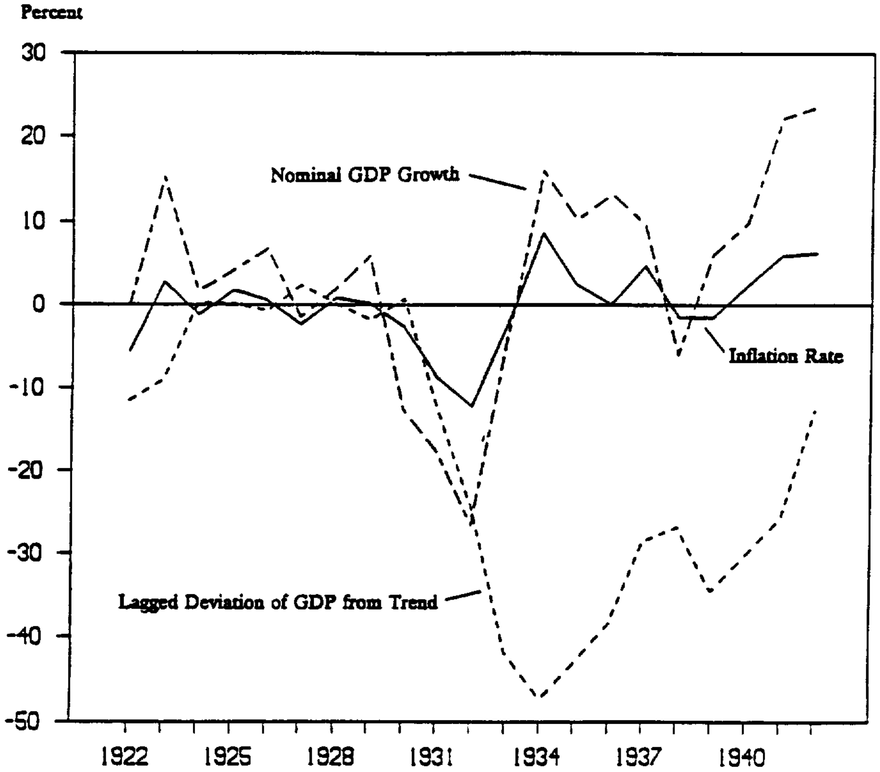


FIGURE 2

MATERIALS OUTPUT AS A PERCENT OF GDP

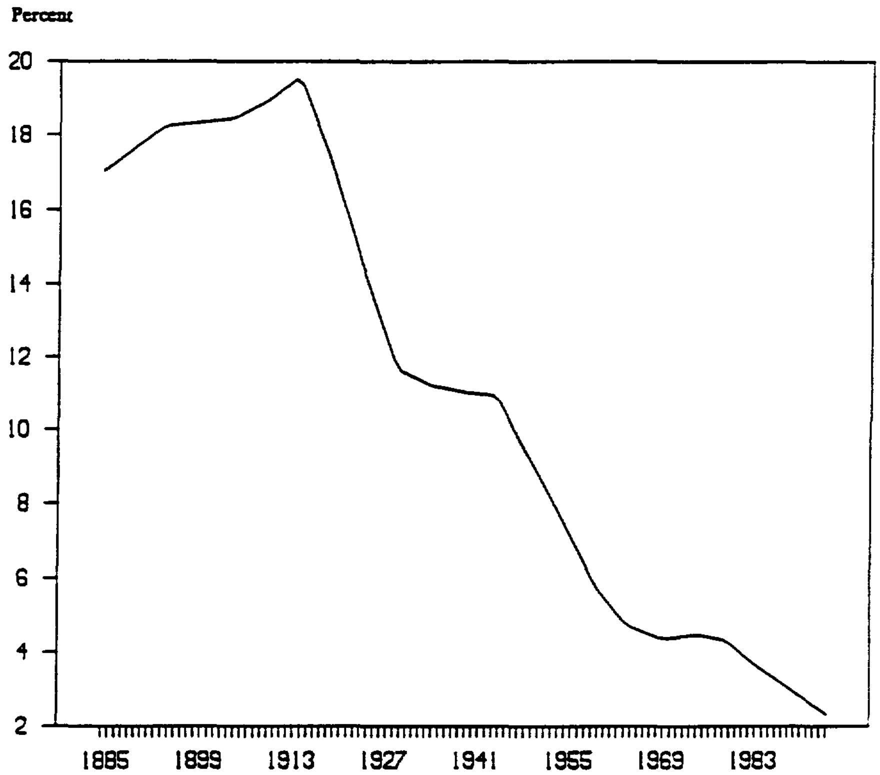
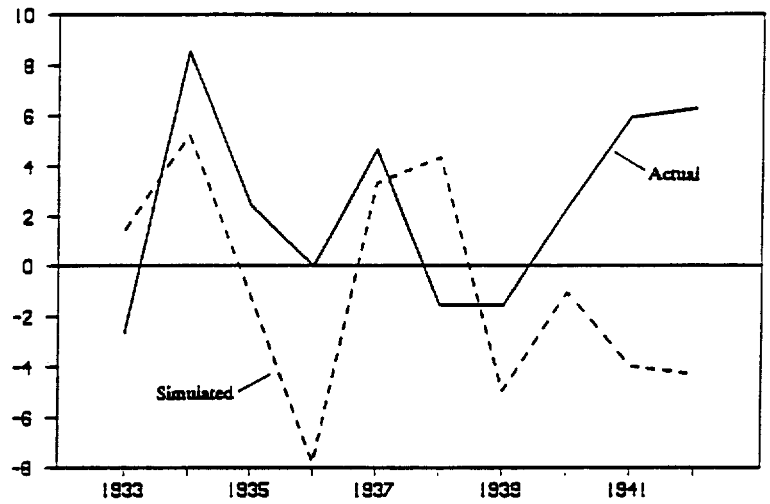


FIGURE 3

ACTUAL AND SIMULATED INFLATION AND PRICE LEVEL IN THE 1930S

a. Inflation (Percent)



b. Price Level (Logarithms)

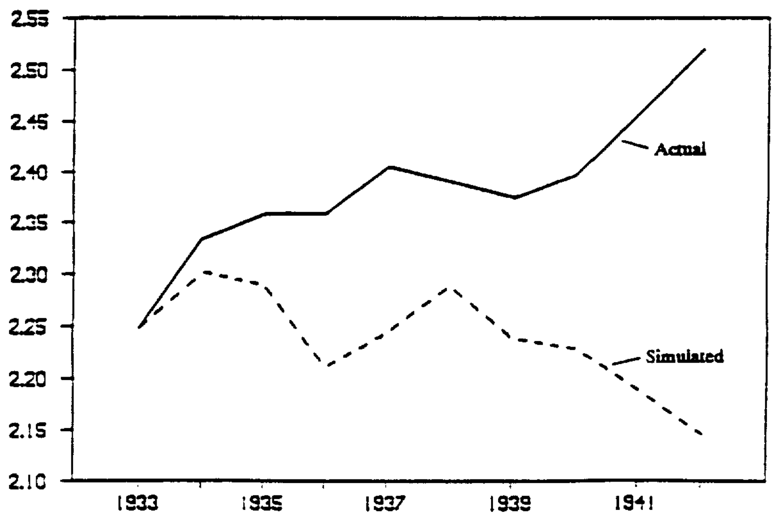


FIGURE 4

FINISHED GOODS AND RAW MATERIALS INFLATION IN THE 1930S