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IMPROVEMENTS IN MACROECONOMIC STABILITY: THE ROLE OF WAGES AND PRICES

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Improvements in Macroeconomic Stability: The Role of Wages and Prices

ABSTRACT

This paper compares macroeconomic performance in the United States from 1891 through 1914 with the period after the Second World War by estimating reduced form autoregressions for prices, wages and output, by looking at their moving average representations, and by giving them simple structural interpretations. The results show that the impulses to the economic system were smaller in the later period, but the propagation mechanisms are much slower and more drawn out. The smaller shocks are therefore translated into larger and more prolonged fluctuations in output and inflation than would occur if the earlier dynamics were applicable in the later period. A tentative explanation for the changes in the dynamics is a slower speed of wage and price adjustment combined with a different accommodative stance for the monetary system.

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Macroeconomic fluctuations have been less severe in the last thirty years than in the period before the Second World War. Although the recessions in the 1970s and 1980s have been large and have been associated with big swings in inflation, the average amplitude of cyclical fluctuations is still smaller than in the pre-war period.

This improvement in macroeconomic performance was already evident to most economists by the end of the 1950s. It served as the focal point of Arthur Burns' 1959 presidential address before the American Economic Association. Burns contrasted the milder post-war fluctuations with those he studied with Wesley Clair Mitchell at the National Bureau of Economic Research. He attributed the improvement to countercyclical fiscal and monetary policy as well as to structural changes in the economy: more stable corporate dividends, steadier employment practices, better inventory controls, and greater financial stability due to deposit insurance.

The improvement in economic performance still deserves the attention of macroeconomists. An understanding of the reasons for the improvement is invaluable for recommending what changes in policy should, or should not, be adopted. Moreover, at a time when macroeconomic research is undergoing difficult and fundamental changes, the improvement serves as a useful reminder of the practical importance of continued progress in macro-theory and macro-econometrics. Regardless of one's approach to macroeconomic research, one can, as James Tobin[1] has urged, "take some encouragement from the economic performance of the advanced democratic capitalist nations since the Second World War."

The purpose of this paper is to examine the role of wage and price rigidities in this improvement in macroeconomic performance. Wage and price rigidities are at the center of most modern economic theories of the business cycle. According to these theories, if wages and prices were more flexible, the economy would experience shorter and less severe business cycle fluctuations. Many economists have therefore suggested economic reforms--such as synchronized wage and price setting--to make wages and prices more flexible.

The paper examines changes in wage and price rigidities and in macroeconomic performance by concentrating on two episodes in United States history: the quarter century before the First World War from 1891 through 1914, and the slightly longer period after the Second World War from 1952 through 1983. Each period includes 8 economic fluctuations. By ending the earlier period before the First World War, we exclude the economic turbulence of both of world wars as well as the Great Depression of the 1930s.[2] Even with these exclusions economic fluctuations in the earlier period were larger in magnitude than in the post-war period. The data also indicate that wages and prices were more flexible in the earlier period. This latter finding, which has also been noted by other researchers,[3] presents a puzzle. Less flexibility of wages and prices should lead to a deterioration in economic performance. The comparison suggests that the opposite has occured. Either other factors--such as those mentioned by

Burns---were strong enough to offset the reduced wage-price flexibility, or macro-theory needs some revision, if it is to provide a satisfactory explanation for economic fluctuations in both of these periods of United States history.

The research reported here makes use of some recently developed econometric time series methodology. The differences in economic fluctuations in the two periods are documented using simple reduced form vector autoregressions and their moving average representations. These give the "facts without theory," much as the Burns-Mitchell NBER reference cycle methods did. This reduced form evidence is then given an explicit structural interpretation in a simple mathematical form. One advantage of this statistical approach over the earlier NBER methods is that it provides a tight and formal connection between theory and the facts. The connection between theory and the facts revealed through reference cycle charts is necessarily looser and less formal, although these charts can be very useful in the early stages of model development. The methodology used here to compare time periods by looking both at reduced forms and simple structural models is similar to that which I used for an international comparison of different countries in Taylor (1980) and Taylor (1982).

1. A Simple Scorecard for Macroeconomic Performance

It is useful to begin with some simple but objective statistical measures of macroeconomic performance in the different periods. These measures as well as all the statistical analysis in this paper are based on annual data. Output is measured by real GNP, prices by the GNP deflator, and wages by average hourly earnings in manufacturing.

The means and standard deviations of the three detrended series are presented in Table 1. To be specific, let Y be real GNP and let Y* be potential GNP. Then detrended output given by y=(Y-Y*)/Y*, and is referred to as the *output gap* in the figures and tables of the paper. Potential GNP is assumed to be growing at a constant, but different, exponential rate in each of the periods. The level of potential is chosen so that the average of y is zero in each of the periods. Experimentation with some alternative assumptions about the growth of Y* did not affect the results by much. For example, when the trend in Y* was permitted to change in 1973 to reflect the slowdown in productivity growth in the U.S., the results where similar. I chose to detrend output using a deterministic trend rather than first differences to capture the tendency for output to return to its potentail growth path after a disturbance.

On the other hand, wages and prices were detrended by taking first differences of the logarithms; that is, by looking at the rate of price inflation (p) and the rate of wage inflation (w). In the post-war period there is no tendency for the price level to return to a trend path after a disturbance. At best, the *rate of inflation* tends to regress to some mean value; even this tendency was not present in the post-war data before 1982-83. Although the U.S. was on a gold standard during the period before the First World War, the level of prices and wages show no tendency to regress to a fixed trend or level in that period either, presumably because of changes in the world gold stock and in the relative price of gold.

The statistics reported in Table 1 refer to the detrended series for output y, wage inflation w, and price inflation p. According to the standard deviation measure, output fluctuations have been about 25 percent smaller in the period after the Second World War than in the quarter century before the First World War. The improved output performance does not extend to inflation, however. The standard deviation of the year over year inflation rate is about the same in the two periods---up slightly for wage inflation (w) and down slightly for price inflation (p). The average inflation rate is much higher in the post-war period by both measures of inflation.

To provide some perspective I have also included in column three of Table 1 the same performance measures for the period from 1910 through 1940, which includes both the First World War and the Great Depression. This period is far worse than the other two by any of the performance measures. Output fluctuations are almost three times larger than in the post World War II period, and inflation fluctuations are about four times larger. Only the average inflation rate is less in this period than in the post-war period, but since the average is taken over very large positive values and very large negative values this is not a very meaningful performance measure.

2. Output and Inflation Fluctuations

The statistics in Table 1 are far from sufficient for characterizing the dynamic behavior of two such serially and contemporaneously correlated variables as output and inflation. Time series charts for inflation and output in the two periods are shown in the upper and lower panels of Figures 1 and 2. For additional perspective, the corresponding charts for the 1910-1940 time period are shown in the middle panels of Figures 1 and 2. Note that the scales on the charts for the different time periods are different. (The output gap $y=(Y-Y*)/Y*$ is superimposed on both the wage inflation charts and the price inflation charts). Some of the milder recessions in the earlier period are smoothed out by the use of annual data. The severe recession that began early in 1893 and ended in mid 1894 stands out as one of the worst of the period as does the brief but sharp recession that began with the financial panic in 1907. The period ends with the 1914 recession before the beginning of the First World War.

The charts clearly indicate that the tendency for inflation to fall in recessions and rise in booms is not a new phenomenon. Inflation fell during all of the more severe downturns between 1891 and 1914. Inflation was negative on average from 1891 to 1907, and positive on average from 1907 until 1914. During this latter sub-period the world gold supply steadily increased.

A comparison of the charts for the earlier period with the charts for the later period reveals in a rough way many of the differences between the two periods that we will focus on in this paper. *First*, the amplitude of the fluctuations in output is smaller in the post-war period as we have already observed. (Again note the difference in the scales on these figures). *Second*, the duration of the fluctuations in inflation is longer in the post-war period; inflation has been much more "persistent". Stated another way, wages and prices have developed more rigidities, in the sense that past values of wages and prices influence their current values. Much of the higher inflation persistence is due to the prolonged period in the 1970s when the inflation rate was abnormally high before it fell sharply in 1982 and 1983. In comparison, during the period before the First World War wage inflation fluctuated up and down with much more rapidity. Even the persistent negative trend in prices and wages before 1897 is swamped by the fluctuations in the inflation rate; similarly the positive trend after 1897 is hidden by the larger fluctuations around the trend. The *third* important difference between the two periods is in the duration of the fluctuations of real output. As with inflation, these are longer since the Second World War.

The *fourth* important difference between the two periods is more difficult to see in the charts, but is somewhat more evident in Figures 3 and 4. It relates to the timing of the fluctuations of inflation and output. In the post-war period, there is a marked tendency for increases in inflation to bring about a downturn in the economy, although with a lag. After the downturn inflation begins to fall. For example, an increase in inflation in the late 1960s preceeded the downturn in the economy in 1969-

70. After the downturn inflation declined. Similarly, an increase in inflation in 1973-74 preceeded the downturn in the economy in 1974-75. Inflation then subsided. Finally, an increase in inflation in 1979-80 preceeded the back-to-back recessions in 1980-82. And as usual, inflation then fell. It is very difficult to detect similar patterns in the 1891-1914 period. Increases in inflation do not seem to lead the economic downturns. And the declines in inflation seem to occur simultaneously with the declines in the real economy. Although this timing difference can be pried out of the charts, it emerges much more easily in the statistical time series analysis of the next two sections.

The middle panels in Figures 1 and 2 clearly indicate that the amplitude of the fluctuations is much larger in 1910-1940 period than in either the period before or the period after. The effect of the First World War is evident in the boom and the subsequent recession of 1920. But the extended boom in the 1920s and the Great Depression dominate the charts. The wide fluctuations in wages and prices indicate the same type of flexibility that is evident in the period before the First World War. The persistence of wage and price inflation--a sign of wage and price rigidities used in macro-theory--definitely seems to be relatively new phenomenon.

3. Vector Autoregressions

The dynamic properties of output, wages and prices can be examined more systematically by estimating unconstrained vector autoregressions. Estimates of bivariate autoregressions for wage inflation and output, and for price inflation and output are reported in Tables 2 and 3 for both the 1891-1914 period and for the 1952-1983 period. The lag length is equal to two years for all the regressions. For annual data this choice of lag length seemed to eliminate most of the serial correlation of the residuals to the equations. Higher order systems with both wage inflation and price inflation together with output were also estimated, but are not reported here. At this level of aggregation the movements of wages and prices are very similar, so that the addition of a third variable does not add much to the analysis.

These autoregressions are not necessarily structural equations. They are reduced form equations that in principle can be derived from a variety of systems of structural equations. The lag coefficients in the autoregressions are in principle functions of parameters in all the structural equations. The shocks to each of the autoregressive equations are in principle functions of the shocks to all the structural equations and depend on simultaneity parameters in the structural equations. In this section the aim is simply to describe the autoregressions rather than give them a structural interpretation.

A quick glance at Tables 2 and 3 reveals that the structure of the autoregressions differs by a large amount in the two periods. Both the structure of the shocks to the equations (the impulses) and the lag coefficients (the propagation mechanism) are much different.

The Impulses

The variance of the shocks, or the impulses, to the output equation, has decreased sharply from the pre-war to the post-war period. To the extent that macroeconomic policy works by changing the dynamics of the economy--as it would with feedback policy, the finding that a reduction in the size of the shocks explains most of the reduced variability suggests that such feedback policy was not responsible for improvements in performance. However, part of the change in policy could affect the variance of the shocks by working "within the period" to offset exogenous disturbances. This would be more likely for the automatic stabilizers which react simultaneously, but with annual data even a feedback policy which reacts to economic disturbances within the year would affect the variance of the shocks rather than the dynamics of the system.

The variance of the shocks to the inflation equations is also much smaller in the post-war period. Since the overall variance of inflation is about the same in the two periods, changes in the propagation mechanism must have had a positive influence on the variance of inflation. The impulses have become weaker. It is perhaps surprising that the variance of the shocks to inflation have become smaller. According to these estimates, an increased importance of price shocks in post-war business cycles is not supported by a comparison with the period before the First World War.

The contemporaneous correlation between the shocks to the equations is positive in both the pre-war and the post-war periods. However, the correlation is stronger in the pre-war period. More of the action seems to come within the annual time interval during the pre-war period.

The Propagation Mechanism

The sum of the coefficients of the lagged inflation rates in the inflation equations is much smaller in the earlier period. This change is more marked for wage inflation than for price inflation. This change is consistent with the increased persistence of inflation in the post-war period that is evident in the time series charts. The sum of the coefficients on lagged output in the output equation is also higher in the post-war period, reflecting a corresponding increase in the persistence of output fluctuations.

The difference in the temporal ordering of inflation and output movements which seems to emerge from the time series plots is evident in the cross, or off-diagonal, autoregressive coefficients. In the pre-war period lagged inflation has either a positive or an insignificant effect on output. In the post-war period the effect of lagged inflation on output is significantly negative. Looking at the other side of the diagonal, in the pre-war period lagged output has a negative effect on inflation. In the post-war period lagged output has a positive effect on inflation.

3. <u>Moving Average Representations</u>

The moving average representations provide a more convenient way to look at the propogation mechanisms in the economy. They can be derived directly from the autoregressive equations. The vector autoregressions reported in Tables 2 and 3, can be written in matrix notation as follows:

(1) $$z_t = A_1 z_{t-1} + A_2 z_{t-2} + e_t ,$$

where $z_t = (w_t, y_t)'$ in the systems with wage inflation and output, and where $z_t = (p_t, y_t)'$ in the systems with price inflation and output. A_1 and A_2 are 2 by 2 matrices of lag coefficients. The 2 by 1 vector e_t is supposed to be serially uncorrelated. The moving average representation is then given by

(2) $$z_t = \Sigma_{i=0} \Theta_i e_{t-i} ,$$

where the Θ_i matrices are found by succesive substitution of lagged z's in equation 1. Alternatively, and perhaps more intuitively, the Θ matrices can be computed by dynamically simulating the effects of unit shocks to each of the equations in (1). The two elements of the first column of the Θ_i is given by the effects of a unit inflation shock on inflation and output, respectively, in this simulation. The two elements of the second column of the Θ_i are given by the effects of a unit output shock on inflation and output, respectively, in the simulation.

Denote the elements of the first column of Θ by θ_{pp} and θ_{yp}, and the elements of the second column of Θ by θ_{py} and θ_{yy}. These four elements of the Θ_i matrices are tabulated in Tables 4 through 7 for i equals 0 to a value where the coefficients are negligible in size. The coefficients are also plotted in Figures 3 and 4 for easy comparison of the two time periods.

The use of moving average representations in macroeconomics originates with the influential paper by Sims(1980) in which he refers to it as innovation accounting; the approach has since been adopted by many other researchers. There are many moving average representations of a given multivariate process depending on what one assumes about the contemporaneous correlation between the shocks. Sims suggests that a form be chosen so that the covariance matrix of the shocks be diagonal--an orthogonalization of the shocks. This requires a transformation of the Θ_i matrices. The transformation is a function of the correlation of the shocks and depends on how one wishes to order the way the shocks enter the system. The methodology used here is different than that of Sims in that the Θ_i matrices have not been transformed to yield orthogonal shocks. I have found that such a transformation makes it difficult to give a direct structural economic interpretation of the Θ_i matrices. The methodology used here was also used for very similar purposes in an international comparison of economic performance in Taylor(1980).

Figures 3 and 4 indicate the enormousness of the change that has taken place in the dynamics of inflation and output since the period before the First World War. The charts on the diagonal of Figures 3 and 4 show the persistence of inflation θ_{pp}

and output θ_{yy}. Both have increased.

The cross effect of the shocks has changed even more. The θ_{py} coefficients have changed sign; an output shock has a long delayed effect on inflation in the more recent period. Before the First World War this dynamic effect was very small. Recall, however, that a positive *contemporaneous* relation between output and inflation existed before the First World War. The θ_{yp} coefficients have changed in the reverse direction. Whereas inflation shocks generated a reduction in output in the more recent period, they generated an increase in output before the First World War. This change, which emerges so clearly from the moving average representations, is the same change that was just barely visible in the time series charts: when inflation rises in the recent period, output falls; inflation then subsequently subsides.

4. Summary of the Facts

The preceeding examination of the facts of inflation and output fluctuations in the 1891-1914 period (the first period) and the 1952-1983 period (the second period) can be summarized as follows:

(1) Output fluctuations are smaller in amplitude and more persistent in the second period.

(2) Inflation fluctuations are about the same in amplitude in both periods, but are more persistent in the second period.

(3) Inflation shocks have a negative, but lagged, effect on output in the second period; output shocks have a positive,

but lagged effect on inflation in the second period. No such timing relation exists in the first period. If there is any intertemporal effect in the first period, it is in the reverse direction.

(4) There is a positive contemporaneous correlation between the inflation shocks and the output shocks in both periods. This correlation is larger in the first period.

(5) The variances of the shocks to inflation and to output are smaller in the later period.

5. Structural Interpretations

The vector autoregression can be viewed as a reduced form of a structural model. Unfortunately the mapping from the reduced form to the structural form is not one to one. The traditional identification literature shows formally that there will in principle be many structural models that are consistent with a given reduced form. In practice, however, the situation is not as dismal as it sounds in principle. There are a relatively small number of theoretically sound or "reasonable" structural models. Moreover, the properties of an estimated reduced form can frequently narrow the range of possible structural models.

The post-war period.

The third property of the estimated autoregressions listed at the end of the last section is very useful for nailing down a reasonable structural model. The dynamic interaction between inflation and output in the post-war period is very strong. Inflation "Granger-causes" output in a negative direction; and output "Granger-causes" inflation in a positive direction. This pattern naturally leads to the following interpretation for the post-war period.

The Federal Reserve, or the "aggregate demand authorities" in general, are concerned with stabilizing inflation as well as unemployment. For aggregate demand shocks this joint aim causes no conflict; the best policy for both price and output stabilization is to offset the shocks. When an inflation shock comes, however, there is a conflict. The Fed must decide how "accommodative" to be. On average during the post-war period the Fed seems to have made a compromise. Policy is described by a policy rule. When an inflation shock occurs, the Fed neither fully "accommodates" the shock by increasing the rate of growth of the money supply point for point with inflation, nor tries to eliminate the shock immediately by sharply reducing money growth. Instead, it lets money growth increase, but by less than the inflation shock. The result is the dynamic pattern observed in the vector autoregressions. When inflation increases the Fed lets real money balances---appropriately defined---fall, and the economy slips into a recession. Hence, inflation "Granger-causes" output. The slack demand conditions then gradually work to reduce inflation. Hence, output "Granger-causes" inflation.

This structural interpretation is by no means new, and it is gradually being incorporated in standard textbooks. For the data used here the following simple algebraic structural model seems to match the reduced form very well:

(3) $$p_t = \delta p_{t-1} + \alpha E y_t + u_t ,$$

(4) $$y_t = -\delta_1 p_{t-1} + \delta_2 p_{t-2} + y_{t-1} + v_t ,$$

The notation for output y_t and inflation p_t is the same as earlier. The operator E is the conditional expectation based on information through period t-1. The shocks u_t and v_t are assumed to be serially uncorrelated.

The first equation is a simple price adjustment equation. This equation has no simultaneous effects between output and inflation. The second equation is the policy rule described above. It states that the rate of growth of output relative to trend is reduced if inflation has risen. If this system is to match up with the reduced form evidence, the parameters should all be positive.

The estimated equations (written with the constants explicit and the t-ratios in parentheses) are:

$$(5) \quad \underset{}{p_t} = \underset{(10.1)}{.89p_{t-1}} + \underset{(3.6)}{.25Ey_t} + \underset{(1.3)}{.55}, \quad \sigma=1.0, \; R^2=.83$$

$$(6) \quad y_t = \underset{(-3.5)}{-1.01p_{t-1}} \underset{(2.5)}{+.69p_{t-2}} + y_{t-1} \underset{(1.6)}{+1.17}, \quad \sigma=2.0, \; R^2=.67$$

These equations were estimated using the full information maximum likelihood method. This method takes account of the cross equation restrictions that occur when the second equation is used to forcast output in the first equation. The output equation is already in reduced form and is clearly not much different from the estimated equation in Table 2. The reduced form for inflation can easily be derived by substituting in the expectation of equation (6) into equation (5). It also matches up well with the reduced form equation in Table 2.

Equation (6) indicates that there is much less accommodation of inflation in the short-run than in the long run. The short-run reaction coefficient is about -1 while the long-run reaction is about -.3. Equation (5) indicates that inflation responds to slack demand with a lag.[4] The coefficient on lagged inflation depends on the structure of contracts in the economy as well as on expectations of inflation; the parameter would change with a change in the policy rule that changed expectations, and in this sense it is incorrect to refer to the equation as structural.

The policy rule can be written in the following interesting form:

$$(7) \qquad y_t - y_{t-1} = -.32p_{t-1} - .69(p_{t-1} - p_{t-2}) + 1.06.$$

In other words, the rate of growth of real GNP (relative to potential) is reduced by 32 percent of the inflation rate in the last period plus 69 percent of the change of the inflation rate. The response of the Fed to high inflation is stronger when inflation is increasing than when inflation is decreasing. A nominal GNP rule could be interpreted[5] as having an implied coefficient -1 on the lagged inflation rate, with no adjustment for increasing or decreasing inflation. The estimated rule is less accommodative than a nominal GNP rule in the short-run, and more accommodative than a nominal GNP rule in the long-run.

The Pre-war Period.

The above model of price adjustment and policy is explicitly oriented to the post-war period in the U.S. The wide differences between the autoregressions in the pre-war and the post-war period indicate that the same model is unlikely to fit in the pre-war period. In fact, the model does very poorly in the pre-war period. The coefficient on lagged inflation in the inflation equation (3) is negative though small and insignificant, while the coefficients on lagged prices in the output equation (4) are all positive. As the reduced form results suggested, the dynamic relation between inflation and output in the pre-war period is weak and opposite in sign compared to the post-war period.

The price adjustment equation without the insignificant lagged inflation rate is

$$(8) \qquad p_t = \underset{(2.5)}{.28y_t} + \underset{(2.0)}{1.33.}$$

Hence, although the lagged inflation rate disappears the adjustment coefficient is about the same size as before.

There are two possible implications of this failure of the post-war model.[6] *First*, prices and wages appear to be more flexible in the pre-war period in that their correlation with output fluctuations is almost entirely contemporaneous. Adjustments occur within the annual time interval, unlike the post-war period where the adjustments are drawn out for several years. *Second*, macroeconomic policy appears to be very accommodative; inflation shocks seemed to have no prior negative effect on output. Are these implications plausible?

More Flexible Wages and Prices?

The reduced importance of the lagged inflation term could be due to simple expectations effects as well as to changes in the structure of wage and price setting. The inertia effect in the post-war is a combination of expectations effects and structure. Since inflationary expectations were probably much lower in the pre-war period, the effect of lagged inflation would be smaller. Unfortunatly it is difficult to distinguish these two effects with aggregate data.

The problem has been addressed by Cagan (1979) and Mitchell (1983) using microeconomic data. Although neither author looks at data before the First World War, their findings are probably relevent for the comparison of this paper. Cagan compares price movements in the business cycles of the 1920s with price movements in the business cycles after the Second World War. Mitchell compares wage adjustments in the 1930s with wage adjustments in the post-war period. Both find that price and wage adjustments were larger and more frequent in the earlier period. From a microeconomic perspective wages and prices were more flexible.

Two possible reasons for this change have been noted. First, the increased importance of large business enterprises and large unions could have centralized price and wage decisions and made them less subject to short-run market pressures. In the major labor unions, for example, the costs of negotiating a large settlement made it economical to have long three year contracts in many industries. The overlapping nature of these contracts added to the persistence of wage trends. Second, economic policy changed so as to reduce the severity of recessions and thereby lessen the need to reduce wages and prices quickly in the face of slack demand conditions. This policy effect is different from the expectation of inflation effect mentioned above.

More Accomodative Policy?

Although the U.S. Treasury took on some central bank functions in the early 1900s, during most of the 1891-1914 period monetary policy was determined soley by the U.S. commitment to the gold standard. A gold standard is normally thought to generate aggregate demand "discipline". Policy would automatically be non-accommodative. For example, if there was an inflation shock then a contractionary policy would be necessary in order to bring the price level back to its relative position with gold. Then why does the data suggest the opposite, that policy was accommodative?

One explanation comes from the fact that the U.S. was a small open economy during this period. Most price shocks probably came from abroad, much as the price shocks in the 1970s came from abroad. An increase in external prices with a fixed exchange rate will make domestically produced goods cheaper. This will lead to a balance of payments surplus until internal prices rise. A balance of payments surplus increases the money supply for a country on a gold standard. The increase in the money supply will therefore tend to occur just as the domestic price level rises in response to the rise in world prices. Policy will look very accommodative.

A fixed exchange rate gold standard will be less accommodative to price shocks that originate at home. A price shock will raise domestic prices relative to external prices. The resulting balance of payments deficit will reduce the domestic money supply and the economy will tend to fall into a recession. Internal prices will then fall. This type of scenario either did not occur in the 1891-1914 period, or it occured so quickly that the timing can not be detected with aggregate annual data. It is interesting that accommodation under a gold standard seems to be different for external shocks than for internal shocks. According to modern expectations theories this discrimination is appropriate. Internal endogenous price and wage shocks are discouraged, while external exogenous price shocks are accommodated. Because the external price and wage behavior is unlikely to be influenced by the monetary policy in a small open economy, accommodation will not do any long run harm. But internal price and wage behavior is likely to be adversely affected by an accomodative policy.

Another way to describe the pre-war policy rule is that it was accommodative in the short-run, permitting much slippage to accommodate external price shocks, but non-accommodative in the long-run. Prices in the United States could not differ from world prices in the long-run. This is in contrast to the characterization in the previous section of policy in the post-war period: in the short-run policy is much less accommodative than in the long-run.

To summarize, the interpretation that prices and wages adjust quickly and that policy is very accommodative in the short-run is plausible from a microeconomic perspective. Unlike in the post-war period, where lags in the relation between output and inflation permitted one to narrow down the field of potential models, the pre-war data is more ambiguous, however. If all the action occurs within the annual timing interval it is difficult to distinguish one structural model from another. The lags are not long enough to identify the structure. In fact, the contemporaneous relation between prices and output in equation (8) could have been generated from a mechanism like the Lucas (1972) supply curve. If prices were as flexible as they appear to be during this earlier period, then the Lucas model itself is more plausible.

6. Concluding Remarks.

Macroeconomic performance in the United States from 1891 through 1914 was much different from the performance after the Second World War. This difference is apparent in reduced form autoregressions, in their moving average representations, in simple structural models, and even in simple time series charts of the data. The shocks, or *impulses*, to the economic system were smaller in the second period, mainly because of the policy and structural changes that Arthur Burns mentioned in his 1959 presidential address. Deposit insurance, for example, reduced the shocks to aggregate demand that came from financial panics.

But the dynamics, or *propagation mechanisms*, of the economic system are much slower and more drawn out in the post-war period. This tends to translate the smaller shocks into larger and more prolonged movements in output and inflation than would occur if the pre-war dynamics were applicable in the later period. In other words the change in the dynamics of the system offset some of the gains from the smaller impulses. These post-war dynamics can be given a structural interpretation in terms of the accommodative stance of monetary policy, and the speed of wage and price adjustments. These dynamics were not evident in the pre-war period.

One interpretation of these developments is that the change in the dynamics was a direct result of the reduction in the importance of the shocks. For example, prices and wages may have became more rigid because of the reduced risks of serious recessions, or because movements in the money supply began to do some of the macroeconomic stabilization work that was previously done by wage and price adjustments. The analysis of this paper is not conclusive on this or the other interpretation that the change in the dynamics was unrelated to the change in policy. But the possibility that a combination of the smaller post-war shocks with the shorter pre-war dynamics might improve macroeconomic performance, should be sufficient motivation for further study of these historical developments and their alternative interpretations.

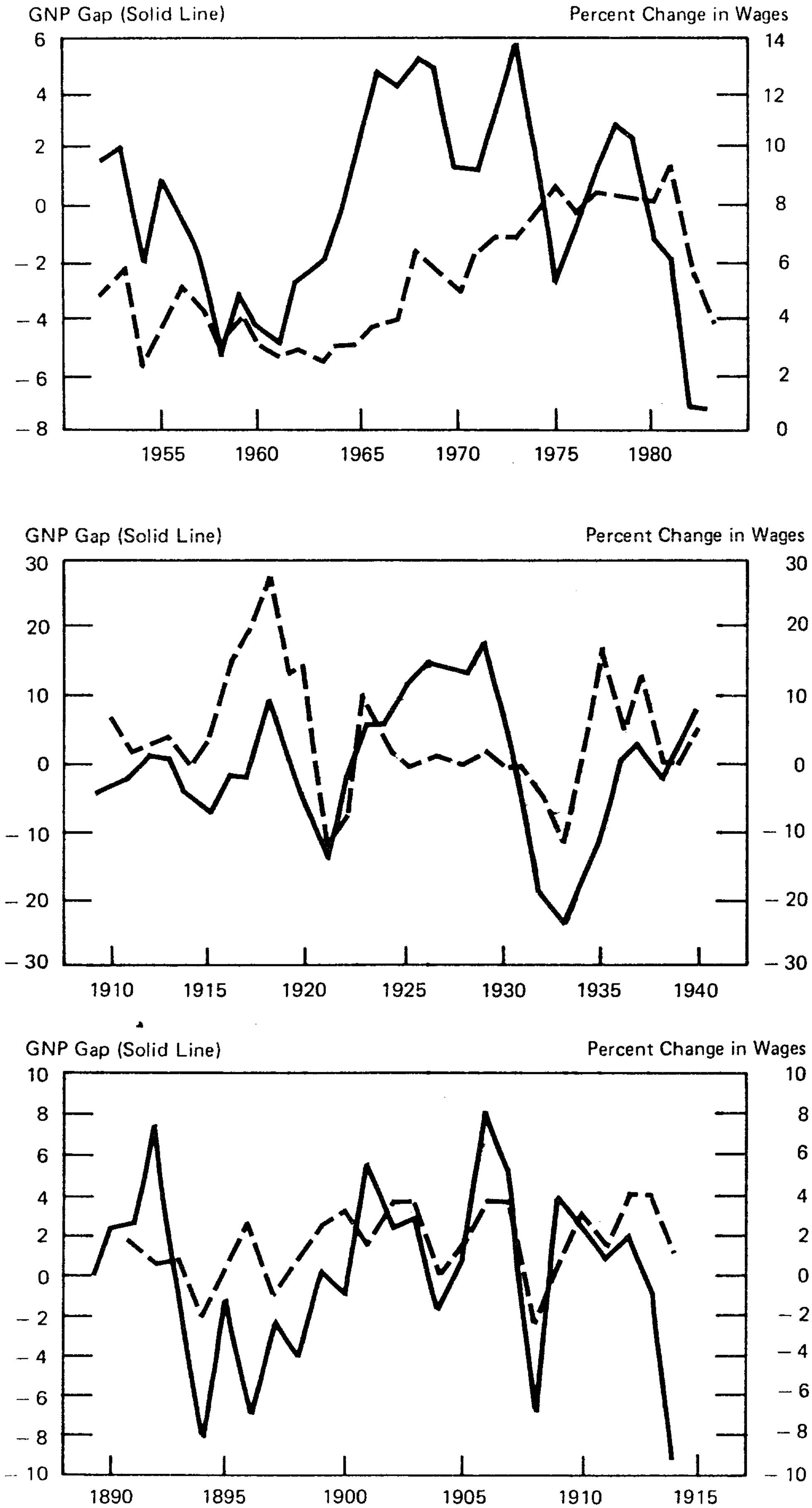

FIGURE 1
WAGE INFLATION AND DEVIATIONS OF REAL
OUTPUT FROM TREND DURING THREE PERIODS

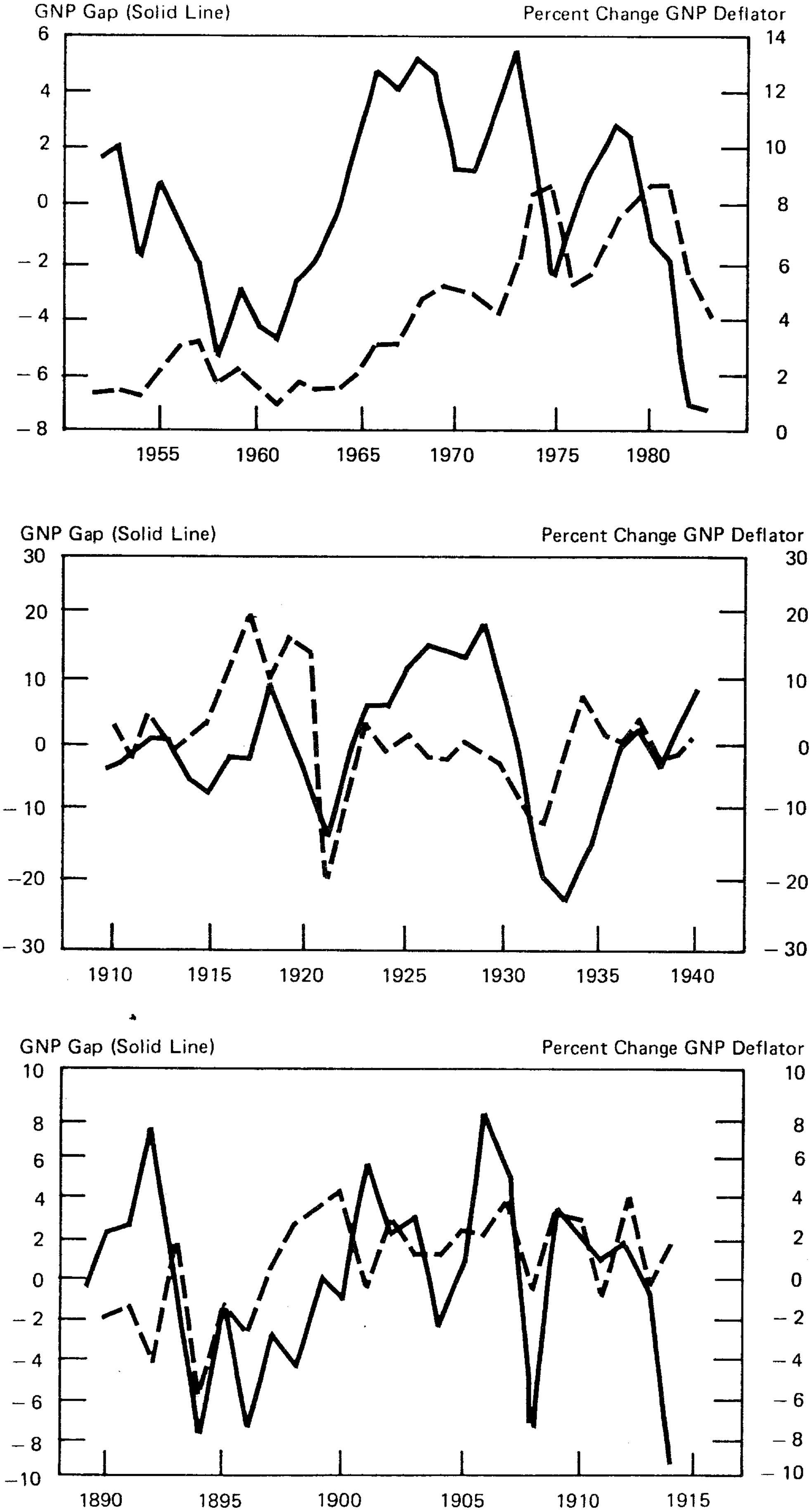

FIGURE 2
PRICE INFLATION AND THE DEVIATION OF REAL
OUTPUT FROM TREND DURING THREE PERIODS

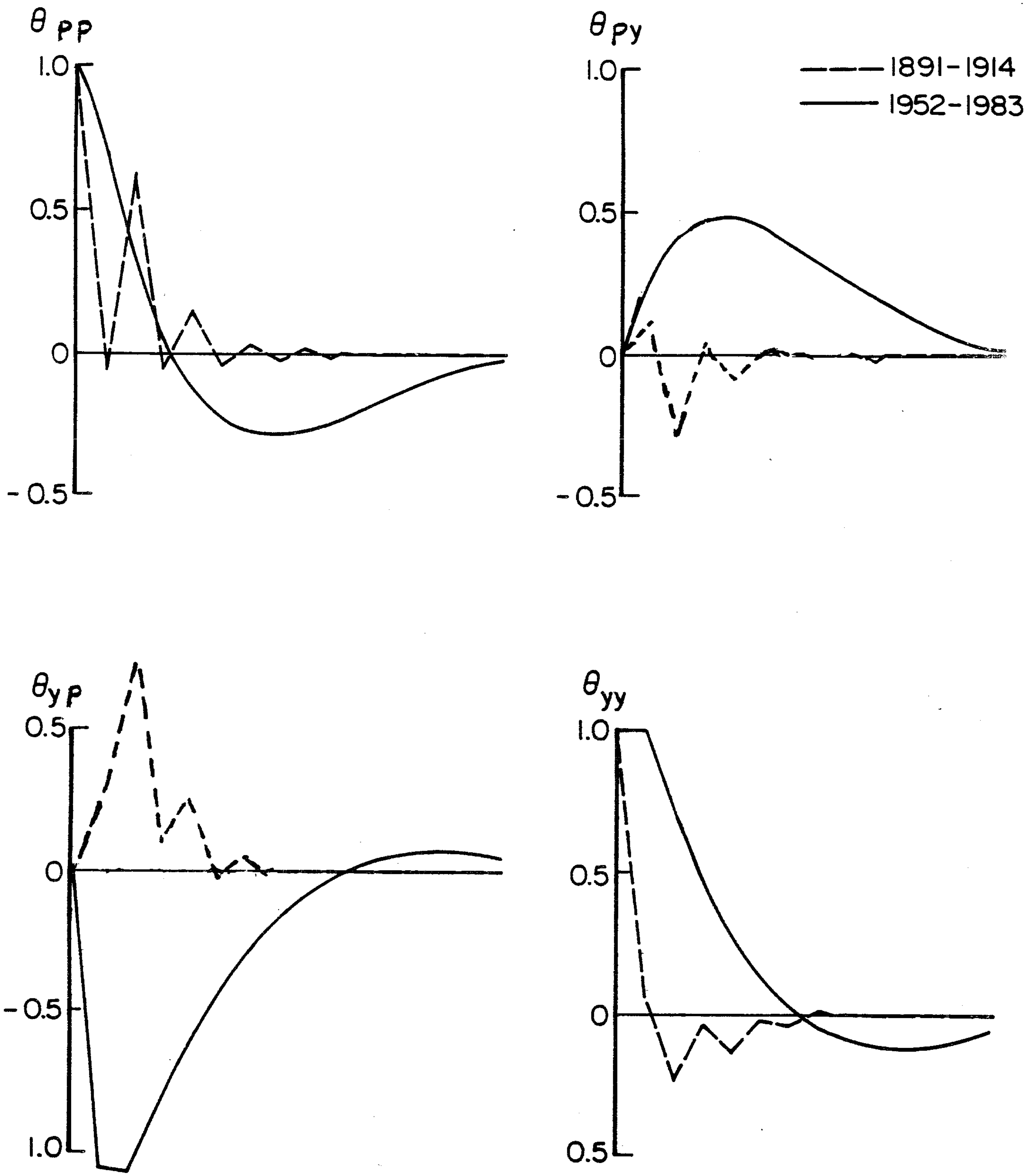

Figure 3: Moving Average Representation for Price Inflation and Output.

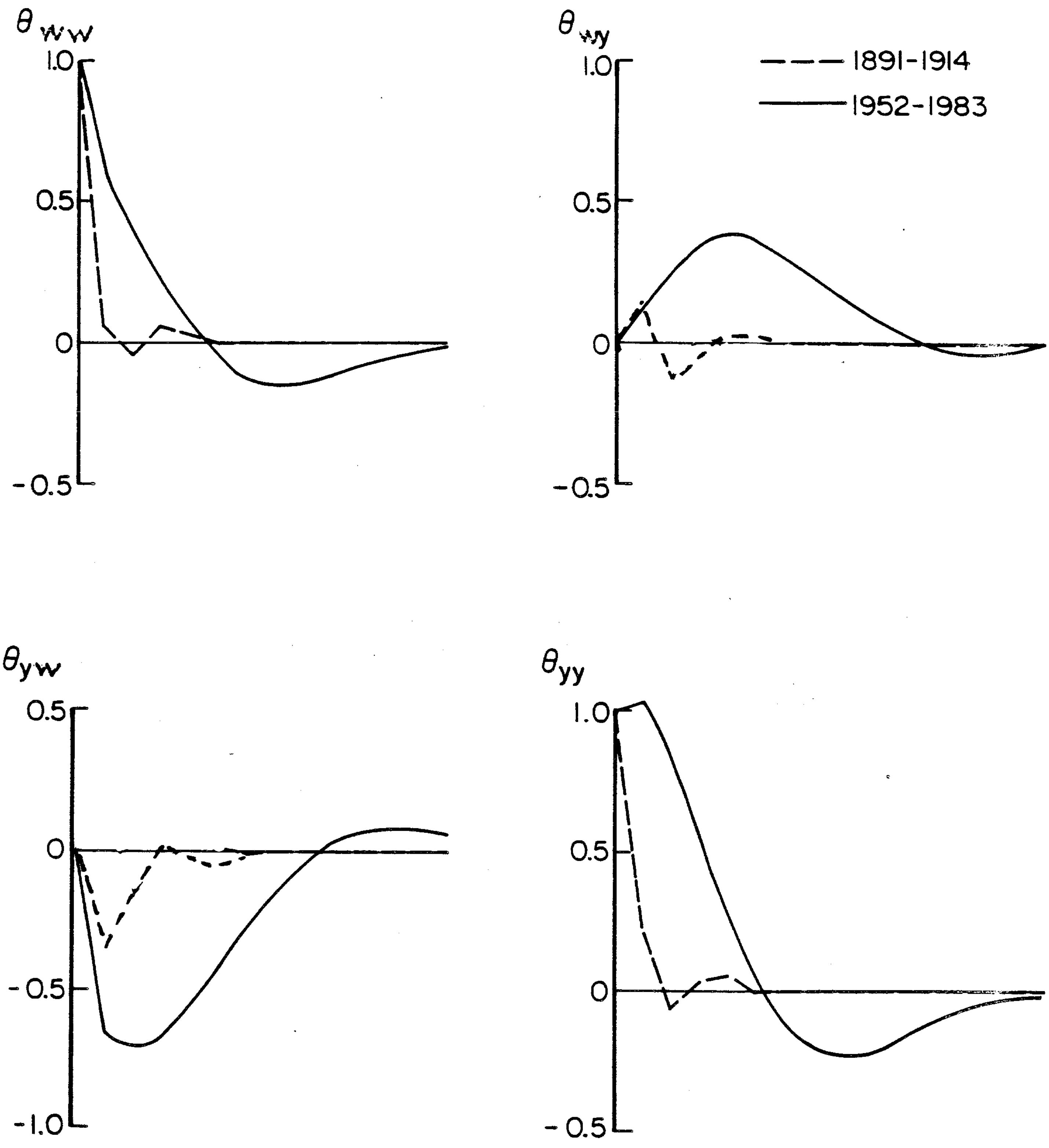

Figure 4: Moving Average Representation for Wage Inflation and Output.

TABLE 1

Measures of Inflation and Output Stability

	1891-1914	1952-1983	1910-1940
Standard deviation of:			
Output gap	4.8	3.6	10.1
Wage inflation	1.9	2.2	8.9
Price inflation	2.8	2.6	8.1
Average of:			
Wage inflation	1.5	5.4	4.1
Price inflation	0.9	4.2	1.5

Note: By definition the average output gap is zero. Prices are measured by the GNP deflator and wages by average hourly earnings in manufacturing.

TABLE 2

Autoregressive Estimates for Price Inflation and Output
1891-1914 and 1954-1983

Sample period: 1892-1914

Dependent Variable	Lagged dependent variables: p(-1)	p(-2)	y(-1)	y(-2)	ρ	σ	R^2
p	-.051 (-0.3)	.574 (3.3)	.108 (1.0)	-.281 (-2.5)	-.02	1.91	.46
y	.279 (0.8)	.734 (2.0)	.053 (0.2)	-.260 (-1.1)	-.18	4.00	.24

Contemporaneous correlation between residuals = .30

Sample period: 1954-1983

Dependent Variable	Lagged dependent variables: p(-1)	p(-2)	y(-1)	y(-2)	ρ	σ	R^2
p	.721 (3.5)	.084 (0.4)	.257 (2.7)	-.027 (-0.3)	-.09	1.03	.82
y	-1.05 (-2.6)	.76 (2.0)	1.00 (5.2)	-.004 (-0.0)	-.05	2.07	.66

Contemporaneous correlation between residuals = .23

Note: Each equation was estimated with a constant term. The variable p is the annual percentage rate of change in the GNP deflator. The variable y is the percentage deviation of output from linear trend estimated over the sample period. The numbers in parentheses are t-ratios. ρ is the first order autocorrelation coefficient. σ is the standard error of the residuals.

TABLE 3

Autoregressive Estimates for Wage Inflation and Output
1891-1914 and 1954-1983

Sample period: 1891-1914

Dependent Variable	Lagged dependent variables: w(-1)	w(-2)	y(-1)	y(-2)	ρ	σ	R^2
w	.052 (0.2)	.007 (0.1)	.147 (1.3)	-.213 (-1.8)	.02	1.66	.30
y	-.358 (-0.6)	-.030 (-0.1)	.220 (0.7)	-.063 (-0.2)	.05	4.49	.04

Contemporaneous correlation between residuals = .66

Sample period: 1954-1983

Dependent Variable	Lagged dependent variables: w(-1)	w(-2)	y(-1)	y(-2)	ρ	σ	R^2
w	.569 (2.5)	.175 (0.7)	.097 (0.8)	.103 (0.8)	-.03	1.20	.70
y	-.650 (-1.6)	.336 (0.8)	1.026 (4.5)	-.181 (-0.8)	.04	2.21	.62

Contemporaneous correlation between residuals = .52

Note: The variable w is the annual percentage rate of change in average hourly earnings in manufacturing. For the definition of other variables see the note to Table 2.

TABLE 4

Moving Average Representation for Price Inflation and Output
1891-1914

θ_{pp}	θ_{py}	θ_{yp}	θ_{yy}
1.00	.00	.00	1.00
-.05	.11	.28	.05
.61	-.28	.73	-.23
-.06	.04	.10	-.03
.15	-.10	.24	-.14
-.04	.02	-.01	-.00
.02	-.02	.04	-.03
-.02	.01	-.02	.01
.00	-.00	-.00	.00
-.00	.00	-.01	.00
-.00	.00	-.00	.00

Note: Derived from the autoregressive coefficients reported in Table 2.

TABLE 5

Moving Average Representation for Price Inflation and Output
1952-1983

θ_{pp}	θ_{py}	θ_{yp}	θ_{yy}
1.00	.00	.00	1.00
.72	.26	-1.05	1.00
.33	.41	-1.06	.72
.06	.48	-.85	.47
-.12	.48	-.65	.27
-.23	.44	-.47	.12
-.28	.38	-.32	.02
-.29	.31	-.20	-.05
-.27	.24	-.10	-.09
-.24	.18	-.03	-.11
-.20	.12	.02	-.12
-.16	.08	.05	-.11
-.12	.04	.07	-.10
-.08	.01	.07	-.08
-.05	-.00	.07	-.06
-.03	-.02	.06	-.05

Note: Derived from the autoregressive coefficients reported in Table 2.

TABLE 6

Moving Average Representation for Wage Inflation and Output
1891-1914

θ_{ww}	θ_{wy}	θ_{yw}	θ_{yy}
1.00	.00	.00	1.00
.05	.15	-.35	.22
-.04	-.17	-.12	-.07
.06	-.06	.01	.03
.03	.01	-.01	.04
-.00	.00	-.02	.00
-.00	-.01	-.00	-.00
.00	-.00	.00	.00
.00	.00	-.00	.00

Note: Derived from the autoregressive coefficients reported in Table 3.

TABLE 7

Moving Average Representation for Wage Inflation and Output
1954-1983

θ_{ww}	θ_{wy}	θ_{yw}	θ_{yy}
1.00	.00	.00	1.00
.57	.10	-.65	1.03
.44	.26	-.70	.81
.21	.35	-.69	.52
.06	.37	-.58	.25
-.06	.35	-.43	.02
-.12	.29	-.28	-.12
-.15	.22	-.15	-.20
-.15	.14	-.05	-.23
-.13	.08	.03	-.22
-.10	.02	.07	-.18
-.07	-.01	.09	-.13
-.04	-.03	.09	-.09
-.02	-.05	.08	-.05
-.00	-.05	.07	-.01

Note: Derived from the autoregressive coefficients reported in Table 3.

Footnotes

1. See Tobin (1980).

2. The interwar period would also make a useful comparison. In the first draft of this paper I looked at the period from 1910 through 1940. To omit the observations from the First World War--which would be analogous to the omision of the Second World War from the later sample--would mean that the period could not begin until 1919 at the earliest; and since some observers interpret the 1920 recession as a direct consequence of demobilization, the same logic would call for starting in 1921 or 1922. The sample size would then be less than 20 annual observations, which is already very small for statistical time series analysis. If one worried further that the great depression was unique to itself and should not be lumped together with other cycles, then one would be left with the 1920s, a period which is far too short for statistical analysis. For these reasons I decided to focus on the earlier period before the First World War. This period has some other advantages as a contrast with the 1952-1983 period. These are discussed in the next section. I am grateful to Otto Eckstein, Robert Gordon, and Phillip Cagan for useful discussions and suggestions on these points.

3. See Cagan (1979), Gordon (1983), and Mitchell (1983), for example.

4. The data cannot discriminate between the assumptions that y_t or E_t appears in equation (5). The contemporaneous correlation is positive and could equally well be due to the correlation between the structural shocks as to a direct simultaneous effect of y_t on p_t.

5. Taken literally a nominal GNP rule would respond to inflation shocks in the current period. In practice, however, a lag would probably occur.

6. It should be noted that there are fairly strong dynamic feedback effects from output and prices two years earlier in the price inflation system (see Table 2). This is puzzling since the impact from prices and output one year earlier is weak. This two year leap is the reason for the sawtooth moving representation for this system (see Figure 3).

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