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ABSTRACT

Accounting for the Growth of Real Wages of U.S. Manufacturing Production Workers since the Nineteenth Century

Why have the real (consumption) wages of U.S. workers risen since the nineteenth century? Some economists answer that increases in real wages have followed increases in labor productivity over time. In this paper, this hypothesized association is confronted with annual observations of changes in the wages and changes in the labor productivity of U.S. manufacturing production workers from the end of the 19th century to the beginning of the 21st century. Correlates with changes in real wages in addition to productivity are considered including statutory legislation, trade unionism, and the state of the business cycle.

JEL Classification: J31, N31, N32

Keywords: real wages, labor productivity, trade unions, legislation, monopsony

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ACCOUNTING FOR THE GROWTH OF REAL WAGES OF U.S. MANUFACTURING PRODUCTION WORKERS SINCE THE NINETEENTH CENTURY

John H. Pencavel [*]

Why are the real wages of American workers higher today than they were a century ago? To workers, the real wage that matters is their compensation relative to the prices of goods and services they buy. In response to the constraints imposed by available data, the analysis here concentrates on one well-defined group of workers, namely, manufacturing production workers. For these workers, reasonably accurate observations on their average hourly compensation are available over many years and on the prices of goods and services they buy. Also labor productivity in manufacturing (that will figure prominently in the analysis) encounters fewer measurement problems than in other sectors of the economy.

A common answer offered by economists to the question above is that workers' real wages are higher today because workers are more productive today than they once were: this is a plausible explanation as the physical and mental health of workers has improved (Costa (2015)) and, insofar as manufacturing labor was complementary with physical capital, so the investments in the quantity and sophistication of physical capital raised the demand for labor and raised their wages and employment. In addition, reductions in the length of the work day and the work week raised workers' output per hour. Some claim that this rise in the productivity of workers is the reason why their wages have risen.

An example is Mankiw (2016, p. 63)) who selects the years from 1960 to 2013 to compare the per cent change in output per hour in the non-farm business sector (2.1%) with the per cent

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[*]The comments of Luigi Pistaferri, Isaac Sorkin and Frank Wolak on an earlier draft improved this paper.

change in workers' hourly compensation divided by the implicit price deflator in that sector (1.8%), a measure of real product wages. He concludes, "Theory and history both confirm the close link between labor productivity and real wages. This lesson is the key to understanding why workers today are better off than workers in previous generations". In this paper, workers are deemed to be better off when their real consumption wage (i.e., their nominal wage deflated by a measure of the cost-of-living) rises, not when their real product wages rise. Subsequently, all references to real wages in this paper relate to the real consumption wage.

For those who ascribe to this "close link", the past four decades may have been disconcerting: since about 1980, increases in labor productivity have considerably outpaced increases in the real wages of these workers. This is shown in Figure 1 which traces the movements from 1980 to 2019 in the average real hourly compensation of manufacturing production workers and an index of labor productivity in manufacturing. To facilitate the comparison of these two variables, in Figure 1, the values of both real wages and of labor productivity in 1980 have been set to 100. Between 1980 and 2019, the compound annual growth rate of real wages in manufacturing was 0.12 per cent while the compound annual growth rate of manufacturing labor productivity was 2.28 per cent. Both real wages and labor productivity in manufacturing increased between 1980 and 2019 but the magnitude of the productivity increases substantially exceeded the meagre increases in real wages.

Another feature of the U.S. labor markets in recent decades is illustrated in Figure 2: the decline in trade unionism. Figure 2 shows the membership of trade unions in manufacturing as a per cent of employment in manufacturing, often called union density and denoted here in year t by D_t. Real wages are also shown in Figure 2 and, again, for the purpose of comparison, both real wages and trade union density are assigned the value of 100 in 1980. The compound annual growth rate of manufacturing union density between 1980 and 2019 was about -3.0 per cent.[1]

These facts about the movements of real wages, labor productivity, and trade unionism in manufacturing industry prompt a number of questions. Is the association between the growth in productivity and the growth of real compensation in the years between 1980 and 2019 anomalous? Is this contrast between wage growth and productivity growth in these years attributable to atypical fast growth in productivity or is it attributable to unusually slow growth of real wages or is it both? Is the decline of trade unionism linked to the low growth in real wages such that, in years when unionism was growing, real wages were rising?

I. IS THE PERIOD FROM 1980 TO 2019 SINGULAR?

Consider the data to be used to address the questions in the previous paragraph and in the analysis later in this paper. What will be called wages is, precisely, the average hourly compensation (it includes fringe benefits) of American manufacturing production workers. Building on the research of others, this wage series was constructed by Lawrence Officer (2009). His series ends in 2006, but for the purpose of the research here it is extended to 2019. The values after 2006 are listed in the appendix together with all the observations in the version of the paper online.[2] It is converted to a "real"wage by deflating it with a cost-of-living index as given by Officer and Williamson (2020). It is in 1982-84 dollars and in 1982-84 it averaged 11.26. It is the real

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[1] The actual value of union density in manufacturing was 20.4 per cent in 1980 and 6.3 per cent in 2019. These numbers are based on responses to questions asked in the Current Population Survey and are listed conveniently in Hirsch and Macpherson (2021). The 1982 CPS included no union question so the value for 1982 interpolates the 1981 and 1983 values of D_t.

[2] At https://siepr.stanford.edu/publications/work/accounting-growth-real-wages-us-manufacturing-production-workers-twentieth

consumption wage as befits this analysis that asks why manufacturing production workers today are better off than manufacturing production workers used to be. This real wage in year t will be denoted by W_t.[3]

The observations on manufacturing output per worker hour (labor productivity) are based on John Kendrick's (1961) research .[4] Labor productivity in year t will be expressed here by X_t. It is an index number that takes the value of 100 in 1958.

Trade union density D_t, that is, total trade union membership as a per cent of non-agricultural employment (agricultural employment being a largely non-union sector with a number of sole proprietors not employees).[5] Although the series on D_t in Figure 2 is restricted to union membership in manufacturing, it is not possible to narrow union membership to manufacturing in all the years before 1973. This is regrettable, but it is necessary given the data available. It may well not be a serious problem as, during the period from 1973 and 2019 when both union membership in

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[3] Williamson's (1995) series (from 1898 to 1988) of the real wages of non-farm unskilled workers is highly correlated with Officer's series used here as is the per cent annual change in these wages.

[4] Annual values of output per worker hour and real output in manufacturing from 1889 to 1957 are from Table D-II (pp. 465-466) of Kendrick (1961) Appendix D. After 1957, values of both variables are available online at the Office of Productivity and Technology, the U.S. Department of Labor, Bureau of Labor Statistics, under Historical Productivity and Cost Measures at https://www.bls.gov/productivity/tables .

[5] These data have been compiled and organized by Leo Wolman (1924), Leo Troy (1965), Leo Troy and Neil Sheflin (1985), and Barry Hirsch and David Macpherson (2021). Gerald Friedman (1999) has improved and extended to earlier years the data on union membership although between the years 1897 and 1914 (the last year to which Friedman's data relate), the correlation between his values of D_t and those used here is high: the correlation coefficient between the two series is 0.966 . Richard Freeman's (1998) series on trade union density end in 1995. Moreover, for the years from 1897 to 1995, the correlation coefficient between the series on union density I have constructed and Freeman's series is 0.97. The sources for the series on trade union density used in this paper are given beneath Figure 6.

manufacturing and union membership in the whole economy are available, the correlation coefficient between the annual values of D_t restricted to manufacturing and those of D_t for the whole non-agricultural economy is 0.996.[6]

With these observations, define ΔW_t as the per cent change in real wages in year *t* from the previous year, ΔX_t the per cent annual change in labor productivity in manufacturing in year *t* , and ΔD_t the per cent annual change in union density in year *t*. To determine whether the relation between real wages and labor productivity from 1980 to 2019 is special, the annual observations on these variables from1898 t0 2019 are divided into three periods of (approximately) 40 non-overlapping years: from 1898 to 1937; from 1938 to 1979; and from 1980 to 2019. Table 1 presents descriptive statistics of these variables in the period 1980-2019 compared with the periods 1898-1937 and 1938-1979 and also for the entire period from 1898 to 2019. The gap between changes in productivity and changes in real wages is, indeed, larger in the years from 1980 to 2019 than in the other periods. This is attributable to the unusually low growth in real wages because the growth in productivity is not unusually higher but lower in the years from 1980 to 2019 than the productivity growth in the other periods. The mean growth in real wages is largest in the period from 1898 to 1937. This period's mean growth in productivity and in trade union density is also highest in this period.

To answer the question of whether, in periods when real wages were rising, trade union density was also rising, the answer is "yes": real wages were rising in the periods from 1898 to 1937 and from 1938 to 1979 and. in both of these periods, the mean value of ΔD_t is positive. Hence what

[6] Similarly, Troy and Sheflin (1985, pp. 3-15) provide per cent trade union membership density figures for manufacturing for a number of years between 1930 and 1984. The correlation coefficient between these and their non-agricultural density figures is 0.90.

is needed to understand the growing gap between real wage movements and labor productivity movements in the last 40 years or so is to determine the reasons for the slow growth of real wages.

Is there evidence of a close association between changes in real wages and changes in labor productivity beyond a few selected years? A simple method with annual observations to examine the link between changes in labor productivity in year *t* and the corresponding change in real wages in year *t* is to estimate the following regression equation:

$$(1) \qquad \Delta W_t = \kappa_1 + \alpha_1 \Delta X_t + u_{1t}$$

where u_{1t} is a stochastic addition to the relation between per cent changes in real wages and per cent changes in labor productivity. It represents omitted variables and random errors in measuring ΔW_t. κ_1 and α_1 are parameters whose values are to be determined. According to the orthodox view, increases in labor productivity accompany increases in real wages in which case α_1 will be positive. Call this the weak version of the real wage-labor productivity hypothesis. Some appear to expect α_1 not only to be positive but also to equal unity implying that increases in labor productivity will give rise to increases of the same amount in real wages. This will be called the strong version of the real wage-labor productivity hypothesis. ΔW_t and ΔX_t are both measured as percent changes so the parameter α_1 may be called the elasticity of real wages with respect to labor productivity.

A rationale for a positive association over time between increases in real wages and increases in labor productivity might call upon the microeconomic analysis of the classical profit-maximizing firm that operates in competitive product and labor markets. Such a firm will choose its labor input such that the firm's marginal product of labor equals its given real product wage. Explicitly, the first-order condition for the competitive firm is $MP_L = v/r$ (where *v* is the nominal wage, *r* the firm's product price, and MP_L the marginal product of labor). Workers are "better off" when *w/c* rises where c is a cost-of-living index and w/c is the real wage series considered in this paper.

When a firm operates in a non-competitive labor market and faces an upward-sloping (with respect to the wage) labor supply function, the wage-elasticity of labor supply intrudes between real wages and the marginal product of labor. That is, the monopsonist's first-order condition is $(1 + \eta)^{-1} MP_L = v/r$ where η is the inverse of the wage elasticity of labor supply and the marginal product of labor exceeds the real product wage. The link between changes in the marginal product of labor and changes in the real product wage requires the wage-elasticity of labor supply to be held constant.

Evidence produced by Manning (2003), Yeh *et al.*(2022) and others suggest monopsony should be considered the default case in which case "theory" does not imply a close link between changes in labor productivity and changes in real wages unless other things (representing changes in the wage-elasticity of labor supply) are held constant. In this monopsonistic case, equation (1) ought to be replaced with equation (2) below

(2) $$\Delta W_t = \kappa_2 + \beta_1 \Delta X_t + \beta_2 \Delta M_t + u_{2t}$$

where ΔM_t stands for variables that are associated with changes in the labor supply elasticity. In this paper, among other variables, ΔM_t will be measured by the per cent annual change in manufacturing production: if the relevant model is monopsony in which the labor supply function is positively-sloped with respect to wages, then increases in production that are prompted by increases in the demand for labor will put upward pressure on wages and β_2 will tend to be positive. Indeed, to an aggregate of firms such as all of manufacturing, an upward-sloping (with respect to the wage) labor supply curve is to be expected.

In equations (1) and (2), variables are expressed as rates of change because the change in real wages is the subject of this paper. It also reduces the possibility of making incorrect inferences from mutually correlated time trends in variables when the variables are expressed in levels. The research on the association between changes in real wages and changes in labor productivity has a long history. Consider some of this work.

II. PREVIOUS STUDIES OF REAL WAGES CHANGES AND PRODUCTIVITY CHANGES

Henry L.Moore

An early examination is that of Henry Moore (1911) who used annual observations reported by François Simiand on the mean daily wages and daily productivity of French coal miners in the second half of 19th century. Daily wages were constructed by dividing the total amount paid in wages each year by the number of worker-days of work each year and labor productivity is defined as the total annual product as a fraction of worker-days each year. Note that the denominator of the annual mean wage so defined and the denominator of the labor productivity variable are the same so that any error in measuring days of work will result in a spurious positive correlation between wages and productivity. Moore concluded "an increase or decrease in the productivity of labor is accompanied with an increase or decrease in wages" (p. 51). Although Douglas (1934, p. 107) described Moore's work as "notable", it is not clear in Moore's analysis of Simiand's data whether the wage variable is nominal or real and, if real, whether it corresponds to the consumption wage or the real product wage.

Paul H. Douglas

Paul Douglas undertook a major project on wages in the 1920s and 1930s. It resulted in two volumes : *Real Wages in the United States 1890-1926* published in 1930 and *The Theory of Wages* in 1934. His observations between 1899 and 1926 on all manufacturing show the compound annual growth rate of labor productivity (namely, 1.57 per cent) growing faster than the compound annual growth rate of real wages (namely, 0.94 per cent). He draws inferences from graphs of annual values of labor productivity and annual values of real wages from which he concludes (1934, p. 202) "there seems to be [a] close correspondence between the imputed final productivity of labor and the wages of workers".

Recent Research

The recent experience of the growing gap between increases in productivity and increases in real wages has generated a flurry of papers investigating aspects of this link.[7] Many have provided valuable comparisons of the U.S. experience with those of other countries. Much of this work (including all the papers in footnote 7)has drawn upon observations in the years since the Second World War.

III. A NEW ANALYSIS

In contrast to the studies cited in the previous paragraph, this investigation makes use of annual values of variables from the late 19th century to the second decade of the 21st century. Descriptive statistics on the level of real wages W_t, on the level of labor productivity X_t, and on their annual per cent changes ΔW_t and ΔX_t over the entire analysis period from 1898 to 2019 are contained in Table 2.

Changes in Labor Productivity

Figure 3 provides a long view of the real wage and labor productivity series. It conforms to

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[7] Among many are notable papers by Bivens and Mishel (2015), Greenspon, Stanbury, and Summers (2021), Meloni and Stirati (2023), Mishel and Gee (2012), Pessoa and Van Reenen (2012), and Strauss and Wohar (2004).

a view that some appear to hold about the link between real wages and labor productivity, namely, movements in real wages were closely associated with movements in labor productivity until a break in approximately the 1970s . However, the figure is misleading: in drawing a single figure of two variables with a wide dispersion of values over 120 years, differences between the two variables are compressed and difficult to discern.

Real wages and labor productivity are strongly trended and, for the years from 1897 to 2019,both real wages and labor productivity have unit roots to which a common response is to first difference both variables as expressed in equations (1) and (2) above. When both series are first-differenced, the value in one year minus the value of the same variable in the previous year, and plotted over the same period, the consequence is shown in Figure 4 from which an association is difficult to decipher. [8]

It is apparent from Figure 3 that, although both series rise from 1897 to 1980, their years of maximum growth are different: the years of fastest growth for real wages are from 1940 to 1975 whereas the fastest growth of labor productivity was between 1990 and 2004. Over the entire period, real wages rose considerably less than the increase in labor productivity.

So confident are some researchers of the existence of a productivity-real wage link that these or similar productivity data are used by some economists to infer movements in real wages. An example is provided by Gordon and Sayed (2022, p.2) who write "the slow productivity growth between 2010 and 2019 accounts for much of the stagnation in the growth of real wages over that

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[8]A regression of the level of real wages in year t on the level of real wages in year $t\text{-}1$ for the years from 1898 to 2019 results in a regression coefficient on W_{t-1} of 0.995 and an R^2 of 0.998. Analogously the regression of the level of labor productivity in year t on its lagged value results in an estimated coefficient on the lagged variable of 1.01 with an R^2 also of 0.998.

decade". Indeed, in these manufacturing observations from 2010 to 2019, the compound annual growth rate of labor productivity was -1.067 per cent and the corresponding compound annual growth rate of hourly real compensation was -0.2085; both were negative although productivity growth was more negative than the negative change of real wages.

This comparison of the compound annual growth rate of labor productivity in manufacturing with the compound annual growth rate of the real wages of manufacturing workers is now extended to the period from 1900 to 2019 as follows. The annual observations from 1900 to 2019 of real wages and labor productivity are divided into eight 15-year periods: from 1900 to 1914; from 1915 to 1929; from 1930 to 1944; from 1945 to 1959; from 1960 to 1974; from 1975 to 1989; from 1990 to 2004; and from 2005 to 2019. Within each of these eight periods, the per cent compound annual change in real wages, $[G(W)]_t$ and the per cent compound annual change in labor productivity $[G(X)]_t$ are calculated.

The eight pairs of values of $[G(W)]_t$ and $[G(X)]_t$ are presented in a scatter diagram in Figure 5. Are periods when the growth rate of labor productivity is relatively high also periods when the growth rate of real wages is high? The impression in Figure 5 is of a weak positive relationship: the simple correlation coefficient between $[G(W)]_t$ and $[G(X)]_t$ in Figure 5 is +0.374 that is not significantly larger than zero by the conventional criteria.

In Figure 5, all but one pair of observations are below the 45^o line meaning that the years since 1980 are not the only years when labor productivity grew faster than real wages. The conspicuous exception is the period of the Great Depression during which falling consumer prices gave a fillip to real wages and the growth in real wages exceeded the growth in productivity.[9] Real wage growth and labor productivity growth are neither fully synchronized nor totally asynchronized: both grew at approximately the same rate between 1915 and 1929 and between 1945 and 1959.

Equations (1) and (2) are now applied to the annual values of per cent changes in real hourly compensation ΔW_t and the per cent changes in labor productivity ΔX_t. With respect to equation (2), changes in the elasticity of the wage-elasticity of labor supply will be represented by the per cent annual change in manufacturing production ΔM_t that is positive in an expansion and negative in a contraction; it is an indicator of the stage of the business cycle. In addition, a dichotomous variable, N_t, is included in equation (2) that takes the value of unity in 1934 and zero in all other years: it recognizes the operation of Title I of the National Industrial Recovery Act (NIRA) whose "codes" mandated a decline in weekly hours without changing weekly earnings, with a consequent rise in hourly compensation. To allow for any trends in omitted variables (or in the supply elasticity), a linear trend T_t is included in equation (2) as in equation (2)* below:

$$(2)^* \quad \Delta W_t = \kappa'_2 + \beta'_1 \Delta X_t + \beta'_2 \Delta M_t + \beta'_3 N_t + \beta'_4 T_t + u'_{2t}$$

In equation $(2)^*$, u'_{2t} is a stochastic term that absorbs random errors in measuring changes in real wages and the effects on changes in real wages of omitted variables.

Descriptive statistics on the variables in equations (1) and $(2)^*$ over all the years from 1898 to 2019 are provided in Table 2. When fitted to the entire period from 1898 to 2019, the least-squares estimates of equations (1) and $(2)^*$ are denoted equations (1a) and (2a) in Table 3. These

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[9] In the1930s, nominal wages changed little while consumer prices fell resulting in a rise in real wages. The consumer price index in 1933 was 76 per cent of its 1929 level and by 1939 it was still 81 per cent of its level a decade earlier. Real wages in 1939 were 1.52 times greater than their value in 1929 whereas labor productivity in 1939 was 1.26 times greater than its value in 1929.

provide little support for the hypothesis that annual increases in labor productivity in manufacturing are closely associated with annual increases in real wages in manufacturing. Neither the weak nor the strong version of the real wage-labor productivity hypothesis is supported and the fraction of the variance in wage changes removed by changes in productivity alone is unimpressive.

The other columns of Table 3 report the least-squares estimates of the equations (1) and (2)* fitted to various sub-periods. Essentially the strong version of the real wage-labor productivity hypothesis is rejected in all the sub-periods. The weak version of the hypothesis is consistent with the estimates in recent periods although the fraction of the variance in wage changes accounted for in these estimated equations is unremarkable and the implied effect of a typical increase in productivity on wage increases is small.[10] Of the eight equations in Table 3, the estimated coefficient on ΔX_t (the elasticity of wages with respect to productivity) is largest in the decades (1949-2019) after the Second World War (equation (2e). These inferences are unaffected by adding lagged values of the per cent change in labor productivity to the equations in Table 3.

In most periods, real wage movements tend to be procycical in that increases in production, ΔM_t, are associated with increases in real wages. The operation of the National Industrial Recovery Act increased real wages by thirteen per cent.

<u>Movements in Trade Unionism</u>

Raising the wages of its members has been an explicit goal of trade unions since their formation. Unions have been concerned with real wages as shown by the fact that national collective bargaining agreements often make a provision for differences in nominal wages according to

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[10] Consider a value of 2.5 per cent for ΔX_t (its mean value over all years) with no other changes. equation (2e)implies the effect on ΔW_t is 0.88 per cent, about one-half of the mean value of ΔW_t .

differences in the cost-of-living across places and also that unions sometimes spent scarce resources on strike activity to support demands for increases in money wages to offset increases in retail prices. Automatic cost-of-living adjustments to money wages were already common in union-negotiated contracts when the U.S. Congress authorized them for Social Security benefits in 1972.[11] A union's proximate objective is higher money wages but the ultimate goal is higher real wages.

Trade unions are a natural surrogate for the wage-elasticity of labor supply that intrudes between real wages and productivity when firms are monopsonistic . Does evidence exist to support the hypothesis that U.S. trade unions have succeeded in their objectives of higher real wages? This issue is taken up by determining whether periods in which real wages increased were also times when the bargaining power of unions was higher.

A number of economists[12] have demonstrated that union bargaining power rises when trade unions are growing and, in this paper, this is expressed by ΔD_t, the per cent change in year t of trade union density. Changes in trade union density, (that is , changes in the membership of trade unions as a per cent of non-agricultural employment) can be inferred from Figure 6. Trade union density rose from 4.2 per cent averaged over the last three years of the nineteenth century to 32.5 per cent in the early 1950s after which there was a gradual decline until the late 1970s. The decline became more pronounced after 1980. Over all the years from 1897 to 2019, the mean union membership-employment ratio is 17 percent with a minimum of 4.1 per cent in 1898 and a maximum of 32.5 per

[11] In1976, automatic cost-of-living adjustment clauses covered 71 per cent of workers in major collective bargaining agreements in manufacturing Devine (1996).

[12]Lewis (1963, pp. 212-3) provided evidence supporting the implication that the effects of unionism on wages are greater when unions are growing (as did Douglas (1930, p.562)and Ashenfelter *et al.* (1972)). Hines (1964) supplied evidence for the U.K.

cent in 1953. Some may question whether these levels of membership are sufficiently high to confer on trade unions an importance for labor market outcomes.

The answer is that the activities of trade unions affect the labor market outcomes not only of their members but also of workers who are not members. Governments use the terms of union-negotiated collective bargaining agreements to set minimum standards that their contractors must satisfy. Also private non-union employers have altered the terms of employment of their workers to discourage them from being receptive to unionism, the "threat effect" of unions. In 1914, Henry Ford (an outspoken opponent of unions) doubled the daily pay of his workers and reduced the length of their working day from 9 to 8 hours in response to the successful union organizing campaigns in neighboring Ohio.

Other examples of non-union manufacturing firms tailoring their pay and benefits to dissuade their employees from organizing include McCormick and International Harvester (Ozanne (1968)), Eastman Kodak, Sears Roebuck and Thompson Products (Jacoby (1997)), and the many cases supplied by Rees and Shultz (1970) in their detailed analysis of Chicago's labor markets. They accounted for the weak association between wages and the union status of their workplaces to the threat that unions posed for non-union workplaces: "the price of remaining nonunion may be to offer union wages" (p.182). The "threat effect" of unions was not restricted to the wages and hours of workers at non-union firms. Unions sought changes in the internal organization of firms. Writing of the development of the personnel department in many firms in the inter-war years, Jacoby (1985, p. 255) noted "it best served the purpose of thwarting unionism by introducing the same reforms the unions sought".

There is now an empirical literature determining whether the wages of individual non-union workers are related to union density in the same industry or to union density in the same location. There is a variety of methods and results but a study most relevant to the research in this paper is that of Hirsch and Neufeld (1987) who examine the wages of the same group of workers studied here, production workers in manufacturing. They find that, holding constant each worker's schooling, age, race, gender, and region, variations in union density in the same three-digit industry have almost the same (positive) effect on non-union manufacturing production workers' wages as the measured effect on unionized manufacturing production workers' wages, a finding consistent with the above claim that "the activities of trade unions affect the labor market outcomes not only of their members but also of workers who are not members".

Descriptive statistics on D_t and ΔD_t in the years from 1898 to 2019 are provided in the final two columns of Table 2. Note that the dispersion of ΔD_t (as measured by the coefficient of variation (σ/μ) and the quartile deviation relative to the median *(QD/M)*) exceeds that of other variables in Table 2. The minimum value of ΔD_t was -19.44 per cent recorded in the year 1922 during the contraction that followed the First World War while the maximum value of 32.65 per cent occurred in 1900 as unions registered large membership gains relative to their low base at that time.

First, examine whether inferences with respect to unionism and real wages can be drawn from the division of the years from 1900 to 2019 into eight sub-periods of 15 years and, analogous to Figure 5, graph the association in each of these sub-periods between the per cent compound annual change in real wages $[G(W)]_t$ and the per cent compound annual change in trade union density $[G(D)]_t$. This is shown in Figure 7 in which periods when the rate of growth of union density were high were also periods when the growth of real wages was relatively high. The association between $[G(W)]_t$ and $[G(D)]_t$ is unambiguously positive. The correlation coefficient between

$[G(W)]_t$ and $[G(D)]_t$ is + 0.74 and is significantly larger than zero by the usual standards.

With the 122 annual observations from1898 to 2019, consider whether movements in trade union bargaining power as measured by ΔD_t can improve the description of real wage movements reported above. To this end, analogous to equation (1), start with the simple specification

(3) $$\Delta W_t = \kappa_3 + \mu_1 \Delta D_t + u_{3t} \ .$$

When trade union bargaining power is high as indicated by positive values of ΔD_t, μ_1 in equation (3) is conjectured to be positive. Analogous to α_1 in equation (1) being called the elasticity of wages with respect to productivity so μ_1 in equation (3) may be called the elasticity of wages with respect to trade union density. Equation (3) is the time-series counterpart to the many cross-section investigations in which proportionate differences in wages across industries are related to differences in trade union density across industries(Lewis (1986, Ch.3) provides a review of this research); replace proportionate differences in wages across industries with per cent changes in wages from year to year and replace differences in union density across industries at a given moment with per cent changes in union density from year to year and the result is equation (3).

Equation (3) is a parsimonious specification. An expanded specification builds on equation (2) as follows:

(4) $$\Delta W_t = \kappa_4 + \gamma_1 \Delta D_t + \gamma_2 \Delta X_t + \gamma_3 \Delta M_t + \gamma_4 N_t + \gamma_5 T_t + u_{4t}$$

where, as above, ΔX_t is the per cent annual change of manufacturing labor productivity, ΔM_t is the per cent annual change in manufacturing production, a business cycle indicator, N_t (standing for the National Industrial Recovery Act) is a dichotomous variable that takes the value of unity in 1934 and of zero in all other years, T_t is a linear time trend, and u_{3t} and u_{4t} are residuals in year *t* containing the consequences for ΔW_t of omitted variables and of random errors in measuring ΔW_t. Least-squares estimates of equations (3) and (4) fitted to the 122 years from 1898 to 2019 are contained in Table 4. For the entire period from 1898 to 2019, according to equation(4a), the partial elasticity of wages with respect to trade unionism is 0.086 whereas the partial elasticity of wages with respect to productivity is 0.024. Table 4 also reports equations containing only changes in productivity and changes in union density as regressors.

The estimates of the elasticity of wages with respect to productivity are small relative to their standard errors except for the years after the Second World War. These are years during which the effect of trade unions is least : trade union density reached its peak in the early 1950s and, of the 31 annual observations on ΔD_t from 1949 to 1979, 20 are negative and one is zero. The decline from 1980 to 2019 was especially steep: of the 40 annual observations on ΔD_t from 1980 to 2019, 33 are negative and five are zero. It is no wonder that a positive effect of ΔD_t on ΔW_t is not estimated in equations (3c) and (4c) in Table 4 whereas a positive effect is calculated in all the other equations.

During the post-Second World War period, the years during which trade union density declined more (i.e., 1980-2019) was also the period during which real wages rose less.[13] The 1980-2019 period was particularly severe for trade unions and for the compensation of these workers. It has already been reported (Table 1) that, of all the 40 year periods between 1898 and 2019, the per cent increase in real wages was the smallest between 1980 and 2019. Precisely, in the five years from1980 to 1984, real hourly compensation of these workers (in 1982-84 dollars) averaged \$11.17 and they averaged \$11.74 in the five years from 2015 to 2019. In a period when wages changed little, trade union density fell from 18 percent in the 1980-84 years to an average of 6.5 per cent in

[13] In the years from 1949 to 1979, the arithmetic mean value of ΔD_t was -1.09 % and the mean value of ΔW_t was 2.22 % ; in 1980-2019, the mean value of ΔD_t was -2.87 % and the mean value of ΔW_t was 0.043 %. When unionism declined more, real wages rose less.

the 2015-19 years. When unionism diminished, real wages languished.[14] Consequently, unlike equations (4a) and (4b), in equations (3c) and (4c), the estimated coefficient on ΔD_t is negative, not positive. These inferences are unaltered if lagged values of ΔD are added to Table 4's equations.

It was written above that "a union's proximate objective is higher money wages but the ultimate goal is higher real wages". Is there evidence that trade unions succeeded in raising nominal wages? Using Officer's (2009) series on the nominal hourly compensation of manufacturing production workers W^N_t, a least squares equation relating the annual per cent change in nominal hourly compensation, ΔW^N_t, to changes in union density, ΔD_t, to annual per cent changes in consumer prices ΔP_t and the unemployment rate, U_t for the years from 1898 to 2019 yields

$$\Delta W^N_t = \underset{(0.627)}{1.036} + \underset{(0.037)}{0.110}\,\Delta D_t + \underset{(0.066)}{1.050}\,\Delta P_t + \underset{(0.071)}{0.078}\,U_t$$

with $R^2 = 0.718$ and $D\text{-}W = 1.86$. The elasticity of nominal wages with respect to union density is 0.11 (to be compared with the real wage elasticity estimated in equation (3a) of Table 4) and the estimated coefficient of unity on ΔP_t implies that this could be interpreted as a real consumption wage equation.

IV. SUMMARY AND CONCLUSIONS

Using information on the typical American manufacturing production worker's real hourly compensation, his life at work today is much improved compared with his forebear's work life at the end of the 19th century. This perspective also suggests that the rate at which his working life has

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[14] The decline in union density manifested itself not only in little change in wages, but also in the link between strikes and wages. That is, whereas strikes were associated with wage increases in the 1970s, that association virtually disappeared in subsequent years. See Massenkoff and Wilmers (2024).

improved has diminished over time: the compound annual growth in the real value of his hourly compensation was lower in the years from 1980 to 2019 than the growth from 1938 to 1979 which, in turn, was lower than the growth from 1898 to 1937. (See Table 1.)

Of course, manufacturing employment has experienced a well-known contraction in recent decades. This contraction is not unprecedented: the relative decline in the employment of these manufacturing workers from 1980 to 2019 was less severe and more gradual than the contraction in the early 1930s and yet the impact on real hourly compensation was many times more positive for the employed in the earlier period.[15] Is it coincidental that trade union density was rising in the 1930s and that it was falling between 1980 and 2019 ?

Because a satisfactory producer price index for manufacturing is not available for all the years from 1898 to 2019, this paper has not sought to test the hypothesis that labor productivity increases in manufacturing are closely associated with increases in real product wages in manufacturing. The U.S. Bureau of Labor Statistics does have an annual producer price index for total manufacturing from 1986. If this is used to deflate the nominal hourly compensation series (call this real product wage series W^P_t) and if annual per cent changes in this real product wage is regressed on annual per cent changes in labor productivity for the 33 years from 1987 to 2019, the estimates are $(\Delta(W)^P_{\ t}) = 0.162 + 0.132\ \Delta(X_t)$ where the estimated standard error attached to the

[15]The compound annual change in manufacturing employment from 1929 to 1932 was -14.52 per cent; the corresponding change between 1980 and 2019 was -1.08 %. At the same time, the compound annual growth rate of real hourly compensation between 1929 and 1932 was + 2.80 per cent and + 0.12 per cent between 1980 and 2019. In the face of a more severe contraction in the early 1930s, real wages increased more than in the years between 1980 and 2019. Although the nominal hourly compensation of these workers fell between 1929 and 1932, the fall was less than that of consumer prices during these years.

coefficient on $\Delta(X_t)$ is equal to 0.241 and an $R^2 = 0.0095$. Given the absence of a producer price index for manufacturing before 1986, this paper has asked whether there exists a "close" association between increases in labor productivity and increases in real consumption wages, increases in real consumption wages being more relevant to statements about whether workers are " better off " today.

If this analysis had been confined to the years since the Second World War as some other research has done, a wage-productivity link would have been confirmed for manufacturing. As it is, the years from the end of the nineteenth century to mid-twentieth century find movements in labor productivity are not highly correlated with movements in real consumption wages.

Contrary to Mankiw's (2016) claim (cited in the first paragraph of this paper) the research here for the U.S. manufacturing industry shows that neither theory nor history "confirm" a close link between changes in labor productivity and the changes in the real wages that correspond to workers being "better off". As shown in Table 1, the mean value of the annual rate of growth of labor productivity in U.S. manufacturing industry exceeded the mean value of the annual rate of growth of manufacturing workers' real (consumption) hourly wages during all of the 40 year periods between 1898 and 2019. The magnitude of this divergence was exceptional in the 40 years after 1979, a period characterized by the smallest growth of real hourly compensation of all forty year periods since 1898.[16]

Increases in labor productivity have not been the only force for raising real wages. Thus, after acknowledging a "tendency" for wages to increase most when productivity increases, John Dunlop (1948, p. 361) wrote "The relationship between changes in productivity and wage rates is

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[16] The only 40 year period when the compound annual growth rate of real wages exceeded the compound annual growth rate of productivity was from 1898 to 1937. It is also the period in which the compound annual growth rate of trade union density is the highest. See Table 1.

not unique since a great many other factors affect wage movements among industries This is confirmed here and trade unionism is one of those other factors.

Statutory legislation (in the form of the National Industrial Recovery Act in 1934) had a sizeable positive effect on real wages. As indicated by the estimated coefficients on changes in manufacturing output (ΔM_t), these workers' real wages tended to be procyclical.

The years from 1980 to 2019 witnessed a remarkable collapse of trade union membership. Given the positive association between the rate of growth of real hourly compensation and the growth of the density of trade union membership during the years up to the mid- 20th century, it is reasonable to believe that, when trade union density was falling, the upward pressure of unions on real wages weakened. In other words, using a specification that recasts the very many cross-section studies of wages and unionism into a time-series context, evidence has been supplied of a positive relation between increases in the real hourly compensation of manufacturing production workers and increases in trade union density from the end of the 19th century. Therefore these workers have reason to attribute their higher consumption levels today, in part, to the activities of trade unions.

When trade union density fell, that upward pressure was diluted and increases in real wages ebbed. Since the 1970s, much of the increase in income has been enjoyed by a very small fraction of income-earners, not manufacturing production workers. The small increase in the wages of manufacturing wages since the 1970s is associated with the weakened state of trade unionism and with the increase in income inequality over the past four decades, a conclusion reached also by DiNardo *et al.* (1996) and Farber *et al.* (2021).

Others have also suggested that, since the 1970s, the "destruction of labor unions" (Levy and Temin (2007) and Greenspon, Stansbury, and Summers (2021)) contributed to the mediocre growth of the wages of workers whose pay was below the median. This paper also shows the converse: when trade unions were growing, they contributed to the increase of real wages of these workers.

If firms do not operate in a competitive labor market, a close association between changes in labor productivity and changes in real wages is not to be expected and trade union bargaining power can exploit this. When positive shocks to labor markets (such as boosts to labor productivity) result in an increase in an organization's net revenues, these revenues are usually assumed to be passed on to the organization's owners or agents. When a trade union is present or when a trade union "threatens", some of these additional revenues are likely to be passed on to workers in the form of higher wages. When unionism is less of a force (as in the years since 1980) a gap appears between the growth in labor productivity and the growth of production workers' wages , but not in the growth of incomes of owners and their agents (management).

In the estimated regression equations above, rarely does the combination of right-hand side variables remove more than one-half of the variation in real wage changes. There is much more to be learned about the movements in the real wages of these workers. Research is also needed to account for the changed circumstances in manufacturing in the late 1940s that resulted in a measurable real wage-productivity link in subsequent years.

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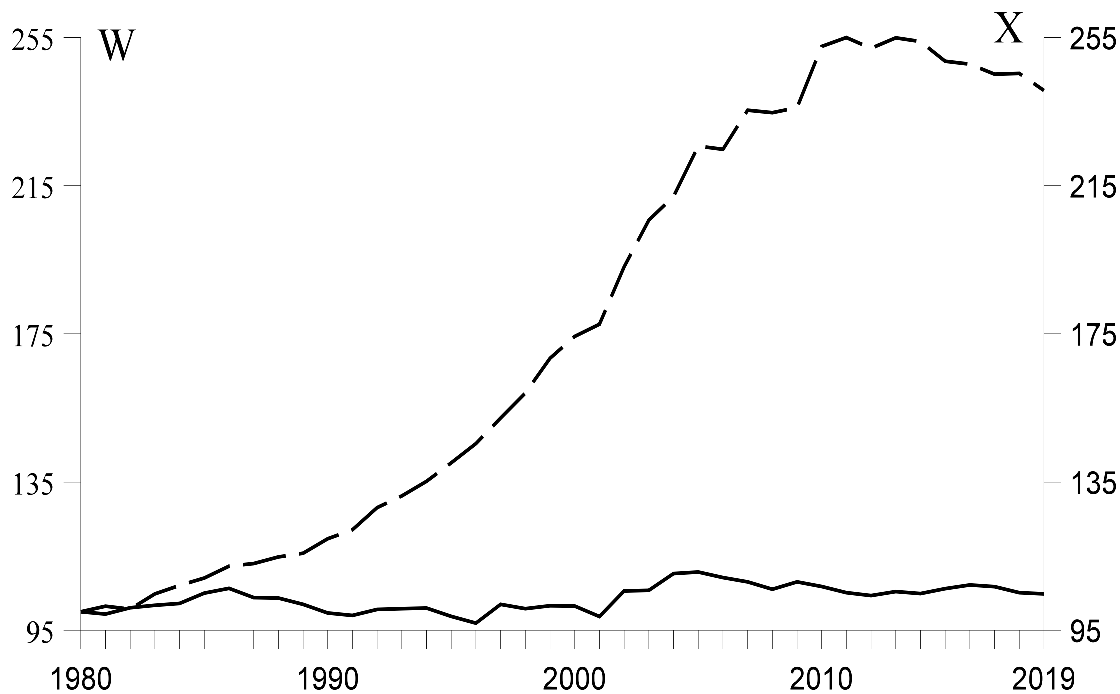
FIGURES

Figure 1

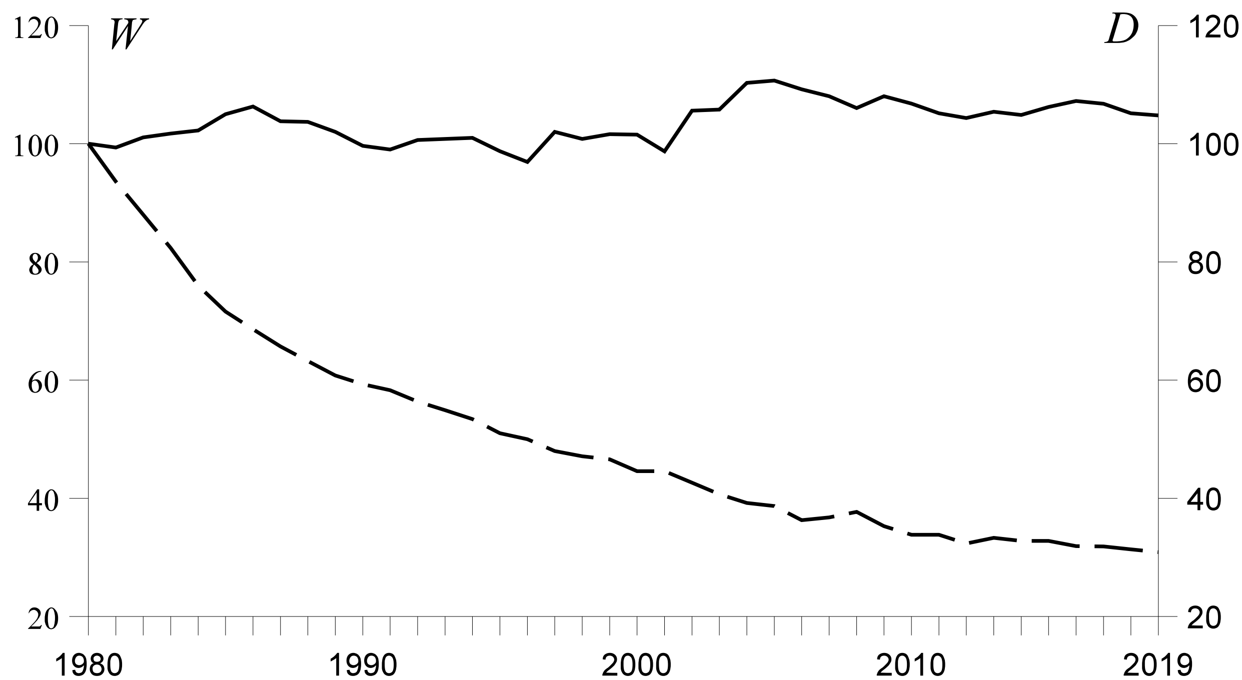
Annual Values of the Real Hourly Compensation of Manufacturing Production Workers and of Labor Productivity in Manufacturing Industry from 1980 to 2019



The real hourly compensation (*W*) of manufacturing production workers in 1982-84 dollars is measured on the left-hand vertical axis and by the solid series in the figure. The index of labor productivity in manufacturing (*X*) is measured on the right-hand vertical axis and by the dashed series in the figure. In this graph to help a comparison of the movements of real wages with productivity, the values of both *W* and *X* have been set to 100 in 1980. Between 1980 and 2019, the compound annual growth rate of real wages in manufacturing was 0.12 per cent while the compound annual growth rate of manufacturing labor productivity was 2.28 per cent.

Figure 2

Annual Values of the Real Hourly Compensation of Manufacturing Production Workers and of Trade Union Density in Manufacturing Industry from 1980 to 2019

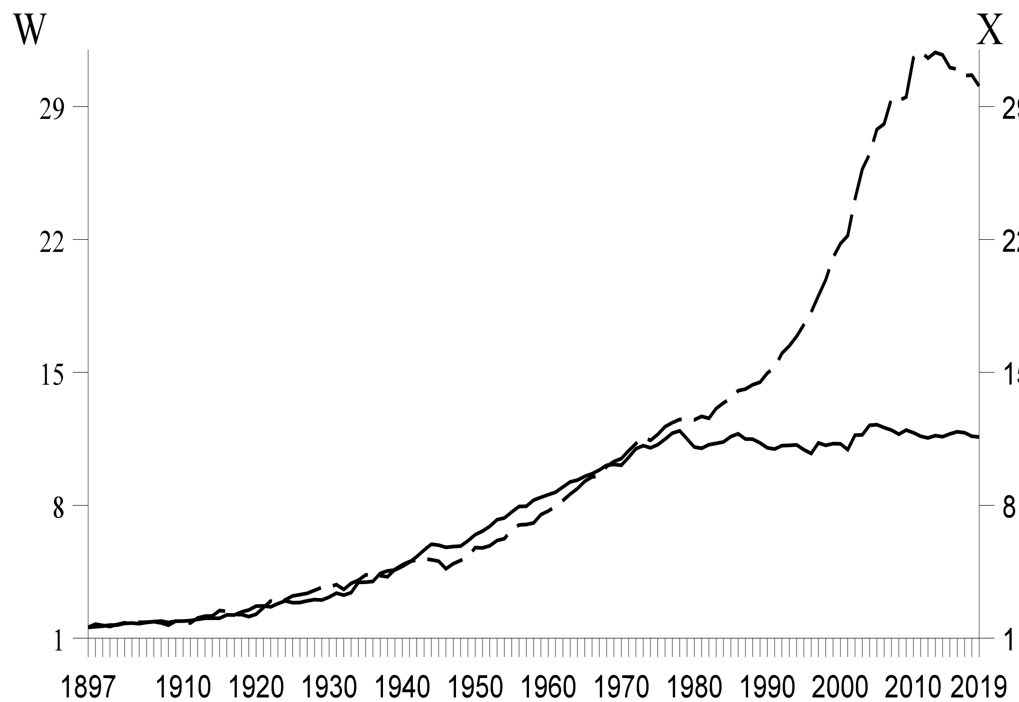


The real hourly compensation (W) of manufacturing production workers is measured on the left-hand vertical axis and by the solid series in the figure. The per cent trade union density in manufacturing (D) is measured on the right-hand vertical axis and by the dashed series in the figure. In this graph, to help a comparison of the movements of real wages with unionism, the values of both W_t and D_t have been set to 100 in 1980. With D_t set to 100 in 1980, its value in 2019 is 30.9 . With W_t set to 100 in 1980, its value in 2019 is 105 . Between 1980 and 2019, the compound annual growth in real wages was 0.12 per cent and the annual compound growth in trade union density in manufacturing was about -3.0 per cent.

Figure 3

Labor Productivity in Manufacturing and the Real Wages of Manufacturing Production Workers

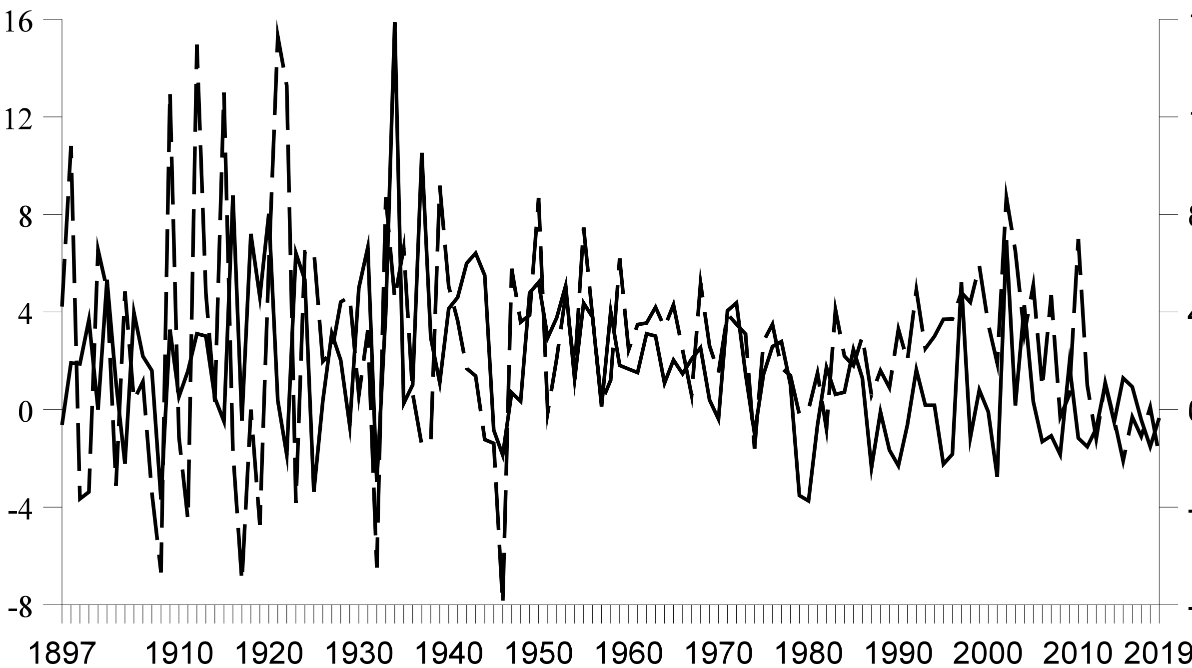
from 1897 to 2019



The real hourly compensation (*W*) of manufacturing production workers is measured on the left-hand vertical axis and by the solid series in the figure. It is expressed in 1982-84 dollars. The index of output per worker-hour in manufacturing (*X*) is measured on the right-hand vertical axis and by the dashed series in the figure. For this graph, to help comparison with real wages, the labor productivity series is recalculated so that it starts at the same value as real wages in 1897.

Figure 4

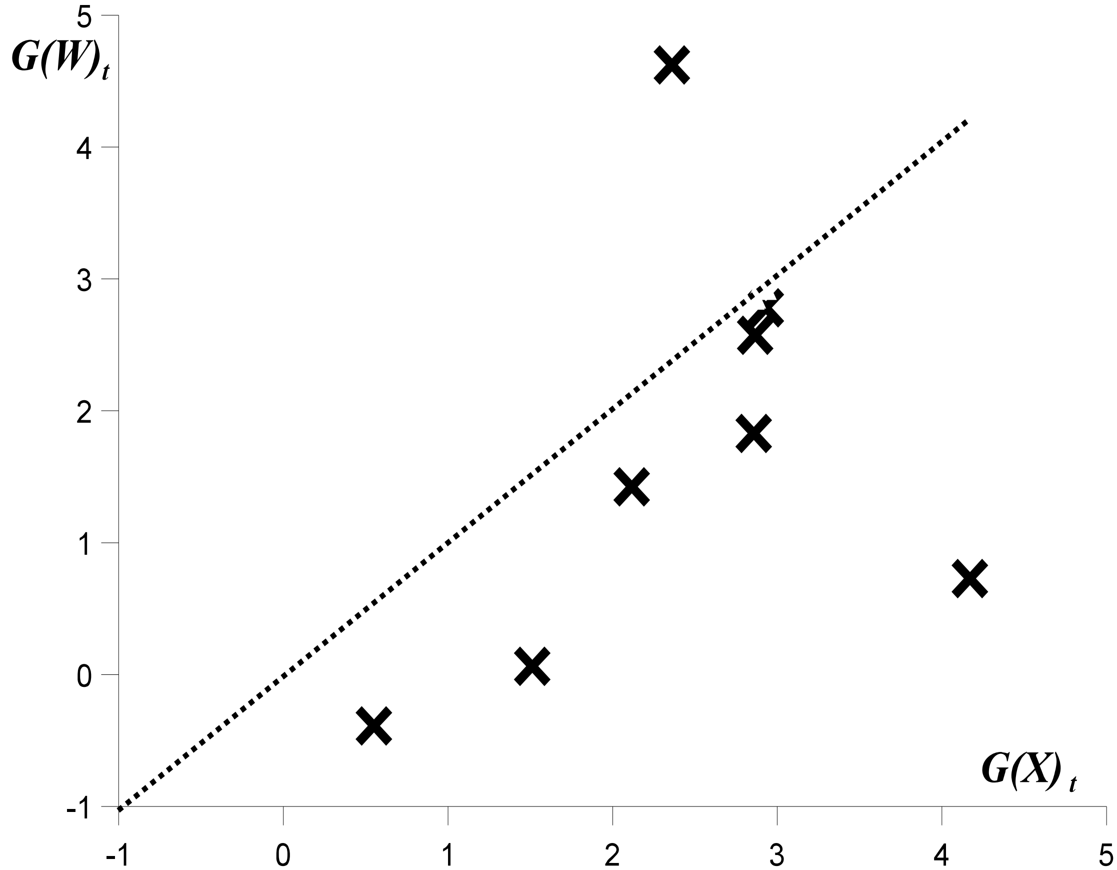
Annual Per Cent Change in Manufacturing Labor Productivity and Annual Per Cent Change in the Real Wages of Manufacturing Production Workers from 1897 to 2019



Per cent Changes in Real Wages are shown as a solid series while per cent Changes in Labor Productivity are shown as a dashed series. No pattern or association is discernible except changes in both series appear larger in absolute value in the years from 1897 to 1950.

Figure 5

The per cent compound annual growth rates of real wages $[G(W)]_t$ and of labor productivity $[G(X)]_t$ within eight periods of 15 Years from 1900 to 2019



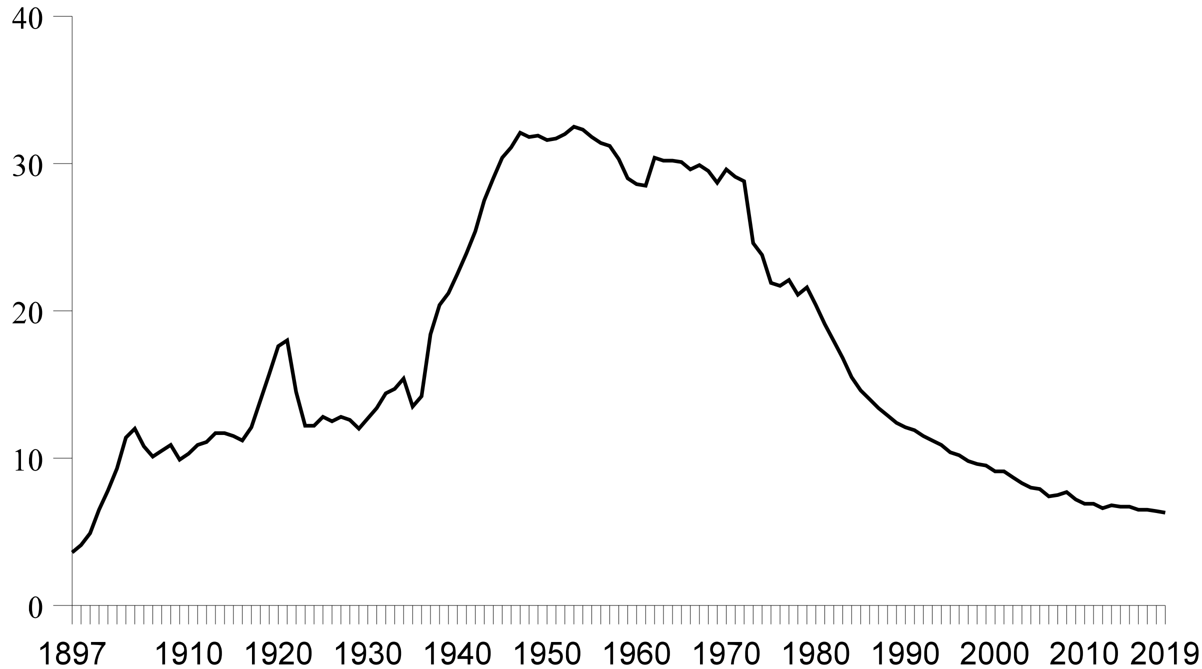
The annual observations from 1900 to 2019 have been divided into eight 15 year periods. Within each of the eight periods the percent compound annual change in real wages $[G(W)]_t$ measured on the vertical axis has been mapped against the per cent compound annual change of labor productivity in manufacturing $[G(X)]_t$ on the horizontal axis. A least-squares regression fitted to these observations yields $[G(W)]_t = 0.335 + 0.566\,[G(X)]_t$ with $R^2 = 0.140$

(0.572)

The dotted line denotes values corresponding to $[G(W)]_t = [G(X)]_t$.

Figure 6

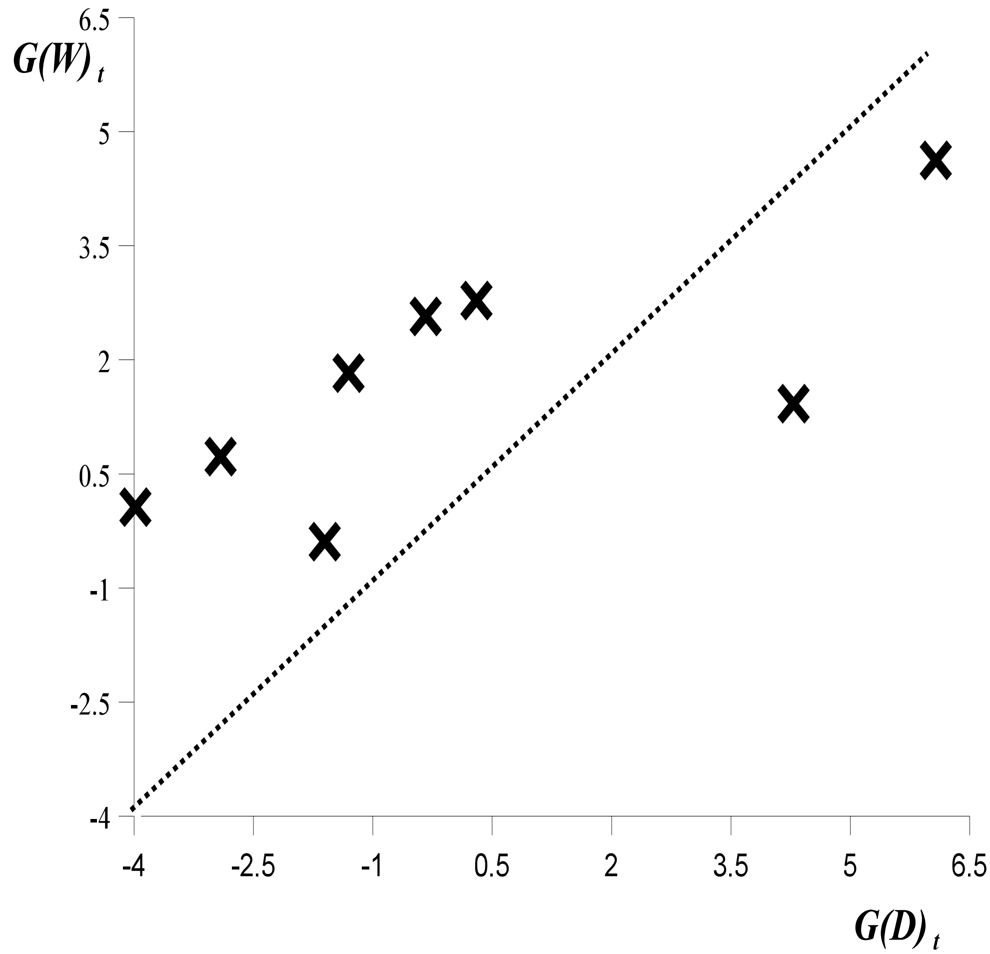
Trade Union Membership as a per cent of Non-Agricultural Employment, D_t 1897-2019



The series in the figure expresses total trade union membership as a percent of nonagricultural employment from 1897 to 2019, union density. The observations from 1897 to 1972 are from Troy and Sheflin (1985, p.A-1) and the observations from 1973 to 2019 are drawn from the Current Population Survey as reported by Hirsch and Macpherson (2021). The 1982 CPS included no union questions so the value for 1982 interpolates the 1981 and 1983 values.

Figure 7

The per cent Compound Annual Growth Rates of Real Wages $[G(W)]_t$ and of Trade Union Density $[G(D)]_t$ within eight periods of 15 years from 1900 to 2019



Within each of eight periods of 15 years the percent compound change annual in real wages $[G(W)]_t$ (measured on the vertical axis) has been mapped against the per cent compound annual change in trade union density $[G(D)]_t$ (on the horizontal axis). The least-squares regression fitted to these observations yields $[G(W)]_t = 1.682 + 0.347\ [G(D)]_t$ with $R^2 = 0.544$

(0.129)

The dotted line identifies values where $[G(W)]_t = [G(D)]_t$.

TABLES

Table 1

Descriptive Statistics on the Per Cent Changes in Real Wages (ΔW_t) of Manufacturing Production Workers, Per Cent Changes in Labor Productivity (ΔX_t) in Manufacturing, and Per Cent Changes in Trade Union Density (ΔD_t) in Three (Approximate) Forty Year Periods and in all 122 Years from 1898 to 2019.

	1898-1937	1938-1979	1980-2019	1898-2019
mean ΔW_t	2.69	2.33	0.043	1.70
median ΔW_t	1.97	2.31	-0.217	1.29
mean ΔX_t	2.72	2.62	2.25	2.53
median ΔX_t	2.17	2.95	1.95	2.45
mean ΔX_t - mean ΔW_t	0.03	0.29	2.21	0.83
median ΔX - median ΔW_t	0.20	0.64	2.17	1.16
mean ΔD_t	4.74	0.54	-2.87	0.80
median ΔD_t	4.40	-0.16	-3.17	-0.63
CAGR % of W	2.63	2.29	0.12	1.65
CAGR % of X	2.34	2.67	2.28	2.38
CAGR % of D	3.93	0.14	-2.97	0.36
CAGR % of X - CAGR % of W	-0.29	0.38	2.16	0.73
Number of observations	40	42	40	122

CAGR % is the Compound Annual Growth Rate in per cent.

Table 2

Descriptive Statistics of Variables used in the Analysis of the Real Wages of Manufacturing Production Workers from 1898 to 2019 (122 years)

	W_t	ΔW_t	X_t	ΔX_t	M_t	ΔM_t	D_t	ΔD_t
mean μ	7.423	1.698	153.4	2.533	462.16	3.648	17.0	0.803
stan. dev. σ	3.951	3.076	132.35	4.169	427.96	9.452	8.859	7.661
minimum	1.60 [1898]	-3.74 [1980]	22.9 [1900]	-7.97 [1946]	25.1 [1898]	-25.28 [1932]	4.1 [1898]	-19.44 [1922]
$Q_L = 25\%$	3.01	-0.421	49.7	0.1	76.9	-0.88	10.2	-3.361
median, M	8.345	1.291	103.1	2.447	274.2	3.294	13.4	-0.626
$Q_U = 75\%$	11.25	3.68	204.7	4.7	776.5	8.2	25.4	3.92
maximum	12.25 [2005]	15.88 [1934]	450.9 [2011]	15.3 [1921]	1290.3 [2018]	33.14 [1941]	32.5 [1953]	32.65 [1900]
range	10.65	19.62	428	23.27	1265.2	58.42	28.4	52.09
σ / μ	0.532	1.812	0.863	1.646	0.926	2.591	0.521	9.540
QD/M	0.494	1.588	0.752	0.940	1.276	1.378	0.567	5.815

Real wages, W_t ,are expressed in 1982-84 dollars. The index of labor productivity in manufacturing, X_t takes the value of 100 in 1958. The index of real output in manufacturing M_t takes the value of 100 in 1929. The years in which the minimum and maximum values of a variable were observed are entered in square brackets. σ / μ is the coefficient of variation, that is, the standard deviation (σ) of a variable divided by the mean (μ) value of that variable. When arranging the values of a variable in ascending order of magnitude, Q_L is the value of the variable at the lower quartile (or 25th percentile) and Q_U is the value of that variable at the upper quartile (or 75th percentile). *QD/M* is the quartile deviation divided by the median value of that variable where the quartile deviation *(QD)* is ½ $(Q_U - Q_L)$. Unlike the range, σ / μ and *QD/M* are measures of dispersion that are comparable across variables measured in different units.

Table 3

Wages and Labor Productivity: Least-Squares Estimates of the Real Wage Equations (1) and (2)*

estimated coefficients on ⇓	(1a) 1898-2019	(2a) 1898-2019	(1b) 1898-1979	(2b) 1898-1979	(1c) 1980-2019	(2c) 1980-2019	(2d) 1898-1948	(2e) 1949-2019
intercept	1.495 (0.326)	2.823 (0.510)	2.403 (0.402)	2.276 (0.636)	-0.582 (0.430)	-2.489 (3.058)	1.711 (0.922)	4.013 (1.111)
ΔX_t	0.080 (0.067)	-0.012 (0.063)	0.038 (0.074)	-0.056 (0.071)	0.278 (0.128)	0.346 (0.144)	-0.103 (0.085)	0.351 (0.109)
ΔM_t		0.070 (0.028)		0.078 (0.030)		-0.081 (0.097)	0.086 (0.037)	-0.019 (0.052)
N_t		13.290 (2.620)		13.198 (2.752)			12.99 (3.20)	
T_t		-0.024 (0.007)		-0.003 (0.013)		0.019 (0.029)	0.021 (0.030)	-0.044 (0.011)
R^2	0.012	0.309	0.003	0.288	0.111	0.139	0.342	0.351
D-W	1.77	1.92	2.08	2.03	2.32	2.30	2.14	1.90
nobs	122	122	82	82	40	40	51	71

Estimated standard errors are in parentheses beneath their estimated coefficients. *D-W* is the value of the Durbin-Watson statistic. The number of observations is given by “nobs”.

Table 4
Wages and Trade Unionism: Least-Squares Estimates of the Real Wage Equations (3) and (4)

	estimated coefficients (and estimated standard errors) on.......						R^2	D-W
	intercept	ΔD_t	ΔX_t	ΔM_t	N_t	T_t		
(3a) 1898-2019	1.609 (0.270)	0.111 (0.035)					0.076	1.85
(3aa) 1898-2019	1.251 (0.318)	0.128 (0.036)	0.136 (0.066)				0.108	1.89
(4a) 1898-2019	2.111 (0.580)	0.086 (0.035)	0.024 (0.064)	0.075 (0.028)	13.057 (2.570)	-0.015 (0.007)	0.342	1.94
(3b) 1898-1979	2.309 (0.358)	0.076 (0.039)					0.043	2.09
(3bb) 1898-1979	2.055 (0.425)	0.089 (0.041)	0.083 (0.075)				0.058	2.09
(4b) 1898-1979	1.323 (0.720)	0.098 (0.038)	-0.013 (0.071)	0.084 (0.029)	12.932 (2.661)	0.010 (0.013)	0.344	2.06
(3c) 1980-2019	-0.343 (0.512)	-0.135 (0.134)					0.026	2.23
(4c) 1980-2019	-4.704 (3.615)	-0.171 (0.151)	0.335 (0.144)	-0.091 (0.097)		0.036 (0.032)	0.170	2.31
(4d) 1898-1948	0.672 (0.990)	0.106 (0.045)	-0.057 (0.084)	0.095 (0.036)	12.697 (3.061)	0.036 (0.029)	0.412	2.14
(4e) 1949-2019	3.970 (1.118)	0.047 (0.074)	0.360 (0.110)	-0.021 (0.052)		-0.043 (0.012)	0.355	1.93