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Does Wage Inflation Cause Price Inflation?

by Gregory D. Hess and Mark E. Schweitzer

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Recent attention has turned from unemployment levels to wage growth as an indicator of imminent inflation. But is there any evidence to support the assumption that increased wages cause inflation? This study updates and expands earlier research into this question and finds little support for the view that higher wages cause higher prices. On the contrary, the authors find more evidence that higher prices lead to wage growth.

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"Unions Seek Big Pay Gains, Sparking Inflation Worries"

Headline, *Wall Street Journal,* September 3, 1999.

Introduction

Wall Street economists and journalists have frequently focused on labor market activities to help foretell inflationary price pressures. Earlier in the current expansion, some considered a low unemployment rate (below 6.5 percent) a harbinger of rising inflation. The commonly held view was that if the aggregate demand for goods and services caused unemployment to fall below some "natural" rate, inflation would accelerate. However, although the unemployment rate continued to fall throughout the 1990s, inflation never rose. This led economists to reconsider whether the "threshold" unemployment rate, termed the natural or nonaccelerating rate of inflation (NAIRU), had fallen from approximately 6.5 percent to 4.5 percent. Recent work by Staiger, Stock, and Watson (1997), however, suggests that even a time-varying natural rate of unemployment is not a very useful tool for predicting inflation.[1]

With uncertainty about the unemployment rate's reliability as an early-warning device for rising inflation, recent attention has turned to wage and compensation growth for a labor market indicator of inflation. The standard argument for how increased labor costs tend to push up prices, leading to the wage-price spiral, is as follows:

> "… when buoyant demand reduces unemployment (at least relative to recent experienced levels), inflationary pressure develops. Firms start bidding against each other for labour, and workers feel more confident in pressing wage claims. If the inflationary pressure is too great, inflation starts spiraling upwards: higher wages lead to higher price rises, leading to still higher wage rises, and so on. This is the wage-price spiral."[2]

Surprisingly, the recent shift in attention to higher wages as the cause of higher prices leaves unexplained the problem of how wages get high in the first place.

The intuition behind this view is that since labor costs are a large fraction of a firm's total costs of production, rising wages and compensation should put pressure on firms to pass these higher costs on as higher prices. We have several reasons to doubt the accuracy of this view. First, if a wage increase is brought about by increased labor productivity, it will not create inflationary pressure.[3] Second, a wage increase will not create inflationary pressure if it leads to a squeeze in profits because a firm cannot pass along cost increases. No firm inherits the right to simply "mark-up" the prices of its output as a constant proportion above its costs; competitive market pressures strongly influence the pricing decisions of firms. Finally, causation could work in the opposite direction: An increase in aggregate demand may permit firms to raise the price of their products, and the resulting increase in profits would lead workers to demand higher wages in future negotiations.

1. Stock and Watson (1999) find that unemployment does not help in forecasting U.S. inflation, but that an indicator of aggregate demand does. However, in contrast to the research we present in this paper, they do not explore issues of simultaneity, measures of productivity, or unit labor costs in their forecasts.

2. Layard, Nickell, and Jackman (1994), pp. 11.

3. Indeed, wage increases supported by productivity growth should not be considered "wage inflation" at all, but we will occasionally use this phrase as it is in the existing literature.

It turns out that the vast majority of the published evidence suggests that there is little reason to believe that wage inflation causes price inflation. In fact, it is more often found that price inflation causes wage inflation. Our recent research, which updates and expands on the current literature, also provides little support for the view that wage gains cause inflation. Moreover, wage inflation does a very poor job of predicting price inflation throughout the 1990s, while money growth and productivity growth sometimes do a better job. The policy conclusion to be drawn is that wage inflation, whether measured using labor compensation, wages, or unit-labor-costs growth, is not a reliable predictor of inflationary pressures. Inflation can strike unexpectedly without any evidence from the labor market.

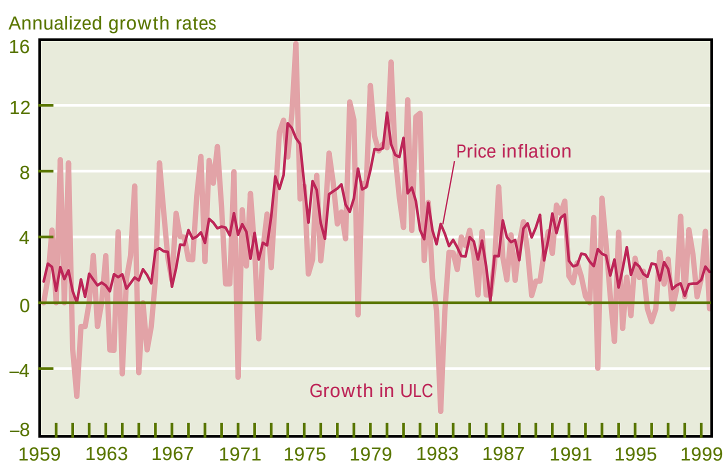
Data

Before exploring the econometric evidence on this debate, we provide a plot of price inflation (as measured by the growth rate of the personal consumption expenditure deflator) and wage inflation (as measured by the growth of nonfarm business compensation) in figure 1.[4] The series are graphed over the time period 1960:IQ to 1999:IIIQ. Although the growth in wages fluctuates more wildly than does inflation, both series generally share the same pattern (they have a correlation coefficient of 0.408): Both trended upwards throughout the 1960s and 1970s, they both peaked and tended to decline throughout the 1980s, and then they stabilized during the 1990s. Obviously, wages and price changes are related, but the direction of causation isn't readily apparent.

As mentioned above, however, the growth of nominal wages may be a poor measure of cost pressures faced by firms, since if wage growth is driven by productivity growth, then firms will not have to pass higher wages on as higher prices. This argument also would require that employers compensate workers for productivity gains; thus, productivity should be accounted for when asking if wages are driven by inflation. Fortunately, the Bureau of

4. The appendix provides a full description of each series.

FIGURE 1 | GROWTH OF UNIT LABOR COSTS AND PRICE INFLATION



Labor Statistics also reports unit labor costs, that is, the labor cost to the firm of producing one unit of output, which adjusts wages for labor productivity. Figure 2 charts price inflation and the growth in unit labor costs for 1960:IQ to 1999:IIIQ. One can see that while unit labor costs are quite volatile, they tend to track inflation closely (the two series have a correlation coefficient of 0.642), but causation is no clearer.

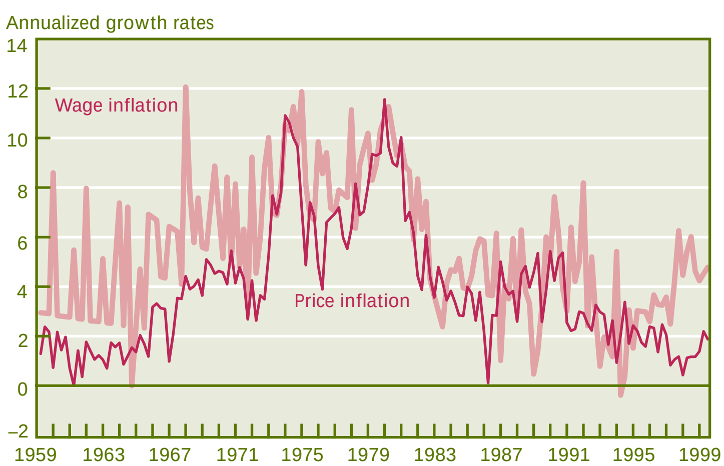
Econometric Literature

While the raw data show that measures of wages and prices move strongly together, the academic literature is divided as to whether there is empirical evidence that wages cause prices. To be clear, academic economists use the term causality as in "Granger-causality." The test for Granger-causality involves examining whether lagged values of one series (say wages) have significant in-sample explanatory power for another variable (say prices). Of course, both variables may "Granger-cause" one another, in which case one can conclude only that both economic series are determined simultaneously; hence, a researcher cannot conclude that one series has an independent causal effect on the other. The matter becomes even more complicated if the series in question are "cointegrated," which is the case if the levels of the series move together over the long run, even though the individual series are best modeled in growth rates. In this case, the researcher must be careful to include "error correction terms" in the Granger-causality tests to allow the series to catch up with one another.[5] The significance of the error correction terms in the Granger-causality test simply reflects the fact that the series in question are driven to return to a long-run equilibrium relationship that is noncausal.

Furthermore, researchers' conclusions about the causal effects between wages and prices often depend on the sample length, the number of explanatory variables used (including the number of lags of each variable), and the particular measure of prices used. Two recent papers typify the disagreement. Mehra (1993) examines a system of variables that includes inflation, the output gap, and unit labor costs as a measure of wages, as well

5. The omission of these error correction terms in a Granger-causality test specified in growth rates would lead to a standard omitted variable bias in the test for Granger-causality.

FIGURE 2 WAGE AND PRICE INFLATION



as dummy variables for wage and price controls and a measure of energy prices, for the period 1956:IQ to 1992:IVQ in the United States. He reports that one can conclude that wages Granger-cause inflation only when one uses the CPI to measure prices, and that one obtains much stronger evidence that prices Granger-cause wages when one uses the more general GDP price deflator. These results are consistent with earlier work by Mehra (1991), Gordon (1988), and Huh and Trehan (1995). More recently, Ghali (1999) re-explores the econometric issues in Mehra (1993) and modifies the system of variables to include the relative price of imported goods, although he shortens the sample period to 1959:IQ–1989:IIIQ and only considers prices as measured by the GDP price deflator. In contrast to the findings of Mehra (1993), Ghali (1999) reports that there is strong evidence that wages Granger-cause prices and advocates that the Federal Reserve should monitor unit labor costs as a predictor of future inflation.

However, the findings by Ghali (1999) are atypical and not confirmed by the results reported below. Three further studies find the systematic evidence that wages cause prices woefully insufficient. First, exploring whether sectoral wage growth causes inflation, Rissman (1995) concludes, " ... In most of the industries examined, the direction of causality runs from prices to wages rather than wages to prices. Only in manufacturing and retail trade does pro-

TABLE 1 | GRANGER-CAUSALITY TESTS[a]

Panel A. Wages Measured by Compensation per Hour with Productivity Included Separately

	Are prices caused by			
Time period	Wages	Productivity	Money	Error correction
1960:IQ –1999:IIIQ	0.330	0.339	0.296	0.054
1980:IQ –1999:IIIQ	0.295	0.163	0.270	0.742

	Are wages caused by			
Time period	Prices	Productivity	Money	Error correction
1960:IQ –1999:IIIQ	0.155	0.622	0.368	0.447
1980:IQ –1999:IIIQ	0.778	0.862	0.422	0.317

Panel B. Wages Measured by Unit Labor Cost

	Are prices caused by		
Time period	Unit labor costs	Money	Error correction
1960:IQ–1999:IIIQ	0.146	0.215	0.233
1980:IQ–1999:IIIQ	0.451	0.687	0.264

	Are unit labor costs caused by		
Time period	Price	Money	Error correction
1960:IQ–1999:IIIQ	0.000	0.000	0.000
1980:IQ–1999:IIIQ	0.000	0.102	0.150

Panel C. Wages Measured by Average Hourly Earnings with Productivity Included Separately

	Are prices caused by			
Time period	Wages	Productivity	Money	Error correction
1960:IQ –1999:IIIQ	0.222	0.330	0.296	0.012
1980:IQ –1999:IIIQ	0.269	0.217	0.492	0.185

	Are wages caused by?			
Time period	Prices	Productivity	Money	Error correction
1960:IQ –1999:IIIQ	0.631	0.403	0.361	0.000
1980:IQ –1999:IIIQ	0.250	0.143	0.245	0.002

a. Each column reports the p-values (that is, the level of statistical significance) for the test that the column variable does not Granger-cause either wage inflation or price inflation.

ductivity-adjusted wage growth appear to help forecast inflation." Second, Clark (1998) has recently explored whether producer prices help predict consumer prices on both an in-sample (Granger-causality) and an out-of-sample basis. He finds that while there is evidence that producer prices Granger-cause consumer prices, the nature of these relationships is so fragile that they simply cannot be used on an out-of-sample basis that would be useful for policy purposes. Finally, recent work by Hogan (1998) finds that even in a price-equation, Phillips-curve specification, unit labor costs are not helpful for predicting U.S. inflation.[6]

Updated Granger-Causality Tests

Table 1 presents our own tests for Granger-causality between wages and prices, using the most recent quarterly data available for the United States.[7] Panel A of the table reports evidence on which variables cause prices and wages. The regression includes lagged inflation, lagged money growth, lagged wage growth, lagged productivity, the lagged relative growth in energy and food prices, dummy variables for the Nixon wage and price controls, and a constant (see the appendix for a complete description of the data).[8] The lag length for each variable is set to four. The regression also includes an error correction term that has been estimated to find the long-run relationship between the log level of wages, prices, money, and productivity.[9] Each panel first reports the evidence on whether the column variable Granger-causes prices, followed by the evidence for whether the column variable Granger-causes wages. The null hypothesis is that there is no Granger-causation, and each column reports the level of statistical significance that one can reject this null hypothesis—the so-called "p-values." In general, a p-value of less than 0.1 is evidence of Granger-causality.

The results in the top panel suggest that for the full sample, 1960:IQ to 1999:IIIQ, the evidence does not show that wages Granger-cause inflation, but rather that prices are driven by their long-run relationship with other variables in the model, as identified by the error correction term. Nor do price inflation and productivity growth Granger-cause wage inflation. Price and wage changes are best predicted by their own lags in these estimates.[10] These results should be viewed as reasonably consistent with those in the literature in that little or no Granger-causality has been found for wages. The inability of these variables to forecast one another "in-sample" continues for the more recent period, 1980:IQ to 1999:IIIQ.

Panel B of table 1 reanalyzes whether wages cause prices, except wages are now measured by unit labor costs. The findings suggest that for both samples, prices Granger-cause unit labor costs, while unit labor costs do not Granger-cause prices. In addition, money and the long-run error correction term Granger-cause prices in the full sample. These findings further reinforce the view that wages (even corrected for productivity growth) have no independent causal effect on prices. As is found often in the literature, there is more evidence that prices Granger-cause wages than that wages Granger-cause prices.

Panel C replaces compensation and the related unit-labor-cost series with a more conventionally measured wage. Compensation includes the value of benefits, bonuses, realized gains in option-based compensation, and the earnings of the self-employed. While it

6. Alternatively, Gali and Gertler (1999) find that a measure of the marginal cost of labor is a relevant determinant of inflation. However, their findings do not consider the simultaneity or causality issues that are the focus of our work.

7. All data were current as of December 7, 1999.

8. These Granger-causality tests do not include a measure of the output gap, as recent evidence suggests that such measures are highly unreliable. Orphanides and van Norden (1999) demonstrate that in some cases the revision in the output gap is as large as the total variability of the output gap. We also do not report results for similar tests, including an import price index, as recommended by Ghali (1999), because including the index restricted the period of analysis but did not materially alter the results from those reported for 1980:IQ to 1999:IIIQ.

9. As pointed out by Ghali (1999), these cointegrating regressions do not include a constant. They were estimated using the dynamic OLS method of Stock and Watson (1993).

10. The weak performance of the money measure might be associated in part with sharply larger rates of money growth in 1999, which were associated with Y2K liquidity concerns. We examined the same relationships excluding the last year and found essentially equivalent results.

is important not to ignore other forms of compensation, these measures necessarily place more weight on the occupations that may be removed from the production process. Perhaps there is a stronger causal relationship between *conventional wages* and prices than between compensation and wages as reported in panels A and B? The Granger-causality results do not support this view. Only the long-run error correction terms are identified as significant in panel C, when conventional wage data are used.

Lengthening the Forecast Horizon

Granger-causality tests are based on the one-period-ahead (in this case, one quarter) predictive capacity of a data series. Policymakers typically look further forward when setting monetary policy. While a one-quarter-out *estimate* of inflation could be used to generate a "dynamic" forecast by plugging in predictions of the explanatory variables to yield a longer-horizon forecast, this process adds no additional information. Instead, we use statistical tests analogous to those yielding the table 1 results to test the information content of wage changes and inflation at a longer horizon. Table 2 repeats the table 1 tests at the more policy-relevant lead time of one year.

TABLE 2 | ONE-YEAR FORWARD PREDICTION TESTS[a]

Panel A. Wages Measured by Compensation per Hour with Productivity Included Separately

	Are prices predicted by			
Time period	Wages	Productivity	Money	Error correction
1960:IQ – 1999:IIIQ	0.298	0.604	0.006	0.022
1980:IQ – 1999:IIIQ	0.029	0.010	0.000	0.081

	Are wages predicted by			
Time period	Prices	Productivity	Money	Error correction
1960:IQ – 1999:IIIQ	0.879	0.340	0.071	0.257
1980:IQ – 1999:IIIQ	0.076	0.557	0.149	0.926

Panel B. Wages Measured by Unit Labor Cost

	Are prices predicted by		
Time period	Unit labor costs	Money	Error correction
1960:IQ – 1999:IIIQ	0.176	0.084	0.814
1980:IQ – 1999:IIIQ	0.009	0.001	0.002

	Are unit labor costs predicted by		
Time period	Price	Money	Error correction
1960:IQ – 1999:IIIQ	0.000	0.460	0.328
1980:IQ – 1999:IIIQ	0.208	0.042	0.130

Panel C. Wages Measured by Average Hourly Earnings with Productivity Included Separately

	Are prices predicted by			
Time period	Wages	Productivity	Money	Error correction
1960:IQ – 1999:IIIQ	0.822	0.469	0.008	0.002
1980:IQ – 1999:IIIQ	0.174	0.715	0.231	0.046

	Are wages predicted by			
Time period	Prices	Productivity	Money	Error correction
1960:IQ – 1999:IIIQ	0.611	0.241	0.054	0.007
1980:IQ – 1999:IIIQ	0.189	0.165	0.706	0.090

a. Each column reports the p-values (that is, the level of statistical significance) for the test that lags 5 to 8 of the column variables do not aid in predicting either wage inflation or price inflation.

Throughout table 2, more variables offer a boost to the model's predictive power at the longer horizon. In panel A, wage changes still do not predict inflation in the full sample. However, prices and wages help predict each other in the second half of the sample. Focusing on the later period, all variables contribute to better estimates of inflation: wages, productivity, money, and the error correction term. Interestingly, money performs far better at one year into the future. Except for predicting wages since 1980, money is consistently significant. Panel B shows similar results when unit labor costs are used as the wage measure. Only in the later period are unit labor costs a significant factor in inflation estimates, but money and the error correction term are frequently significant. In panel C, wages never matter and money works only over the full time span. Overall, there is some support for looking at wages as an indicator of impending inflation, although there is just as much evidence that wages are caused by inflation movements. Money is surprisingly important in this analysis; in fact, it is the most reliable indicator for both wage and price changes.

Judging the Predictive Performance

A shortcoming of Granger-causality tests is that they are based on in-sample estimates of the data. However, financial markets attempt to use this information to predict future inflation, so it is also important to analyze whether empirical models of inflation estimated over available data are useful for forecasting inflation for a later period (such as the 1990s). Financial forecasts are likely to use all of the data available at a given date to predict inflation a number of periods out. Results from such an experiment are presented in table 3a. A number of inflation equations were forecasted over 1990:IQ to 1999:IIIQ using data from 1960:IQ to the assumed forecasting date, which depends on how far out the forecasting exercise is being conducted.[11] The models are labeled in the first column. The univariate model contains a time trend, the lagged price level (in logs), four lags of inflation, four lags of relative growth in energy and food prices, dummy variables for the Nixon wage and price controls, and a constant (see the appendix for a complete description of the data). The model labeled money also includes the lagged level of money (in logs) and four lags of money growth. The wage, productivity, and unit-labor-cost models are similarly defined.[12]

The second column in table 3a reports the root mean squared errors (RMSE) of one-quarter-ahead forecasts. Forecasts with lower RMSE are better than those with higher RMSE. The values in parentheses are the probability that the money, wage, productivity, unit-labor-cost, and hourly-earnings models of inflation have lower RMSE than does the simple univariate model. The null hypothesis is that these models do not have lower RMSE than the univariate model. P-values less than 0.1 generally suggest that the models outforecast the simple univariate inflation model. The third column repeats the analysis with a forecast of inflation one year in advance.[13]

Table 3b performs a similar exercise, except that we now use these key variables to predict wage growth on an out-of-sample basis. The structure of the table is the same as table 3a. Two key results are revealed in these wage growth forecasts. First, neither inflation nor

11. These static forecasts examine how an equation, estimated over one time period, fits over a later sample with quarterly reestimation of the empirical relationships. Forecasts beyond a quarter again are based on a static forecasting procedure. A dynamic forecast would involve estimating an inflation equation and then forecasting each subsequent period based on earlier forecasts. Static forecasts typically do a much better job of predicting than do dynamic forecasts. See also Clark (1997).

12. In contrast to the in-sample Granger-causality tests, where model specification is essential for making correct statistical inference for hypothesis tests, we take a less structural approach for our out-of-sample comparison of RMSE.

13. The degrees of freedom are adjusted to account for the lack of independence in one-year-forward forecasts.

productivity has been very helpful in forecasting wage growth out-of-sample. In fact, they have only a marginal effect in lowering the RMSE; and in one instance, they actually raise it. Second, money growth performs well in predicting wage growth at both horizons.

The out-of-sample forecasts confirm the absence of convincing evidence that wages are good at forecasting prices on an out-of-sample basis. In particular, while the RMSE for the wage model is lower than that of the univariate model at both horizons, the estimated standard error of the improvement in the forecast is so large that we cannot reject the null hypothesis.[14] This outcome is not unusual. The two other wage measures and productivity also offer some mean improvement in the forecast, but they are not consistent enough to be statistically significant. Productivity stands out because it offers the lowest RMSE, but the

14. The comparison of forecast errors is robust to heteroskedasticity and serial correlation of unknown form using a standard Newey-West correction. This approach is similar to that in Blomberg and Hess (1996). See Diebold and Mariano (1995) for general comparisons of forecast accuracy tests.

TABLE 3A | OUT-OF-SAMPLE FORECASTING OF PRICE INFLATION FORECASTS OVER 1990:IQ–1999:IIIQ

Model	One Quarter Ahead Root Mean Squared Error (p-value)	One Year Ahead Root Mean Squared Error (p-value)
Univariate	0.821	1.240
Money	0.758 (0.311)	0.961 (0.046)
Wages	0.711 (0.236)	0.893 (0.335)
Productivity	0.698 (0.118)	0.808 (0.208)
Unit labor cost	0.768 (0.251)	1.090 (0.106)
Average hourly earnings	0.793 (0.673)	1.143 (0.677)

The univariate model contains four lags of inflation, four lags of the relative growth in energy and food prices, dummy variables for the Nixon wage and price controls, the long-run error correction term, and a constant (see the appendix for a complete description of the data). The model labeled money also includes the lagged level of money (in logs) and four lags of money growth. The wage, productivity, and unit-labor-cost models are similarly defined. The p-value reports the level of statistical significance for the test of the null hypothesis that these models do not have lower RMSE than the univariate model.

TABLE 3B | OUT-OF-SAMPLE FORECASTING OF WAGE GROWTH FORECASTS OVER 1990:IQ–1999:IIIQ

Model	One Quarter Ahead Root Mean Squared Error (p-value)	One Year Ahead Root Mean Squared Error (p-value)
Univariate	1.780	1.904
Money	1.528 (0.126)	1.602 (0.046)
Price inflation	1.747 (0.850)	1.765 (0.497)
Productivity	1.719 (0.717)	1.940 (NA)

The univariate model contains four lags of wage growth, four lags of the relative growth in energy and food prices, dummy variables for the Nixon wage and price controls, the long-run error correction term, and a constant (see the appendix for a complete description of the data). The model labeled money also includes the lagged level of money (in logs) and four lags of money growth. The inflation and productivity models are similarly defined. The p-value reports the level of statistical significance for the test of the null hypothesis that these models do not have lower RMSE than the univariate model.

forecast improvement is unfortunately quite variable. Importantly, however, money does contain essential information for forecasting prices over a one-year horizon during this time period. Money also offered reliable improvements in the forecast in the 1990s, suggesting that those who wish to gauge where future inflation is headed should consider money-supply developments.

Conclusion

There is little systematic evidence that wages (either conventionally measured by compensation or adjusted through productivity and converted to unit labor costs) are helpful for predicting inflation. In fact, there is more evidence that inflation helps predict wages. The current emphasis on using changes in wage rates to forecast short-term inflation pressure would therefore appear to be unwarranted. The policy conclusion to be drawn is that inflation can appear regardless of recent wage trends.

Data Appendix

Average hourly earnings: Average hourly earnings of production workers. The data are seasonally adjusted, monthly, available from January 1964 to September 1999. Quarterly average used in analysis.

Money: The adjusted St. Louis Monetary Base. The data are available from 1950:IIQ to 1999:IIIQ. Obtained from FRED, Federal Reserve Bank of St. Louis.

Prices: The personal consumption expenditure deflator. The data are seasonally adjusted, quarterly, available from 1947:IQ to 1999:IIIQ, 1992 = 100.

Productivity: Nonfarm business. The data are seasonally adjusted, quarterly, available from 1947:IQ to 1999:IIIQ, 1992 = 100.

Relative inflation in food and energy prices: CPI inflation less the growth rate of the CPI excluding food and energy.

Unit labor costs: Nonfarm business, unit labor costs. The data are seasonally adjusted, quarterly, available from 1947:IQ to 1999:IIIQ, 1992 = 100.

Wage and price control dummy variables: The first dummy variable takes the value 1 during 1971:IIIQ to 1972:IVQ and 0 otherwise. The second dummy variable takes the value 1 during 1973:IQ to 1974:IVQ.

Wages: Nonfarm business, total compensation. The data are seasonally adjusted, quarterly, available from 1947:IQ to 1999:IIIQ, 1992 = 100.

The data were transformed by taking logs, and quarterly growth rates are annualized.

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