Ups and Downs:

How Wages Change Over the Business Cycle

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The cyclical behavior of real wages — wages adjusted for inflation — has changed over time. Before World War II, real wages in the U.S. were countercyclical: They rose during recessions and fell during expansions. Since the war, however, wages have become procyclical, falling during recessions and rising during expansions. One standard explanation is that economic shocks shifted from the demand side of the economy prewar to the supply side postwar. In this article, Kevin Huang offers evidence of an alternative explanation: the increased role that intermediate goods play in the production process in the postwar era.

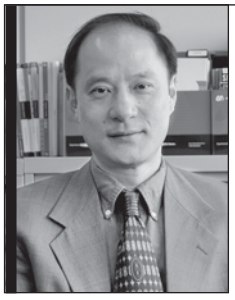
Modern economies experience recurrent fluctuations in business activity. As output and employment fall in recessions and busts and rise in recoveries and booms, other variables of economic significance also go through lows and highs.

One such variable is real wages. Generally speaking, real wages are simply wages adjusted for changes in inflation.[1] For a working family, real wages provide a source of real income, but this income must be earned by giving up valuable leisure time. For a business entity that must hire workers to carry out its operations, real wages constitute part of the firm's real production costs. The way in which real wages fluctuate over business cycles has important implications for both households and firms.

The cyclical behavior of real wages has changed over time. In the prewar period (1919 to 1939), real wages in the United States were countercyclical: That is, real wages went up during recessions and fell during expansions. Since World War II, real wages have become procyclical: They fall during recessions and rise during expansions.

What might have caused this change in the cyclical behavior of real wages? One explanation attributes the change to a shift from disturbances (which economists call shocks) on the demand side of the economy during the prewar period to disturbances on the supply side in the postwar era.

Generally speaking, shocks are unanticipated changes in variables, such as extreme environmental conditions (severe weather, hurricanes, earthquakes, etc.), unanticipated changes in monetary and fiscal policy, and events that alter the world price of energy. Typical examples of demand shocks include unexpected changes in the demand for money, unexpected changes in the money supply[2] or interest rates (monetary policy shocks), unexpected changes in government spending (fiscal policy shocks), financial crises, exchange rate disturbances, and sudden changes in households' tastes or preferences. Examples of supply shocks include sudden disruptions in oil supply, discoveries of oil reserves, and technological innovations.



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[1] In reality, there is more than one measure of inflation. In this article, our use of the term real wages refers to wages adjusted for a cost-of-living index such as the consumer price index (CPI). The CPI measures the cost of labor in terms of a basket of goods consumed by a worker. An alternative notion of real wages is wages adjusted for the wholesale price index or the producer price index (PPI). The PPI measures the cost of labor in terms of the units of goods produced by a worker. The two ideas are often used interchangeably. To tell the story here, I will follow this tradition of not distinguishing between these two measurements of real wages.

[2] The money supply is the quantity of money available in the economy with which to purchase goods and services.

Many economists have argued that demand shocks were more important in the prewar period, especially during the Great Depression, an episode in which unexpected changes in the money supply and financial crises (such as bank failures) played a dominant role. Supply shocks, on the other hand, are more important in the postwar period, especially after the 1970s, when several large oil-price shocks hit the economy.

But trying to explain the change in the cyclical behavior of real wages by pointing to changes in shocks hitting the economy is not appealing because it does not capture all of the empirical facts. To provide a convincing account of this switch in real-wage cyclicality, we must look at another change in the U.S. economy between the prewar and postwar periods, namely, the increased role of intermediate goods in the production process. For example, in the postwar period, the production of final consumption goods — such as home appliances, consumer electronics, and, more recently, computers — requires more intermediate processing, involving greater shares of more processed intermediate inputs, such as pressed steel, plastic, glass, microchips, and processors, and smaller shares of labor and capital.[3]

As I will discuss, it is likely that the switch in real-wage cyclicality arose from the increased share of intermediate goods in production.

REAL WAGES: FROM COUNTERCYCLICAL TO PROCYCLICAL

Real-wage cyclicality is gauged by the statistical correlation between real wages and output. This correlation measures how these two variables co-vary over time. Correlations must lie between -1 and 1: the closer the correlation is to -1, the more the two variables move in opposite directions. The closer the correlation is to 1, the more the two variables move in the same direction.

Economists Susanto Basu and Alan Taylor have computed the correlation between real wages and real output for the prewar and postwar periods (Figure 1).[4] Their results show that, in the prewar era, the correlation between real wages and output was significantly negative (-0.444), suggesting that real wages moved strongly against real output in this period. Postwar, the correlation between real wages and output is significantly positive (0.381) between 1945 and 1971, and it rises further (to 0.503) between 1972 and 1992. Thus, real wages co-move closely with output after World War II. In a 1996 article, Christopher Hanes provides evidence of this change in the behavior of real wages.

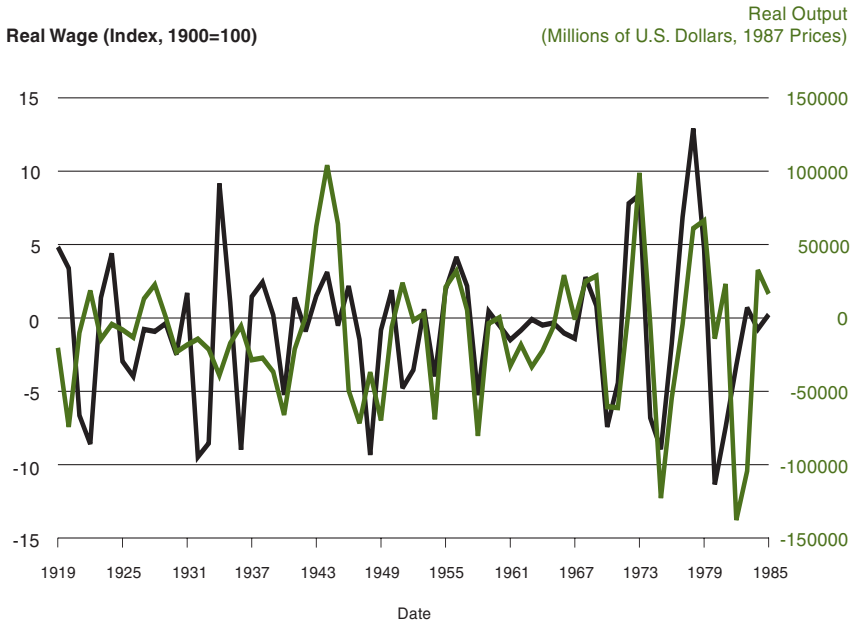
Another insightful account is provided by Ben Bernanke and James Powell, who examine the cyclical property of real wages for the periods 1923 to 1939 and 1954 to 1982. They

[3] In a production economy, goods produced in one sector or industry may be used as intermediate inputs by the same or different sectors or industries for producing goods that may, in turn, be used as intermediate inputs by the same or different sectors or industries, etc., before a final consumption good is produced. Such an input-supplier/output-demander relationship among sectors or industries is usually referred to as an input-output structure. The Input-Output Table of the Bureau of Economic Analysis (BEA) summarizes the U.S. economy's input-output structure. As Robert J. Gordon pictures it, "The gigantic matrix represents the real world, full of heterogeneous firms enmeshed in a web of intricate supplier-demander relationships."

[4] Basu and Taylor used a statistical technique to remove the long-term trends from the data in order to focus on how the data behaved over business cycles.

FIGURE 1

Real Wage and Real Output in the United States (Deviations from Trend)



Source: Basu and Taylor (1999a)

find a marked difference in the cyclical behavior of real wages from the prewar to the postwar period. Bernanke and Powell's study is important for another reason. One could argue that the mix of goods that households consume also changed from the prewar period to the postwar period, and the observed switch in the cyclical behavior of real wages could have simply reflected this change. Studies using aggregate data — that is, data for the economy as a whole — cannot directly address this issue. Instead, Bernanke and Powell employ industry-level data that control for the shift in the mix of goods. Yet their finding is broadly consistent with the evidence presented in Basu and Taylor's paper, which is based on aggregate data.[5]

In sum, the historical evidence suggests a general pattern in the evolution of the cyclical behavior of real wages from countercyclical during the prewar period to procyclical in the postwar era. In particular, the correlation between real wages and real output has switched from significantly negative prewar to significantly positive postwar.

SHIFT FROM DEMAND SHOCKS TO SUPPLY SHOCKS: NOT A CONVINCING STORY

Economic theory is essentially a story about supply and demand. Business-cycle theory seeks to understand how unexpected changes in supply or demand generate cyclical fluctuations of economic variables. As we've noted, one explanation for the switch in real-wage cyclicality is based on this shift from demand shocks to supply shocks.

According to a well-known economic theory, the classic Keynesian theory, demand shocks push prices and output in the same direction, but they do not immediately affect wages very much, because wages are usually set in advance.[6] Consequently, real wages, that is, wages adjusted for inflation, move in the opposite direction from output: Real wages rise when output falls, since as output falls so do prices, while wages are sticky, and vice versa. According to another well-known economic theory, the real business-cycle theory, how much workers get paid depends on their productivity, and supply shocks generally mean that labor productivity — output per worker — and output move in the same direction.[7] As a result, real wages and output move together.

That real wages can respond countercyclically to demand shocks but procyclically to supply shocks might lead one to conjecture that it is indeed the shift from prewar demand shocks to postwar supply shocks that explains the shift in real-wage cyclicality. In particular, the oil-price spikes that occurred in the 1970s are often viewed as the main factor that led to procyclical real wages during the postwar period.

However, this hypothesis is not convincing for at least two reasons. First, while empirical studies suggest that oil-price shocks might have been an important force contributing to postwar business cycles in the U.S., a

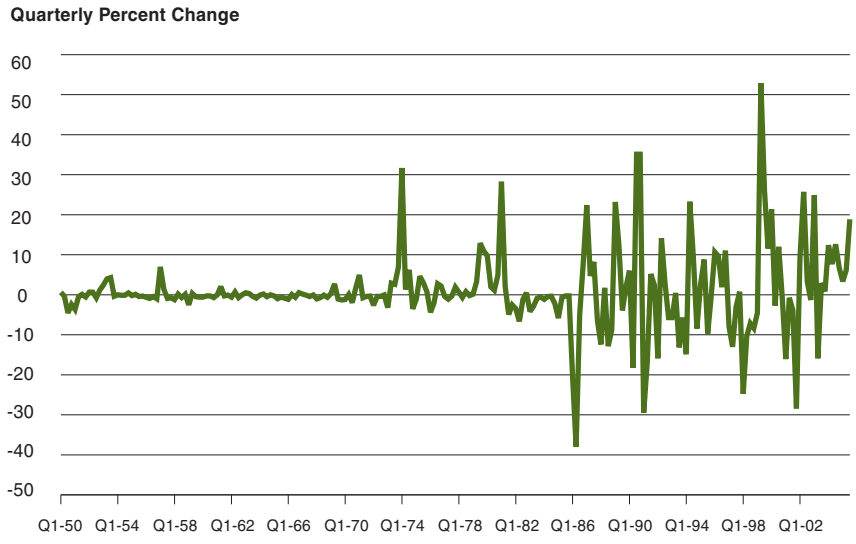
[5] Other studies, such as the ones by Mark Bils; Gary Solon, Robert Barsky, and Jonathan Parker; and Katharine Abraham and John Haltiwanger, provide corroborating evidence in support of such a switch in the postwar era. Evidence based on aggregate data is also provided in the article by Finn Kydland and the one by Wouter J. den Haan and Steven W. Sumner.

[6] Keynesian theory emphasizes the role of demand shocks and wage contracts, that is, agreements between unions and firms on the level of wages firms will pay union workers over a certain period.

[7] Real business-cycle theory emphasizes the role of supply shocks in the economy.

FIGURE 2

Oil Price Shocks in the Postwar Period



Source: Haver Analytics (PPI for crude petroleum - not seasonally adjusted)

study by Kevin Hoover and Stephen Perez and another by Charles Fleischman note that the price of crude oil remained relatively stable until 1973 (Figure 2). Yet, the correlation between real wages and output had already changed from a significant negative value of -0.44 in the prewar period to a significant positive value of 0.38 from 1945 to 1971, an era before the onset of the major oil-price shocks in the 1970s.[8] Indeed, as Christopher Hanes shows, real wages remain procyclical even if the period from December 1973 through June 1980 is excluded from the postwar period. This suggests that forces other than oil-price shocks must have triggered the switch.

Second, in contrast to the prediction of the Keynesian theory, real wages have responded differently to demand shocks in the prewar period than in the postwar period. In particular, the tightening of monetary policy triggered a rise in real wages in the prewar period, especially during the Great Depression, but a fall in real wages and output in the postwar period. For the prewar period, two studies by Barry Eichengreen and Jeffrey Sachs and another by Bernanke and Kevin Carey find that real wages were countercyclical and that monetary policy shocks were a central driving force of this result. On the basis of their finding, Bernanke and Carey dismiss explanations of the relationship between output and real wages during the period 1929 to 1936 that do not involve monetary policy shocks. Michael Bordo, Christopher Erceg, and Charles Evans also present evidence showing that monetary policy tightening led to an increase in real wages during the downturn of 1929 to 1933 in the U.S. and that monetary policy shocks accounted for between 50 and 70 percent of the decline in real GNP at the Depression's trough in the first quarter of 1933.

For the postwar period, a study by Lawrence Christiano, Martin Eichenbaum, and Charles Evans and another by Edward Gamber and Frederick Joutz find that monetary policy shocks, and demand shocks in general, tend to generate procyclical real wages. Marvin Barth and Valerie Ramey also find evidence of procyclical real wages following contractionary monetary policy actions in the postwar U.S. economy. This reversed pattern in the cyclicality of real wages driven solely by monetary policy shocks is inconsistent with a story that relies on a shift from demand shocks to supply shocks.

Even in the absence of supply shocks, we have seen a switch from countercyclical to procyclical real wages.

Thus, even in the absence of supply shocks, we have seen a switch from countercyclical to procyclical real wages. A convincing theory about this switch in real-wage cyclicality needs to hold up, even when demand shocks are the sole driving force of business-cycle booms and busts. Now, let's turn to a theory that emphasizes the role of a change in the U.S. economic structure over the course of the 20th century.

INTERMEDIATE GOODS: INCREASING IMPORTANCE IN PRODUCTION

The key part of this alternative theory involves another major change in the U.S. economy from the prewar to the postwar period: a shift in the mix of the types of inputs used in production. As we know, production of final consumption goods usually requires several types of inputs: labor, capital, and intermediate goods. The historical change is that, in the postwar period, intermediate goods are used more in the production of final goods. In the prewar era, goods that households consumed were relatively less processed — typical prewar goods include simple farm and fishery products and basic consumer durables like hand tools, oil burners and heating apparatus, and coal stoves and ranges — and their production required mostly primary inputs (labor, capital, land, and coal). In the postwar period, goods that households consume are much more complex — typical postwar goods include more processed farm and fishery products and increasingly more sophisticated consumer durables such as gas and electric appliances, home electronics, and intricately made cars and computers — and the production of such goods requires greater shares of manufactured intermediate inputs, which themselves are typically more advanced goods.[9]

Several existing studies illustrate the changes in the production of final consumption goods and in the input-output structure from the prewar to the postwar period. John Kendrick's classic work documents value added (by labor and capital) and gross output (which is the sum of value added and all intermediate inputs used in

[8] James D. Hamilton argues that oil shocks led to some of the pre-1970 recessions in the U.S., but the cyclical effects of these shocks, as he shows, became much stronger during the 1970s.

[9] Recall that intermediate goods are goods (and services) that are purchased from other businesses and that are used up within the production period. Although my discussion focuses on the role of increasing technological sophistication, the fact that the use of intermediate inputs has been rising over time might also reflect increased specialization of production, since, all else constant, the greater the degree of vertical integration, the lower is the proportion of intermediate goods purchased in total output.

production) for several key sectors in the prewar period. Using this information, Zheng Liu, Louis Phaneuf, and I show that the share of intermediate inputs rose significantly in the postwar period.[10]

Two historical studies by Christopher Hanes provide evidence that the input-output structure has become more sophisticated in the postwar period. His general finding is that typical prewar goods were made of relatively unfinished goods, while typical postwar goods involve more intermediate processing before they enter the marketplace. Hanes reports that the share of crude material inputs (such as farm, fishery, and mineral products) in final output in the United States fell significantly from the beginning of the 20th century to the end of the 1960s. He also reports that from the turn of the 20th century to 1986, the share of consumption expenditure on food (excluding restaurant meals) decreased significantly, while the share of consumer durables, a category that includes many complex goods such as automobiles, increased steadily over the same period. The corroborating evidence in the two studies by Basu and Taylor lends further credence to the observation that intermediate goods make up an increasingly larger share of total U.S. output in the postwar period.

Other studies provide evidence of the increased use of intermediate goods in production during the postwar period. The work by Dale Jorgenson, Frank Gollop, and Barbara Fraumeni shows that from 1947 to 1979, intermediate goods account for a large share of the revenue from total manufacturing output in the U.S. and they account for an even higher share of manufacturing costs.[11]

To summarize, existing studies lead us to conclude that there has been a significant increase in the use of intermediate inputs in the U.S. economy from prewar to postwar.

INTERMEDIATE INPUTS AND THE SWITCH IN REAL-WAGE CYCLICALITY

The story of the switch in the cyclicality of real wages is built on the following reasoning. Real wages determine the amount of consumption goods that a worker's wages can buy. The cheaper the good, the more of it can be purchased with wages. How cheap the good is depends on how much it costs to produce. The cost is usually composed of three parts: cost of capital, cost of intermediate inputs, and wages.

Capital, such as plant and equipment, can last for a relatively long time before depreciating completely. The value of capital depends on what the capital is used for during its lifetime. In a capitalistic world, this value is determined in the asset market, which usually responds quickly to changes in current and expected economic conditions. As a result, the cost of capital that a firm incurs in order to carry out its production plans varies a lot over business-cycle booms and busts.

In contrast, since making a sophisticated intermediate good typically requires some advance planning, a firm that needs to use an intermediate good often must lock into a contract that specifies a purchase price long before the good is delivered. The supplier of the intermediate good often needs to lock into contracts with its own suppliers of other intermediate goods required for producing the first good. The business world is full of such sophisticated input-output relationships. For instance, the production of a computer requires many types of intermediate inputs, such as a monitor, a motherboard, a hard drive, and an operating system. Producing a monitor involves other intermediate inputs, such as plastic, glass, and electronic components, and making a motherboard requires microchips, processors, and so forth. Such a business-to-business supply-chain network is a popular business model in many other sectors, such as the automobile industry.

As Robert Gordon describes, the intricate supplier-demander relationships among many firms at many different stages of processing imply that a contractual price between two firms can also matter to other firms involved in the production process since they may be those other firms' direct or indirect suppliers or demanders. As a result, the two firms may be reluctant to change their contractual price even if it is about time to renegotiate their contract unless they know those other firms will do so as well. Since it is difficult for all firms in this gigantic web of complex supplier-demander rela-

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[10] Our study shows that the share of intermediate goods in U.S. production was 0.4 prewar and 0.7 postwar.

[11] Susanto Basu's estimate of the cost share is about 0.80. The revenue and cost shares of intermediate inputs calculated by Huang, Liu, and Phaneuf for the postwar period, based on data in the BEA's 1997 Benchmark Input-Output Tables, are about 0.7.

tionships to synchronize the timing of their contract renegotiations, as demonstrated by many empirical studies surveyed in John B. Taylor's article, the price of an intermediate good can stay sticky much longer than the length of a single contract and typically does not immediately respond to changes in economic conditions.[12]

Firms often sign wage contracts with workers as well, and according to Taylor's survey, the length of wage contracts for labor, on average, is about the same as the length of price contracts for intermediate goods (about one year). Yet, the renegotiation of a wage contract is a relatively simple matter that usually involves only the employee and the employer. Thus, the wage of a worker typically stays sticky just as long as the length of a single contract and often responds somewhat to changing economic conditions.

Generally speaking, the cost of capital is most responsive to changes in economic conditions, next are wages, and the contractual costs of intermediate inputs are least responsive.

With this in mind, we are ready to tell the story. During recoveries and booms, when the level of output rises and firms demand more capital, labor, and intermediate inputs, the cost of capital rises quickly. However, because of contractual obligations, wages rise slowly, and the contractual cost of intermediate inputs does not change much. If the share of intermediate inputs in production is small, a firm's production costs would rise more than its workers' wages because the firm is paying more for capital and using more of it in production. The firm would pass on the increase in its production costs in the form of a higher price for its product.[13] In consequence, because workers pay more for the firm's final good, their real wages fall. The situation is quite different if the share of intermediate inputs in production is large. With a large share of intermediate inputs, a firm's production costs would rise less than its workers' wages because the contractual cost of the intermediate inputs is unchanged. As a result, because workers pay less for the firm's final good, their real wages rise.

The analysis for periods of recessions and busts is symmetric. When intermediate goods make up a small share of the production process, real wages tend to move in the opposite direction from output (real wages are countercyclical). When intermediate goods constitute a large share of the production process, real wages tend to move in the same direction as output (real wages are procyclical).

Liu, Phaneuf, and I demonstrate how the cyclical behavior of real wages can change when the share of intermediate inputs rises. We show that as the share of intermediate inputs in production grows from its prewar value (0.4) to its postwar value (0.7), the correlation between real wages and output switches from a significantly negative number (-0.498), close to its prewar value, to a significantly positive number (0.464), close to its postwar value.[14]

The Link Holds at Other Levels. The link between the cyclical behavior of real wages and the share of intermediate goods holds not just for the U.S. economy as a whole; it also holds at the sector or industry level. As noted by Christiano, Eichenbaum, and Evans, in the postwar U.S. economy, real wages are more procyclical in the manufacturing sector than they are in the economy as a whole. Incidentally, in the postwar era, the ratio of total sales to GDP is greater in the manufacturing sector than in the economy as a whole, indicating that the manufacturing sector uses a greater share of intermediate inputs in production than other sectors (see the table).[15] The findings about the importance of intermediate goods presented in this article lead to a natural conjecture that the differing shares of intermediate goods across sectors/industries may account for the observed differences in the behavior of real wages at the sectoral and industrial levels in the postwar U.S. economy.

Although the analysis in this article is drawn from the U.S. experience, the general insight laid out here linking real-wage cyclicality to the use of intermediate goods may have implications for other economies. For example, the analysis suggests that real wages can be more procyclical in more developed countries than in less developed ones, since production in the more developed economies generally uses greater shares of intermediate goods. Thus, the implications for

[12] This is not to be confused with the notion that the spot price (the price for a good that is paid for now and for which delivery is made now) of certain components of intermediate inputs — such as oil — is quite sensitive to business cycles. What I have emphasized here is that pricing of products that use such inputs — including oil — is often based on contractual costs rather than the spot price.

[13] The argument here ignores cyclical movements in profit margins and assumes that price and cost move in proportion.

[14] To focus on how the data behaved over the business cycles, these authors applied the same statistical technique that Basu and Taylor used to remove the long-term trends from the data and computed the correlations based on the de-trended data.

[15] The U.S. input-output table has gone through a number of redefinitions by the U.S. Bureau of Economic Analysis. I made the necessary regroupings to make the classifications of sectors and industries presented in the table consistent across the three selected years. The shares reported in the table are shares in revenue. To get shares in cost, one needs to adjust for profit margins in the corresponding sectors.

households and firms can also differ across countries in different stages of development.

CONCLUSION

Over the past century, the U.S. economy has seen a significant change in the cyclicality of real wages and in the share of intermediate goods used in the production process. This article explains the link between the two: It's likely that the switch in real-wage cyclicality from countercyclical in the prewar period to procyclical in the postwar era can be attributed to the increased use of more processed intermediate goods in production. This shift in the cyclicality of real wages, the increased use of intermediate goods, and, more important, the link investigated here have implications for households and firms.

TABLE

Share of Intermediate Inputs in the U.S by Sector

	1987	1997	2003
Construction	0.5297	0.5705	0.4938
Manufacturing	0.5923	0.6765	0.6478
Trade	0.2998	0.3614	0.2826
Transportation, Communication, and Utilities	0.4563	0.4773	0.4849
Financial Services	0.3214	0.3018	0.3356
Nonfinancial Services	0.4329	0.3640	0.3970

Source: BEA Input-Output Table. The shares reported in the table are shares in revenue.

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