

# The Cyclical Behavior of Prices and Employee Compensation

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Are prices procyclical? For many economists, they clearly are. As Lucas (1976, 104) put it, “The fact that nominal prices and wages tend to rise more rapidly at the peak of the business cycle than they do in the trough has been well recognized from the time when the cycle was first perceived as a distinct phenomenon.” More recently, however, other researchers have challenged the prevailing view. According to Kydland and Prescott (1990, 17), “[T]he U.S. price level has clearly been countercyclical in the post–Korean War period.”

The issue is of particular importance to macroeconomists who must choose a model to work with. A monetary sector was an integral part of equilibrium dynamic macro models that gained popularity in the 1970s, such as Lucas (1972). Monetary misperceptions could then give rise to procyclical movements in prices. In contrast, the real business cycle models that later gained popularity, such as Prescott (1986), did not have that property. If the behavior of prices over the business cycle were a clearly established empirical regularity, that information would help choose the type of model to use for economic analysis.

This paper attempts to better understand how respected economists can hold such seemingly divergent views of the same data. By closely examining the data on aggregate price measures, I will try to clarify why each view could be correct under specific definitions of important terms. In doing so, I will propose a way of viewing the data that may be useful in other circumstances.

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In particular, the methodology that is employed to assess price cyclicality can be easily used to study other variables of interest. The cyclical behavior of wages has been a subject of controversy for over a half century and is examined in the final section of the paper.

## 1. PRICES AND THE BUSINESS CYCLE

Much of our understanding of the complex phenomena that are unified under the idea of the business cycle was developed by researchers associated with the National Bureau of Economic Research (NBER) in the first half of the twentieth century. Their initial approach was to describe the cycle, either verbally or with voluminous statistics. Their conception of a typical business cycle is now part of our common language, and many statistical regularities that are usually thought to characterize cycles were first noted in their early publications. An important early example of this line of research is Mitchell (1913). Although his observations were based on an American economy much different from our own, much of his account of the behavior of economic aggregates anticipated later developments in economic activity. Prices played a key role in his view of the cycle, as the following passages attest:

A revival of activity, then, starts with this legacy from depression: a level of prices low in comparison with the prices of prosperity, [and]...drastic reductions in the cost of doing business (150). While the price level is often sagging slowly when a revival begins, the cumulative expansion in the physical volume of trade presently stops the fall and starts a rise (151). Like the increase in the physical volume of business, the rise in prices spreads rapidly; for every advance of quotations puts pressure upon someone to recoup himself by making a compensatory advance in the prices of what he has to sell. . . .Retail prices lag behind wholesale. . . and the prices of finished products [lag] behind the prices of their raw materials (152). [O]ptimism and rising prices both support each other and stimulate the growth of trade (153). Among the threatening stresses that gradually accumulate within the system of business during seasons of high prosperity is the slow but sure increase in the costs of doing business (29). The price of labor rises. . . .The prices of raw materials continue to rise faster on the average than the selling prices of products (154). [T]he advance of selling prices cannot be continued indefinitely. . . [because] the advance in the price level would ultimately be checked by the inadequacy of the quantity of money (54). [Once a downturn begins] with the contraction in trade goes a fall in prices (160). [T]he trend of fluctuations [in prices] continues downward for a considerable period. . . .[T]he lowest level of commodity prices is reached, not during the crisis, but toward the close of the subsequent depression, or even early in the final revival of business activity. The chief cause of this fall is the shrinkage in the demand for consumers' goods, raw materials, producers' supplies, and construction

work (134). [E]very reduction in price facilitates, if it does not force, reductions in other prices (160). Once these various forces have set trade to expanding again, the increase proves cumulative, though for a time the pace of growth is kept slow by the continued sagging of prices (162).

Note that this account was based on economic activity under the gold standard at a time when no trend would be expected in the price level. Evidence during that time generally supported the behavior Mitchell described. Zarnowitz (1992, ch. 4), for example, found strong evidence of procyclical prices in the first 150 years of U.S. history. In contrast, under our current fiat money system, the CPI has risen in each of the past 47 years, with an average annual increase of 4.1 percent. This change in monetary regime leads to an immediate modification of Mitchell's analysis that preserves its spirit while conforming to recent evidence. Inflation can be substituted for the level of prices in the writing above, and the logic is preserved; a recession<sup>1</sup> is thus associated with falling inflation and consequently the inflation rate is relatively low at the beginning of a cyclical expansion. Then, as the expansion progresses, the rate of inflation rises, led by relatively large increases in commodity prices. The evidence presented below is consistent with that analysis.

The controversy, though, concerns the cyclical behavior of the price *level* in the last half century. In order to understand the challenge to the conventional wisdom that the price level is procyclical, we need to investigate the exact meaning of cyclical price movements when prices are continually rising. The following section thus examines filtering, that is, removing some measure of a long-run trend from a series in order to study shorter-run movements.

## 2. FILTERING ECONOMIC TIME SERIES

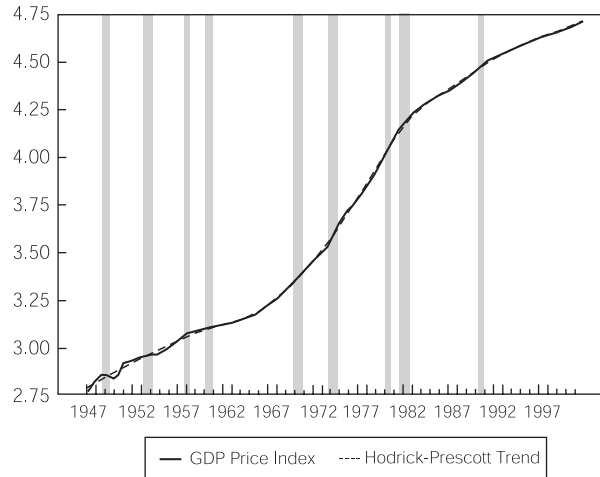
Consider a series of data generated as

$$X_t = (1 + g)X_{t-1}(1 + \varepsilon_t), \quad (1)$$

where  $X$  is a data series, the subscript  $t$  indexes time,  $g$  is a fixed positive number, and  $\varepsilon$  is a random variable with zero mean. The series would grow, on average, at rate  $g$ , and a graph of  $X$  versus time would eventually appear nearly vertical. A common first step in studying the series would be to take logarithms, which would change the time-series plot to a series fluctuating around a straight line with slope  $1 + g$ . In this case, an obvious filter for removing the long-run trend would be to divide each observation  $X_t$  by  $(1 + g)^t$ . In the typical case where  $g$  is not known, one can estimate the coefficients in

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<sup>1</sup> Mitchell used the word *depression* where we would use *recession* today.

**Figure 1 GDP Price Index and Trend**

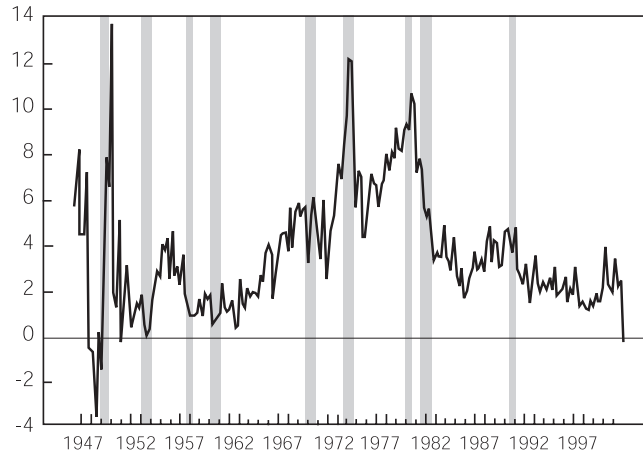
the following regression

$$\ln X_t = \alpha + \beta T_t + v_t, \quad (2)$$

where  $T$  is a trend variable, taking a value of 1 in the first period, 2 in the second, and so forth;  $\hat{\beta}$  is the estimated growth rate of the series; and  $v$  is assumed to be white noise. In this case, the antilog of the estimated residual,  $e^{v_t}$ , would be the detrended value of the observation  $X_t$ . This method is widely referred to as linear detrending. In some cases, a linear trend can fit the data well over a lengthy interval; for example, in Webb (1993) it is shown that real per capita GDP in the United States has fluctuated around a stable linear trend for over 100 years.

This method of detrending is not always appropriate. Suppose that  $g$  varied substantially over time in equation (2). Then imposing a linear trend could lead to long swings above or below trend, and the detrended data would be difficult to analyze. Price data, in particular, are not always and everywhere consistent with a fixed, linear trend; monetary regimes have varied, and within regimes the monetary authority may not have had a constant inflation target. Thus several methods of estimating a flexible, or time-varying, trend have been proposed that could be applied to prices. A conceptually simple method is to estimate the trend by a centered moving average. Thus letting the trend value of  $X$  be denoted  $X^*$ , then

$$X_t^* = \frac{1}{2k+1} \sum_{t=-k}^k X_{t-k}, \quad (3)$$

**Figure 2 Annualized Percentage Change in GDP Price Index**

and the detrended value can be either the difference between actual and trend, or the ratio of actual to trend.

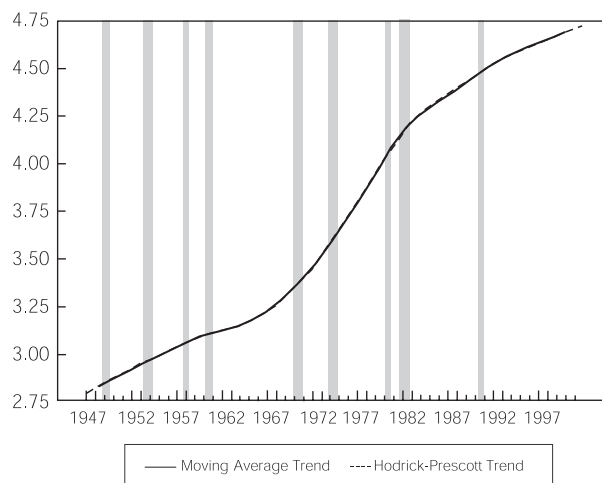
Many macroeconomists use a flexible trend that is produced by a method known as the Hodrick-Prescott (HP) filter (1980). They calculate the trend terms  $x_t^*$  to minimize

$$\sum_{t=1}^N (x_t - x_t^*)^2 + \lambda \sum_{t=2}^{N-1} [(x_{t+1}^* - x_t^*) - (x_t^* - x_{t-1}^*)]^2, \quad (4)$$

where the small  $x$  and  $x^*$  terms are logarithms of their counterparts using capital letters,  $N$  is the number of observations, and  $\lambda$  is a fixed number. For analyzing quarterly macroeconomic data, Hodrick and Prescott recommend a value of 1600 for  $\lambda$ , which will be used below. Intuitively, minimizing the expression (4) trades off deviations from trend, given by the first term, against changes in the trend value, given by the second term.

A final method of removing the trend is to simply take a difference in logs or, similarly, look at percentage changes in a variable. A disadvantage of this method is that the changes over a short period can be dominated by erratic factors.

These methods of removing the trend can be seen in Figures 1 through 4. In Figure 1 the logarithm of the GDP price index is first graphed, with shaded areas denoting cyclical recessions as defined by the NBER. Also included is the trend, estimated with the HP filter. In Figure 2, the quarterly percentage change is graphed, which effectively removes the trend. In Figure 3, the trend of the price index is estimated by the HP filter and a nineteen-quarter

**Figure 3 GDP Price Index Trends**

moving average filter. Both trends appear similar, and indeed, the correlation coefficient between the two is 0.999. Finally, the detrended values are plotted in Figure 4, and again both methods give somewhat similar estimates; in this case, the correlation coefficient is 0.95. Thus, when thinking about the meaning of filtered data, the intuitive moving average filter can be substituted for the less intuitive HP filter, if desired. All three methods indicate that inflation has been highly variable in the post–World War II period, and thus some form of a flexible trend is necessary in order to study price data.

### 3. THE ASSERTION OF COUNTERCYCLICAL PRICES

Kydland and Prescott (1990) studied the cyclicity of prices by examining the correlation of real GNP with the CPI and of real GNP with the GNP implicit price deflator. They found a sizable negative correlation between GNP and each price index and interpreted that negative correlation as demonstrating that the price level is countercyclical. In their words,

This myth [that the price level is procyclical] originated from the fact that, during the period between the world wars, the price level was procyclical. But... no one bothered to ascertain the cyclical behavior of the price level since World War II. Instead, economists just carried on, trying to develop business cycle theories in which the price level plays a central role and behaves procyclically. The fact is, however, that whether measured by

**Table 1 Series with the Segmented Cyclical Trend Removed**

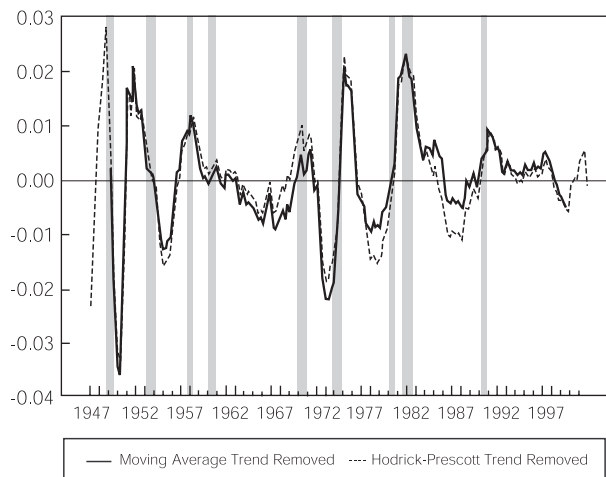
Series	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5
Real GDP	-1.0	0.6	1.1	-1.2	-3.3
GDP Price Index	0.4	-0.4	0	0.4	0.9
Personal Consumption Expenditure Price Index	0.5	-0.4	-0.1	0.6	1.0
Consumer Price Index	0.7	-0.6	-0.1	0.9	1.3
Producer Price Index	1.1	-0.9	0	1.1	1.4
Journal of Commerce Index	-1.6	0.8	1.3	0.1	-5.0
Average Hourly Compensation	0.9	-0.8	0.2	0.8	0.8
Real Average Hourly Compensation	0.3	-0.3	0.3	0.2	-0.2

the implicit GNP deflator or by the consumer price index, the U.S. price level clearly has been countercyclical in the post-Korean War period (17).

Cooley and Ohanian (1991) provided even more evidence of a negative correlation. They examined data over a longer time span and used a variety of methods to remove the trend in prices. An important part of their analysis was to apply the same filter to both prices and output data and then to examine the correlations. For 1948 Q2 to 1987 Q2, using a simple linear trend resulted in a correlation of  $-0.67$ ; using log-differenced data resulted in a correlation of  $-0.06$ ; and using HP-filtered data resulted in a correlation of  $-0.57$ . They interpreted these results as contradicting the view that prices are procyclical.

A common feature of these articles is that they discussed the cyclicity of prices by either redefining or ignoring the traditional business cycle. The traditional definition of business cycles was given by NBER researchers Burns and Mitchell (1946, 3):

Business cycles are a type of fluctuation found in the aggregate economic activity of nations that organize their work mainly in business enterprises: a cycle consists of expansions occurring at about the same time in many economic activities, followed by similarly general recessions, contractions, and revivals which merge into the expansion phase of the next cycle; this sequence of changes is recurrent but not periodic; in duration business cycles vary from more than one year to ten or twelve years; they are

**Figure 4 Detrended GDP Price Index**

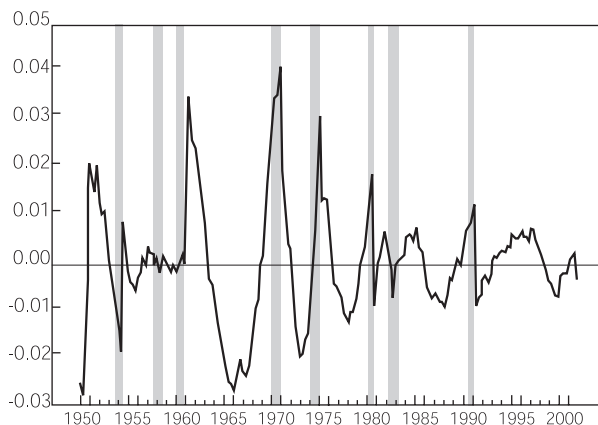
not divisible into shorter cycles of similar character with amplitudes approximating their own.

There are many valid reasons to study detrended macroeconomic variables, but they do not necessarily reveal much about business cycles as defined by the NBER. For example, by definition a detrended series will be symmetric, with positive observations balanced by negative observations. However, the business cycle has been notably asymmetric in the post–World War II United States. Most obviously, expansions last much longer than recessions. The length of the average recession has averaged 10.5 months, whereas expansions have averaged over five times as long, 56.9 months. In fact, the one expansion from 1991 to 2001 lasted 120 months, while all ten recessions from 1948 to date have totaled 105 months.<sup>2</sup>

Another property of focusing on detrended data is that results may be crucially dependent on the particular method used to detrend the data. As Canova (1998, 475) puts it, based on a study of data on real economic activity, “[Stylized facts] of U.S. business cycles vary widely across detrending methods, and . . . alternative detrending filters extract different types of information from the data.” This effect can be seen in Figures 2 and 4 for the GDP price

<sup>2</sup> For this calculation it is assumed that the recession that began in March 2001 ended in December 2001.



**Figure 5 GDP Price Index, Segmented Trend Removed**

index. In Figure 2, differencing the data produces a series that tends to rise in cyclical expansions and fall in recessions. Conversely, applying the HP filter or a moving average filter to the same data series, as shown in Figure 4, yields a series that tends to fall in cyclical expansions and rise in recessions. Thus, whenever an assertion is based on detrended data, one should ask if the assertion is sensitive to the detrending method. Notice that the detrended prices in Figure 4 tend to be negative in the middle of cyclical expansions. That could be due to falling prices, but it could also be due to the rising trend, as both methods illustrated tend to have increasing trends in cyclical expansions. The next section thus takes a different approach to the question of price cyclicity.

#### 4. NEW EVIDENCE ON PRICE CYCLICALITY

Assertions of procyclical prices have relied on purely statistical methods that ignored the traditional business cycle. Does that make a difference? This section looks at evidence based on a statistical method that is based on traditional business cycle dates. The method will be to take a simple trend, as shown in equation (2), that is defined only for a specific business cycle. In this paper, business cycles will be defined from trough to trough, where the date of the trough has been determined by the NBER. For the recession that began in March 2001, the NBER has not yet determined the date of the trough; in this paper, December 2001 will be used in place of an official date of the recession's trough. This method will be referred to below as the segmented cyclical trend, or SCT, method. It is illustrated in Figure 5. Most data series extend back to 1947, which allows nine complete business cycles to be examined.

In order to assess the cyclical nature of price movements, it is useful to divide each cycle into five separate phases to allow distinctive behavior to be observed. All calendar quarters will be classified as being in an expansion or a recession. An expansion begins in the quarter after the one that contains a trough, ends in the quarter containing the peak, and is divided into three phases.<sup>3</sup> The first phase, referred to here as early expansion, contains the first fourth of the number of quarters in the cyclical expansion. The second phase, or middle expansion, covers the next half of the number of expansion quarters. The final phase comprises the remaining one-fourth of the number of expansion periods. Recessions begin in the quarter following the peak and end in the quarter containing the trough. Since recessions are on average much shorter than expansions, they can be divided into a first half and a second half.<sup>4</sup> In the author's experience, this has been a useful classification for post-World War II business cycles, but many others can be imagined. In particular, Burns and Mitchell (1946) divided business cycles into nine phases for their analysis.

This cyclical classification is applied in Table 1. Several measures of prices are examined, including the price index for GDP and the price index for personal consumption expenditure from the Bureau of Economic Analysis; the consumer price index and the producer price index for finished goods from the Bureau of Labor Statistics; and the Journal of Commerce Index of commodity prices. The final two lines are discussed in the section below. All data series are seasonally adjusted. Each entry in the table is an average over a cyclical phase for the nine business cycles of items with the segmented linear trend removed.

The first series in the table is real GDP, which is often taken as the prototypical cyclical variable. Its high point is reached in Phase 3, which contains the cyclical peak. Similarly, its low point is reached in Phase 5, which contains the cyclical trough. Thus real GDP behaves as would be expected and is a useful benchmark for the series of prices.

The next four series are broad measures of prices of finished goods. Their behavior is quite different from real GDP. The GDP price index is typical, with its low point in Phase 2 and its high point in Phase 5. This different behavior of output and prices would seem to be consistent with the finding of countercyclical prices. This behavior can also be examined with other methods of detrending. Table 2 presents series of percentage changes, and Table 3 presents data detrended with the HP filter.

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<sup>3</sup> This classification was motivated by the casual observation that growth was often very rapid near the beginning of expansions and was often subpar near the end of expansions.

<sup>4</sup> What if the length of expansion is not evenly divisible by four? For purposes of this section, if there is a nonzero remainder after dividing the number of quarters in an expansion by four, then the number of quarters in the remainder is added to the middle expansion phase. Similarly, if the number of quarters in a recession is odd, that first phase will be one quarter longer than the second.

**Table 2 Series Expressed as Percentage Changes**

Series	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5
Real GDP	2.6	0.8	-0.4	-6.2	-3.9
GDP Price Index	-0.5	-0.2	0.6	0.7	0.2
Personal Consumption Expenditure Price Index	-0.7	-0.3	0.9	1.0	0
Consumer Price Index	-1.0	-0.4	1.5	1.2	-0.4
Producer Price Index	-1.4	-0.4	1.9	1.5	-0.5
Journal of Commerce Index	4.1	-0.2	2.8	-9.0	-8.6
Average Hourly Compensation	-0.4	-0.3	1.1	0.2	-0.6
Real Average Hourly Compensation	0.3	0	0.2	-0.8	-0.6

The entries in Table 2 illustrate the importance of the detrending method. For real GDP, the highest value now occurs in Phase 1, rather than in Phase 3. This means that the real *growth* rate tends to be highest in the early phase of an expansion, even though from Table 1 we know that the *level* of GDP tends to be highest above trend in the late expansion phase. With prices, it is harder to discuss the detrended level of each series intuitively. Note in Figure 1 how the price level has risen consistently over the past half century. Any cyclical tendencies are small relative to the dramatic increase over time. Moreover, the rate of increase is significantly more rapid from the mid-1960s to the early 1980s than at other periods. For many purposes these broad trends may be more important than the cyclical movements. That said, in Table 2, the movements in prices over the business cycle are somewhat different than real GDP, which is again consistent with the assertion of countercyclical prices. Note that in this table inflation is highest when real growth is lowest, in Phase 4. Similarly, real growth is highest when inflation is lowest, in Phase 1. But also note that the entries for finished goods prices tend to increase during expansions, hit their highs in the early recession phase, and decline in the late recession phase, hitting their low point in the early expansion. Thus this general conformity with the business cycle could be viewed as a procyclical movement, but with a one-phase lag.

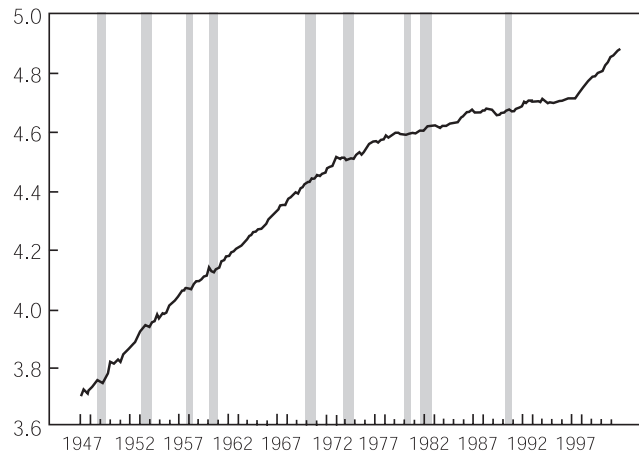
Finally, HP-filtered data are presented in Table 3. These data resemble those in Table 1. Real GDP is highest in the late expansion phase and lowest at the beginning of expansions. Prices of final goods are below trend when GDP is above trend, and vice versa.

**Table 3 Series with the HP Trend Removed**

Series	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5
Real GDP	-1.3	0.5	1.5	-0.1	-0.3
GDP Price Index	0.2	-0.3	-0.1	0.6	0.8
Personal Consumption Expenditure Price Index	0.2	-0.4	-0.1	0.9	1.1
Consumer Price Index	0.2	-0.5	-0.1	1.3	1.5
Producer Price Index	0.3	-0.7	0	1.6	1.7
Journal of Commerce Index	-2.5	0.1	3.2	1.4	-4.9
Average Hourly Compensation	0.3	-0.4	0	0.8	0.7
Real Average Hourly Compensation	0.1	0	0.1	-0.1	-0.3

So far, then, the evidence seems, on balance, to support the assertion of countercyclical prices. Another interpretation is also possible. Until now the language of leading or lagging indicators has not been used, although it has a long tradition in discussions of cyclical behavior. Looking at the price indexes for finished goods in Table 1, one can see that these series reach their peak two phases after real GDP reaches its peak. This could be due to price stickiness, which is an integral feature of many macroeconomic models, for example, Goodfriend and King (1997). Thus, if changes in aggregate demand affect output before affecting prices of finished goods, that relationship could make a price index a lagging indicator as in Table 1.

Further evidence can be found by looking at commodity prices. Since commodity prices are often determined in spot markets, they can be immediately affected by supply or demand shifts. In contrast, finished goods prices are often set by explicit or implicit contracts and thus do not immediately display the total impact of supply or demand changes. That consideration suggests that commodity prices should be more of a coincident indicator. And in Tables 1 and 3, notice that the Journal of Commerce Index of commodity prices, like real GDP, hits its peak in Phase 3 and hits its low point in Phase 5. This behavior supports the view that commodity prices are a coincident indicator while finished goods prices are a lagging indicator. Thus, these data are consistent with many models that incorporate fluctuations of aggregate demand.

**Figure 6 Real Average Hourly Compensation**

## 5. EVIDENCE ON EMPLOYEE COMPENSATION

The cyclical behavior of wages has a long history of controversy, which began when Keynes (1936) asserted that real wages were countercyclical. Many articles have been written on the subject, and it is possible to find respected authors arguing for a procyclical pattern of real wages, a countercyclical pattern, or no meaningful pattern. For example, see Abraham and Haltiwanger (1995) for selected quotes and a discussion of recent evidence.

Unfortunately, consistent series on wages are not as plentiful as series on prices. This paper examines one particular series, employee compensation, which is available in quarterly form beginning in 1947. It includes wages, salaries, and fringe benefits. The nominal series is deflated with the PCE price index to obtain the real series and is graphed in Figure 6. Here the fluctuations around a trend are quite small, especially before 1973. For many analysts, the main issue is the significant growth in real wages over a half century, with a noticeable slowing between the early 1970s and the mid-1990s.

Both detrended nominal and real compensation are included in the tables. In Tables 1 and 3, the nominal series behaves somewhat like detrended prices of final goods. Both prices and compensation have low points in Phase 2 of the business cycle. Compensation is notably above trend in Phases 4, 5, and 1. In Table 2, the average growth rate of nominal wages is procyclical, hitting its high point in Phase 3 and its low point in Phase 5. Since nominal wage stickiness is often taken as a stylized fact, it may not be surprising that the nominal wage level behaves as a lagging indicator, too, as indicated in Tables 1 and 3.

The controversy has dealt with real wages, however, and the evidence is mixed. The growth rate of real wages seems procyclical in Table 2. That growth rate rises in expansions and declines in recessions. There is also evidence of procyclical real wage behavior in Table 3. But in Table 1 the real wage is above trend in Phases 1, 3, and 4, but below trend in Phases 2 and 5. Here again the choice of filter is important. This illustrates the limits of letting the data speak for themselves; in this case, some theory is needed just to choose a filter to remove the long-run growth trend of real compensation. And it is not surprising that authors have differed on the cyclicity of real wages. None of the evidence, though, supports Keynes's assertion of countercyclical real wages.

## 6. CONCLUSION

Data averaged over phases of post-World War II business cycles were examined for evidence of price cyclicity. The behavior of the level of final goods prices is consistent with the view that prices are countercyclical. Another interpretation, however, is that final goods prices are a lagging indicator, possibly due to price stickiness. Evidence of a procyclical level of commodity prices supports the latter interpretation. Phase-averaged data are also examined for employee compensation. Nominal compensation behaves much like finished goods prices, which would not surprise an analyst who believed that both wages and final goods prices are sticky. Real wage behavior is more difficult to characterize; however, it is difficult to reconcile the evidence presented with Keynes's original assertion of countercyclical wages.

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