WHUS

THE DECLINING GROWTH IN THE WELL-BEING OF THE AVERAGE AMERICAN MANUFACTURING PRODUCTION WORKER IN THE TWENTIETH CENTURY

John H. Pencavel

5 May 2023

ABSTRACT

Why have the real wages of American manufacturing production workers risen over the twentieth century? Why have their working hours fallen? Using annual observations on the average hourly compensation and average weekly hours of work of these workers, explanations are sought for the movements in real wages and working hours of these workers that involve changes in labor productivity, in trade unionism, and in statutory legislation.

66 words

Keywords: real wages ,weekly hours, trade unions, labor productivity , legislation

JEL Classification Code: J22, N31, N32

Department of Economics

Stanford University, Stanford,

California, 94305-6072

THE DECLINING GROWTH IN THE WELL-BEING OF THE AVERAGE AMERICAN MANUFACTURING PRODUCTION WORKER IN THE TWENTIETH CENTURY

John H. Pencavel *

When a worker's real wage rises and when hours of work fall, the economist infers the worker's well-being has risen. By this yardstick, the typical American manufacturing production worker experienced a huge improvement in well-being in the 20th century: this worker's real hourly compensation in 2000 was almost seven times its level in 1900 and he worked in 2000 almost fourteen fewer hours in a typical week than in 1900. To what can this increase in well-being be attributed?

The comparison in the previous paragraph of the real wages and working hours of this worker in the first year of the 20th century with the first year of the 21st century overlooks the fluctuations and interruptions in well-being at work in the years between. The time when these improvements slowed or stopped was different for real wages from that for working hours. Therefore, an explanation for this pattern for real wages may well not be the same as that for hours.

The research here makes use of annual values of variables from about 1900 to the second decade of the 21st century. The availability of accurate data determines the initial year of observations and the onset of the Covid-19 pandemic with uncertain effects on the variables analysed determines the year at which the observations stop. At certain points below, the analysis period will be reorganized into several shorter periods to help the inquiry.

---

* Prepared for the Symposium celebrating the Centennial of Princeton University's Industrial Relations Section June 2023 . I thank Neil Shen for his conscientious research assistance and Isaac Sorkin for his comments on an earlier draft.

This investigation opens with an analysis of the movements of real wages followed by an analysis of hours of work . A summary and a statement of inferences concludes the paper.

I. CHANGES IN REAL WAGES

Movements in Real Wages

The importance of the movements in real wages for assessing the changes in a worker's standard of living has been well- expressed by Paul Douglas (1930) and Orley Ashenfelter (2012). The course of real wages of American manufacturing production workers from 1897 to 2019 is shown in Figure 1. Precisely, this variable is the average real hourly compensation (it includes fringe benefits) of these workers. They are a collection of men and women employed in various workplaces with different characteristics and skills including electricians. carpenters, machinists, general laborers, and janitors. The average masks this heterogeneity. If one of these workers should leave his or her current work, he or she is not replaced without some cost to the employer and this gives the workers bargaining power with their employers.

Average hourly compensation is converted to a "real" value through the use of a price deflator that measures the cost of consumer goods. Building on the work of others, the price index was constructed by Officer and Williamson (2020) . Real wages are expressed in 1982-84 dollars. As shown in Figure 1, real wages grew strongly from the beginning of the 20th century to the late 1970s with little growth from about 1980 to 2019: the real hourly compensation (in 1982-84 dollars) of these workers was \$11.07 in 1980 and, forty years later, \$11.60 in 2019, a compound annual growth rate of 0.12 per cent. The slow growth of the real wages of manufacturing production workers in the years from 1980 to 2019 may be seen as the culmination of a declining growth over the previous century: dividing the 122 years from 1898 to 2019 into three (approximate) 40 year periods , the compound annual growth rate of real wages was 2.64 % from 1898 to 1938, 2.32 % from 1939 to 1979, and 0.120% in the years from 1980 to 2019. [1]

Another feature of these wage movements is that their year-to-year volatility has declined over time. Evidence of this is presented in Table 1 in which the entire period from 1898 to 2019 is divided into 3 sub-periods of (approximately) 40 years each: from 1898 to 1937, from 1938 to 1979, and from 1980 to 2019. Within each 40 year period, the values of three indicators of volatility are reported: first is the coefficient of variation, that is, the standard deviation of the annual values of real wages divided by the mean value of wages in each period; second is the quartile deviation of the annual values of real wages [2] divided by the median; and third is the mean and median values of the variance of each year's residual from an estimated wage equation as reported beneath Table 1. All three indicators of real wage volatility suggest least volatility in the most recent period from 1980 to 2019. See Stock and Watson (2003) and the references there about the decline in volatility of many economic variables.

Changes in this manufacturing real wage will be approximately representative of the changes of many workers' wages, at least workers with a comparable bundle of attributes.

---

[1] The 40 year increase in the compound annual growth of real wages does not continue into the earlier years of the 19th century: from 1857 tp 1897 it was 1.64% and from 1816 to 1856 it was 2.05 %. All greater than the growth between 1980 and 2019.

[2] The quartile deviation (*QD*) is defined as ½ $(Q_U - Q_L)$ where Q_U is the value of real wages at the upper quartile (or 75th percentile) of the real wage distribution and Q_L is the value of real wages at the lower quartile (or 25th percentile) in each period.

Movements in Manufacturing Labor Productivity

Conventional labor demand and labor supply functions derived from familiar optimizing behavior imply a link between real wages and labor productivity. Hence, many would reason that shifts in these functions over time induced by technological change or by shocks from foreign trade and immigration will result in changes in real wages and a corresponding change in labor productivity and the labor input. Therefore, it is argued, changes in real wages will be associated with changes in labor productivity both when wages are rising and when they are falling. [3]

An example of the implicit orthodox reasoning 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 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 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 entire 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

[3] See Dunne *at al.*(2004) for a persuasive cross-section (across manufacturing workplaces) analysis of a link between wages and labor productivity in the 1980s.

$[G(X)]_t$ are calculated.

The eight pairs of values of $[G(W)]_t$ and $[G(X)]_t$ are presented in a scatter diagram in Figure 2.[4] The question being asked of this figure is: 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 2 is of a weak positive relationship: the simple correlation coefficient between $[G(W)]_t$ and $[G(X)]_t$ is + 0.374 that is not significantly larger than zero by the conventional criteria.

Recall that, in any given period, the calculation of the compound annual growth rate of a variable involves a comparison of the value of that variable in an initial year with the value at a terminal year. This may well provide useful information when the values of the variable display a clear and uniform trend in the intervening years. In circumstances when a clear and uniform trend is not apparent in these years, the use of compound annual growth rates is less meaningful. Information is now drawn from all the years.

To this end, Figure 3 graphs the annual observations of real wages and of labor productivity in manufacturing from 1897 to 2019. Although both series rise over time, their years of maximum growth are different: the years of fastest growth for real wages are from 1930 to 1944 whereas the fastest growth of labor productivity was between 1990 and 2004. Between 1898 and 2019, the two series reach their maximum values in different years: the maximum value of productivity is in the year 2011 whereas the maximum value of real wages is recorded in 2005. At these maximum values, productivity (in 2011) was18 times its value in 1898 whereas, at its maximum value, real wages (in 2005) were 8 times its value in 1898. Real wages rose considerably less than the increase

[4] The values of $[G(W)]_t$ and $[G(X)]_t$ in the bottom left corner of the figure correspond to the period from 2005 to 2019. All the values of $[G(W)]_t$ and $[G(X)]_t$ and other compound annual per cent growth rates are contained in Table 13.

in labor productivity.

Of particular note is the divergence at around 1980 after which there is little subsequent growth in real wages while productivity continues to rise to 2011. This may be easier to detect in Figure 4 which focuses on the years from 1970 to 2019. Much has been made on the divergence between the faster growth of labor productivity than of real wages since about 1980 and the consequent fall in the share of wages in total income. [5] However, this movement in productivity relative to real wages is by no means unprecedented: productivity grew more than real wages in the years from 1900 to 1914 while real wages grew more than productivity in the years from 1930 to 1944. 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.

To prepare for the analysis of annual values of real wages and of labor productivity, consider first the profit-maximizing employer's choice of the labor input when the labor market is competitive and the wage is predetermined with respect to the employer's decisions. The first-order condition for an optimum is when the marginal product of labor (MP_L) equals the real wage (w/p) or in (natural) logarithms $ln\,(w/p) = ln(MP_L)$ Converting this to a stochastic equation that allows for the equation to be applied to annual observations over time, t

$$(1) \qquad \Delta W_t = \kappa_1 + \beta_1 \Delta X_t + \varepsilon_{1t}$$

where W_t is the real wage in year t and ΔW_t means the per cent difference in real wages between two

[5] Suppose $S = (wL)/(pX)$ is labor's share of income. Taking logarithms, rearranging variables, and forming differences over time, $\Delta lnS = \Delta ln(w/p) - \Delta ln(X/L)$ from which it is evident that, in a competitive labor market, when labor productivity (X/L) increases more than real wages (w/p) , S will decline.

adjacent years, differences in natural logarithms being percentage differences. ΔX_t is the percent difference from one year to the next in output per worker-hour in manufacturing . Variables are expressed as rates of change because the change in real wages is a subject of this paper and also it reduces the possibility of drawing incorrect inferences from mutually correlated time trends in variables. ε_{1t} in equation (1) represents a residual in year t embodying the effects on ΔW_t of omitted variables and random errors in measuring real wages.

There are two problems with equation (1) as a characterization of the orthodox model in a competitive labor market. The first is that, according to conventional microeconomic theory, the relevant dimension of labor productivity is the marginal product of labor whereas, in equation (1), ΔX_t is the change in the average product of labor. Short of estimating a production function for manufacturing, movements in the average product are assumed to be positively correlated with movements in the unobserved marginal product of labor.

A second problem is that the real wage that results in a link with productivity is the money wage relative to the price of output whereas the W_t on the left-hand side of equation (1) has been deflated by the price of the goods bought by the worker. This is because, as expressed in the title of this paper, our interest is in the well-being of the worker. Using different language, according to the orthodox reasoning, it is the product wage that is relevant to the employer's employment decision, not the consumption wage. Because a satisfactory producer price index for all manufacturing to deflate nominal wages is unavailable over all the years of this analysis, movements in producer prices are assumed to be positively correlated with movements in consumer prices. In recent years, that correlation can be calculated and a high correlation does exist.[6]

Thus the two problems remain, but the "solutions" are within the boundaries of familiar assumptions in empirical economics.

The reasoning above that led to equation (1) rested on the assumption that the prototype firm faced a predetermined wage as is the case of the firm operating in a competitive labor market. Consider next the firm that operates in a non-competitive labor market and faces an upward-sloping (with respect the wage) labor supply function. In this (monopsonistic) setting, the net-revenue maximizing management have a choice to make about the wage to pay their employees. In this case, the labor input will be chosen such that the real wage will be a discounted value of the marginal product of labor and the first-order condition of a net-revenue maximizing firm may be written

$$w/p \;=\; (1 + \eta\,)^{-1}\, MP_L$$

where η is the elasticity of labor supply with respect to wages. Typically, real wages are less than the marginal product of labor and the link between the marginal product of labor and the real wage requires the supply elasticity to be held constant (unless productivity changes are orthogonal to changes in the supply elasticity). Forming natural logarithms of the monopsonist's first-order condition above and recognizing that differences in logarithms are percentage differences

$$(*) \qquad \Delta\, ln\, (w/p) \;=\; \Delta ln\, (MP_L\,) - \Delta \ln (1 + \eta)$$

where Δ indicates per cent changes and variables that affect the supply elasticity (perhaps the extent

[6] As a measure of changes in producer prices, suppose one uses the per cent annual change in the GDP implicit price deflator and, as a measure of changes in consumer prices, suppose one uses the per cent annual change of the personal consumption expenditure chain-type price index. In the 50 years from 1965 to 2015, the correlation coefficient between these two price changes is +0.93. The observations on the per cent changes in these two price indices may be found in Table B-3 (page 404) of the *Economic Report of the President* February 2016.

of unemployment and the wages paid by other firms) intrude between changes in real wages and changes in productivity. Preparing equation *(*)* for its application to annual observations over time , rewrite equation (*) as

$$(2) \quad \Delta W_t = \kappa_2 + \beta_2 \Delta X_t + \beta_3 U_t + \beta_4 N_t + \varepsilon_{2t}$$

where ΔW_t in equation (2) stands for $\Delta \ln (w/p)$ in equation (*) , where $\kappa_2 + \beta_2 \Delta X_t$ in equation (2) is the counterpart to $\Delta \ln (MP_L)$ in equation (*), and changes in the elasticity of labor supply with respect to wages $\Delta \ln (1 + \eta)$ are represented by the unemployment rate U_t and by a dichotomous variable, N_t, that is 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. The operation of these codes may have affected the elasticity of labor supply to these firms differently. ε_{2t} in equation (2) 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.

Evidence provided by Manning(2003), Yeh *et al.* (2022), and others suggest this monopsonistic setting should be considered the default case. In this event, when computing the link between changes in wages and changes in labor productivity, other variables should be held constant. Given uncertainty over the identity of these variables that need to be held constant, the presence of a stable positive relation between real wages and productivity should be treated as a hypothesis subject to empirical corroboration or refutation, not as something beyond examination.

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 estimates of equations (1) and (2) in the top two rows of Table 3 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. On the other hand, according to equations (2c) and (2d) in Table 3, a meaningful relationship between these two variables appears to exist in the years after 1938. Nevertheless, in each 40 year period, less than one-fifth of the variation in real wage changes is removed by changes in labor productivity alone. Moreover the implied effect of a typical increase in productivity on wage increases is small.[7]

Equations (2e) and (2f) of Table 3 combine the years from 1939 to 2019 and a positive association between increases in real wages and increases in labor productivity is confirmed although, again, there is ample room for other variables to contribute an explanation for the movements in real wages.

The NIRA codes are estimated to have raised real wages by 13 to 14 per cent in 1934.

Movements in Trade Unionism

Raising the wages of its members has been an explicit goal of trade unions since their formation. Unions have been concerned with real wages (that is, money wages adjusted for changes or differences in retail prices) as shown by the fact that national collective bargaining agreements often make a provision for differences in nominal wages according to differences in the cost-of-living across places and also that unions sometimes spend 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 a feature of union-negotiated contracts before the U.S.

[7] Consider a value of 2.5 per cent for ΔX_t (its mean value over all years) with no other changes. Equation (2c) implies the effect on ΔW_t is 0.082 per cent, less than one half of the mean value of ΔW_t.

Congress authorized them for Social Security benefits in 1972.[8] In all these cases, a union's proximate objective is higher money wages but the ultimate goal is higher real wages.

Does evidence exist to support the notion that trade unions in the U.S.A. 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 where union bargaining strength is indicated by variables that have demonstrated their association with union bargaining power in previous research. This is the time-series counterpart to the many cross-section investigations in which differences in wages among individual workers are related to differences in their union status.

Figure 5 graphs annual observations of total trade union membership as a per cent of non-agricultural employment from1897 to 2019, agricultural employment being a largely non-union sector with a number of sole proprietors, not employees. This series is often called "union density" and will be denoted by D^T_t. It starts the 20th century with 6.5 per cent of these workers who were union members.[7] With Federal government support, union density grew noticeably in the years of the First World War. In the 1920s, unionism languished (the "lean" years (Bernstein (1960)) when many employers operated schemes to obstruct union growth.

These included first "yellow dog contracts" according to which, as a condition of

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

[7] 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 ΔT_t and D^T_t and those used here is high. The correlation coefficient between the two series is 0.930 for ΔT_t and 0.966 for D^T_t .

employment, existing and newly hired workers swore never to join a union at the workplace (see Seidman (1932)) and, second, company unions (or shop committees) that gave employees the appearance of providing them with an agent but which were under the control of management (Douglas (1921)). Both yellow dog contracts and company unions were outlawed in the 1930s but they flourished in the 1920s. More generally, the growth of on-the-job benefits offered by employers to their workers in the 1920s under the guise of "welfare capitalism" served as devices to dilute the appeal to workers of unionism. [8]

Union membership contracted along with employment in the first half of the 1930s , but then rebounded in the more union-friendly legal environment of the late 1930s. Union density grew during the Second World War but, in the following decade. with an environment less favorable to unionism than the late 1930s [9], union density changed little[10] In the 70s, unionism exhibited signs of decline which became clear after 1979. Approximately, from the beginning of the 20th century, unionism trended upwards to mid-century, changed little for several decades, and then entered a period of contraction from which it may now be emerging.

Over all the years from 1897 to 2019, the mean union membership-employment ratio is 17

---

[8]Yellow dog contracts were forbidden (in the private sector) by the Norris-LaGuardia Act (the Anti-Injunction Bill) in 1932. Company unions were banned in 1935 by the National Labor Relations Act (the Wagner Act).

[9] This is illustrated by the Labor-Management Relations Act (or Taft-Hartley Act) of 1947 which modified provisions of the National Labor Relations Act (or Wagner Act) of 1935 that employers had criticized and "it contributed to the slower extension of unionism to new territory" (Rees 1989, p. 19). The Taft-Hartley Act denied unions of foremen the safeguards of the National Relations Act .

[10] Between 1946 and 1955, the average value of $D^T{}_t$ was 31.9 ranging from a low of 31.1 in 1946 to a high of 32.5 in 1953.

percent with a minimum of 3.6 per cent in 1897 and a maximum of 32.5 per 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. Well-known examples are the Davis-Bacon Act and the Walsh-Healey Act under which contractors with the Federal government are required to pay their workers "locally prevailing wages and fringe benefits" which usually means those set down in bargaining contracts negotiated by unions in the contractor's area. A number of U.S. states have similar regulations.

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. A famous example is Henry Ford who strongly disliked unions[11] and, in 1914, doubled the daily pay and reduced the length of the working day from 9 to 8 hours of his workers at a time when unions were successfully organizing workers in neighboring Ohio and when the unions had expressed their intent to organize workers in Michigan. The threat of being unionized induced Ford to raise the pay and reduce the length of the work day of his employees.

Another example is provided by McCormick and International Harvester whose Wisconsin Steel Works plant was non-union yet routinely the workers received wages and benefits equal to

---

[11] For instance, when a strike broke out at a firm supplying bodies to Ford's plant, Ford responded by sending some of his own employees to the struck firm to serve as strike-breakers. Ford paid bounties to those of his employees who supplied the names of fellow workers who expressed union-friendly statements and these union sympathizers were summarily dismissed. See Meyer (1981, Ch. 8).

those negotiated by the United Steel Workers of America in other plants. Ozanne (1968, p.74) writes that this "illustrates the very broad influence that even a small percentage of union members in the work force can have if the union movement is growing and constitutes a real threat [of organization] to other firms".

Many other cases are 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). At certain times and places, the wages and working hours of workers at unionised establishments have defined the standard that any employer valuing social approval would need to satisfy for his or her workers.

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".

Lewis (1963, pp.23-4) conjectured the "threat effect" of a non-union employer becoming unionized is more likely to operate when "unions have threatened to organize the establishments of the non-union employers and have recently demonstrated their capacity to carry out their threats by organizing comparable establishments". Lewis (1963, pp. 212-3) provided evidence supporting the implication that the effects of unionism are greater when unions are growing and Hines (1964) for the U.K. and Ashenfelter *et al.* (1972) for the U.S. supplied more evidence.

These researchers used two indicators of trade union bargaining strength: the per cent of all employed workers who are members of trade unions, D^T_t, whose movements in the U.S. are shown in Figure 5; and the percentage growth of aggregate trade union membership in a given year over the previous year, ΔT_t. The course of ΔT_t from 1898 to 2019 is drawn in Figure 6 . These two variables will be used to indicate the bargaining strength of unions in the empirical analysis below: the bargaining strength of unions is conjectured to be high when ΔT_t is positive and when D^T_t is relatively high. Ashenfelter *et al.* (1972) and Bernanke (1986) used the incidence of strikes as an indicator of trade union bargaining power. Annual observations on workers involved in (or working days "lost") owing to disputes do not go back as far as the late 19th century.

The final two columns of Table 2 provide descriptive statistics on ΔT_t and D^T_t in the years from 1898 to 2019. Note the remarkable range of values for ΔT_t : as also shown in Figure 6, the minimum value of ΔT_t was -14.5 per cent recorded in the year 1922 during the sharp contraction that followed the First World War while the maximum value of 37.8 per cent occurred in 1937 as the economy recovered from the deep slump in the early 1930s and when the enactment of the National Labor Relations Act of 1935 facilitated the growth of unionism. Evidently there is a cyclical component in ΔT_t, tending to be positive in business expansions and negative in contractions.

Note that whereas real wages are defined for the manufacturing production workers, the union membership observations cover workers in all industries. A reason for this is that observations on union membership restricted to manufacturing are not available until 1973 when the Current Population Survey added a union membership question. (These observations will be considered below.) Moreover, the threat effects of unions on non-union wages are not restricted to workers in the same industry.

When considering unionism, the labor market model underlying the empirical research below is one in which the managers of workplaces (or of several workplaces) representing the owners and the leaders of the union (or unions) representing the workers bargain over hourly wages (w) and over hours per worker (H) and, once these have been set, the managers are left to determine the levels of raw materials and capital. Formally, if the union's objectives are embedded in a well-behaved function $V = g\,(w, H)$ and the objectives of the firm are profits $\Pi = p.f(H) - w\,H$, then Nash-type bargaining involves a class of outcomes for w and H that maximize

$$\Omega(w, H) = (V_t - V^*)^\theta\,(\Pi_t - \Pi^*)^{1-\theta}$$

where the asterisks denote fixed threat points or security levels for each party. θ is the union's relative bargaining power such that $0 \leq \theta \leq 1$. When the union has greater bargaining power, the wage and hours outcomes are closer to the union's preferences than at times when union bargaining power is lower.[12] The task for empirical research is to identify observable counterparts for θ. As stated above, in this paper, changes in union membership and the level of union density are used to indicate variations in θ.

Among unionised establishments, wage increases secured in one sector tend to become the standard by which other unionised workers gauge the performance of their leaders who are pressed to seek similar increases. In this way, wage gains in one group of firms are spread throughout unionised workplaces.

Now consider whether movements in trade union bargaining power as measured by ΔT_t and D^T_t can improve the description of real wage movements reported above. To this end, analogous to equation (1), start with the simple specification

[12] Booth and Ravallion (1993) present several models in this genre.

$$(3) \qquad \Delta W_t = \kappa_3 + \mu_1 \Delta T_t + \mu_2 D^T_t + \varepsilon_{3t} \; .$$

When trade union bargaining power is high as indicated by positive values of ΔT_t and by relatively high union density, μ_1 and μ_2 in equation (3) are conjectured to be positive. If one of the estimated μ coefficients is positive and the other μ coefficient is negative, inferences about the effect of unionism on changes in real wages will depend on the relative magnitudes of the coefficients and on the values of ΔT_t and D^T_t.

Of course, there is a distinction between the effects on wages of ΔT_t and the effects of D^T_t : ΔT_t is the effect of union growth or decline at *t* and is expected to have a positive effect on wages when unionism is expanding; D^T_t measures the minimum coverage of union-negotiated wages and hours at *t* and is used in cross-section industry studies of unionism such as those reviewed by Lewis (1963, Chapter 3). [13]

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

$$(4) \qquad \Delta W_t = \kappa_4 + \alpha_1 \Delta T_t + \alpha_2 D^T_t + \gamma_1 U_t + \gamma_2 \Delta X_t + \gamma_3 N_t + \varepsilon_{4t} \, ,$$

where, as above, U_t is the per cent unemployment rate in year *t* , ΔX_t is the per cent change of manufacturing labor productivity in year *t* over the previous year, and 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. ε_{3t} and ε_{4t} are residuals in year *t* containing the consequences for ΔW_t of omitted

[13] D^T_t measures the minimum coverage because there are workers in unionized workplaces who are covered by the provisions of collective bargaining contracts and yet are not union members. Lewis (1973, p. 260) estimated that in manufacturing in 1958 the coverage of collective bargaining agreements covered four percentage points more workers than the membership-employment percentage. In 1977, the gap between the coverage per cent and the membership rate in manufacturing was 2.1 percentage points.

variables and random errors in measuring ΔW_t .

The least-squares estimates of equations (3) and (4) fitted to the observations on real wage changes, union membership, and the other variables over the years from 1898 to 2019 are reported as equations (3a) and (4a) of Table 4. In equation (3a), the coefficient estimates attached to ΔT_t and D^T_t are positive and an F-test indicates rejection of the null hypothesis that they are jointly uncorrelated with the growth of real wages. The value of the calculated F statistic is given by $F^\wedge$ in Table 4. The coefficient estimates attached to the variables ΔT_t and $D^T{}_t$ in equations (3a) and (4a) are remarkably similar implying ΔT_t and $D^T{}_t$ are each weakly correlated with U_t, ΔX_t, and N_t and, indeed, this appears to be the case.[14]

The least-squares estimates of μ_1 and μ_2 in equation (3a), call them m_1 and m_2 respectively, together with the values of ΔT_t and D^T_t in each year are used to construct an index of the bargaining power of trade unions over wages , $B^w{}_t = m_1 \Delta T_t + m_2 D^T{}_t$. An order-preserving positive linear transformation of $B^w{}_t$ converts this into an index that lies between zero and unity as was θ above. Call this observed index Θ_t , annual values of which are drawn in Figure 7 .[15] As Θ_t is a linear combination of T_t and $D^T{}_t$ and given the estimates attached to T_t and $D^T{}_t$ in Table 4, it is not surprising that the association between ΔW_t and Θ_t is significantly greater than zero and, indeed, it implies that a 1% increase in Θ_t is associated with a 0.7 per cent increase in ΔW_t .

---

[14] The regression of ΔT_t on U_t, ΔX_t, and N_t using observations from 1898 to 2019 yields an R^2 value of 0.060. An analogous regression in which $D^T{}_t$ is the left-hand side variable generates an R^2 of 0.016.

[15] The positive linear transformation is $\Theta_t = 0.126 + (0.14)\, B^w{}_t$. If the estimates of α_1 and α_2 are used to construct the index of union bargaining power, the resulting values are close to those drawn in Figure 7 reflecting the similarity of the estimated coefficients on ΔT_t and $D^T{}_t$ in equations (3a) and (4a) .

The maximum value of Θ_t (of 0.95) is in the year 1937, shortly after the National Labor Relations Act specified legal procedures for determining the union status of a workplace, and when the percent growth in trade union membership was 37.8, trade union density was 18 per cent, and the percent growth in real wages was 10.5 (at a time when the unemployment rate was 14.3 per cent).

The minimum value of Θ_t (of 0.025) is recorded in two years: in 1922 when ΔT was -14.5 per cent and $D^T{}_t$ was 12 per cent and in 2009 when ΔT was -9.9 per cent and $D^T{}_t$ was 7.2 per cent In all the years from 1898 to 2019, the mean value of Θ_t is 0.36 but there is a discontinuity in 1979-80: the average value of Θ_t during the years from 1898 to 1979 is 0.431 and the average value of Θ_t from 1980 to 2019 is 0.206 implying the bargaining power of unions over wages was relatively weak in the years from 1980 to 2019.

According to equation (4a) of Table 4, at the mean values of ΔT_t (3.05 per cent) and of $D^T{}_t$ (17.0 per cent), the implied value of ΔW_t is 1.64 per cent which is more than ninety per cent of the actual mean value of ΔW_t.[16] : the real wage implied by the mean values of the trade union variables is close to the actual mean real wage .

In addition, according to equation (4a), applying conventional standards of statistical significance, changes in labor productivity now appear to be positively related to changes in real wages for the entire period from 1898 to 2019: a one percent growth in productivity is associated with a one-tenth per cent increase in real wages other things equal. One-third of the observed variation in real wages between 1898 and 2019 is removed by the linear combination of the

---

[16] This simulation sets $\Delta X_t = N_t = 0$ and sets U_t to 22.8. Given the estimated coefficient on U_t in equation (4a), namely, 0.015, at 22.8, the unemployment rate exactly offsets the value of the intercept (-0.342).

variables that include both trade unionism and labor productivity.

Real wages show little movement over the business cycle (as inferred from the estimated coefficient on U_t). The application of the codes of the National Recovery Act is associated with a 12 percent increase in the real wages of these workers in 1934.

It was observed above that annual per cent changes in trade union membership assumed some large (positive and negative) values over these years. As outliers can be very influential in least-squares, a trimmed set of observations was defined; this trimmed set omits the four years in which ΔT_t and D^T_t assumed their minimum and their maximum values. These omitted years are 1898, 1922, 1937, and 1953. Equation (4b) of Table 4 provides the least-squares estimates of equation (4) fitted to the trimmed set of 118 annual observations. Although the estimated coefficients in equation (4b) on the trade union bargaining variables are attenuated compared with those in equation (4a), they remain significantly greater than zero on a joint *F* test.

The inference that the bargaining power of unions over real wages was relatively weak in the years from 1980 to 2019 derived from an equation whose parameters were determined using observations from 1898 to 2019. If this inference of weak union bargaining power from 1980 to 2019 is correct, it might be revealed in an entirely different regime in the years from 1980 to 2019. Therefore, observations in the years from 1898 to 2019 were split into two periods : one from 1898 to1979 and the other from 1980 to 2019 and equation (4) was estimated using observations on each period separately. Descriptive statistics on the variables for these two periods are given in Table 5 from which it is evident that, when unionism was stronger (from 1898 to1979), real wages were growing; when unionism was shrinking (from 1980 to 2019), real wages were either declining (according to the median value for this period) or rising little (according to the arithmetic mean).

The consequences of fitting equation (4) to the years 1898-1979 and 1980-2019 separately are given by equations (4c) and (4d) of Table 4. With respect to the implied effects of unionism on changes in real wages, the inferences from equation (4c) are similar (though held with less confidence) to those drawn from equation (4a). In particular the null hypothesis that the estimated coefficients on the union membership variables are jointly zero may be rejected at conventional levels of significance.[17]

However, equation (4d) of Table 4 fitted to the 40 years from 1980 to 2019 is quite different from equation (4a) : during these years from 1980 to 2019, the estimated coefficients on the trade union variables in equation (4d) are jointly not significantly different from zero.

As already noted, the period from 1980 to 2019 is one in which the real wages of these workers changed little: the wages in the five years from1980 to 1984 averaged \$11.17 (in 1982-84 dollars); they averaged \$11.74 in the five years from 2015 to 2019. Is it a coincidence that, 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 the 2015-19 years? When unionism diminished, real wages languished.

In the regression equations reported to this point, the trade union variables, ΔT_t and D^T_t, describe union membership in the entire economy. The wage variable relates to manufacturing production workers. From the year 1973 when the Current Population Survey added union membership questions, it is possible to isolate union membership among manufacturing workers. To determine if inferences about the ineffectiveness of unionism for real wages in the 1980-2019 period are altered by restricting ΔT_t and D^T_t to union membership among manufacturing workers,

[17] A variable measuring changes in the Federal Minimum Wage was added to the right-hand side of equation (4) and the equation was estimated to the years from 1939 to 2019. No statistically significant association with the changes in the real wages of manufacturing workers was found.

equation (4) was estimated to the observations in these years with manufacturing unionism replacing the economy-wide union figures. The consequences are shown in equation (4e) in Table 4 from which it appears that the inferences about the unimportance of unionism for real wage growth during these years are unaffected by the use of union membership among manufacturing workers.[18]

Return to the eight sub-periods of 15 years each and, analogous to Figure 2, 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 $[G(D)]_t$. as shown in Figure 8 : Are periods when the rate of growth of union density high also periods when the growth of real wages relatively high? In this case, 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.

II. CHANGES IN HOURS PER WORKER

<u>Movements in Hours</u>

In 1830, a typical production worker in U.S. manufacturing worked a little over 11 hours per day (Officer, (2009) TableA.5) and approximately 75 hours per week (Lester(1946, p. 344) . Subsequently, these weekly hours trended downwards to 55 hours in 1900 (Jones (1963)) . Many workers reached an eight hour day by 1920 (Whaples (1990)) .

As shown in Figure 9, the 19th century decline in working hours continued into the first decades of the 20th century with further reductions in the first half of the 1930s when the precipitous drop in the demand for labor that defined the Great Depression was expressed in cuts both to

---

[18]The correlation coefficients between the aggregate values of ΔT_t and D^{Tt} and the manufacturing-specific values of ΔT_t and D^{T}_{t} for the years from 1980 to 2019 are 0.805 and 0.994, respectively.

employment and to hours per worker. To these forces were added the "codes of fair competition" of the National Industrial Recovery Act that mandated shorter working hours in manufacturing. Thus, over the years from 1934 to 1940, weekly hours averaged 37 hours - about one-half of those a century earlier. There was a small rise in weekly hours during the Second World War, after which hours returned approximately to their pre-war level.[19]

In the many investigations that use cross-section or panel observations investigating differences in hours of work among individuals, considerable interest has been directed to differences in the hourly wage (sometimes adjusted for income taxes) of workers. Writing in the mid-1950s, Lewis (1957) applied this perspective to the decline in hours "in the last half century". He assumed that labor supply functions were "very stable" and that economic growth caused the demand for labor to rise and, in turn, for wages to increase. Workers responded to this rise in wages by working fewer hours. In other words, the labor supply of hours curve was negatively-sloped with respect to wages; the income effect dominated the substitution effect of a wage increase. This reasoning calls for the inclusion of real wages in accounting for movements in hours of work.

At about the same time as Lewis was writing this, other scholars claimed that the principal factors in the decline of hours from the mid-nineteenth century up to the time of their writing were trade unions. For instance, Lester (1946, pp.245-7) attributed the fall in hours of workers in the bituminous coal, construction, and clothing industries to "the strength of the labor unions" while Reynolds (1954, p.249) wrote "....the initiative for hours reduction came from the trade-unions, not the employers. Almost from their formation, unions began to agitate for reduction of the workday and work week." Reynolds (1954. P. 252) went on to write, "It seems likely that weekly hours will

---

[19] Precisely, weekly hours averaged 39 from 1946 to 1949. They were 37 in 1936-39.

continue to fall during the next two or three decades, and the end of the process is not yet in sight".

Thus there are at least two proposed explanations for the decline in hours per worker up to the late 1930s: the rise in real wages induced workers to supply fewer hours ; and trade unions bargained for shorter hours and overcame employers' opposition to these shorter hours. However, this decline did not continue and Reynold's conjecture of further reductions in hours was not confirmed: there was little change in the weekly hours of manufacturing workers for the next 65 years.[20] From the end of the Second World War to 2019 the weekly hours of these workers have changed little: all of the 74 annual values of hours from 1946 to 2019 fall within 2½ hours of 40. As columns *(v)* and *(vi)* of Table 6 indicate, the concentration around 40 hours is a feature both of the years from 1946 to 1979 and of the period from 1980 to 2019. They constitute a distinct break from the negative movement that hours followed from the mid-19th century to the 1930s.

If a line is drawn through the scatter of annual observations on weekly hours since 1946 in Figure 10, a positive trend is implied according to which hours increased by two weekly hours from 1946 to 2019; this is not a steep positive trend and one easily overlooked, but it is a distinct difference from the negative trend in hours over the previous century. This positive trend in hours since 1946 is slightly higher in the 1980-2019 years than that in the 1946-79 years.

Another feature of hours of work is that, as shown in Table 7, of the approximately three 40 year periods, weekly hours tended to be least volatile in the 1980-2019 years, a property shared with real wages (in Table 1).

---

[20] In the three years 1953, 1954, and 1955 when Reynolds was writing these words , the weekly hours of these manufacturing production workers averaged 40.5. In the three years 2017, 2018, and 2019, their hours averaged 41.9.

An obvious explanation for the end of the decline in hours is that, to discourage long hours, the Fair Labor Standards Act (after amendment in 1940) created for employers of workers covered by the Act a sharp increase in their labor costs after 40 weekly hours and, unlike earlier years, unions were not strong enough to overcome employers' preferences for 40 hours. Unionism's relative weakness is indicated by the decline in D^T_t; although ΔT_t was positive in 22 of the 33 years from 1946 to 1978, total non-agricultural employment (the denominator of D^T_t) grew faster than union membership so that trade union density in 1978 (at 21.1 per cent) was ten percentage points below that in 1946 (at 31.1 per cent). Unionism was showing signs of weakness in the years from the end of the Second World War to the late 1970s.

Further, after 1979, when their real hourly wages stagnated, these workers found overtime hours a relatively attractive means to bolster their take-home earnings and this incentive to work longer hours resulted in union officials being called upon by their members to settle disputes among workers over who was to have the opportunity of working overtime hours.[21]

Given this influential role attributed to the Fair Labor Standards Act, it might be informative to quantify this and to examine the competing explanations for changes in hours of work, consider the following regression equation:

$$(5) \quad \Delta H_t = \kappa_5 + \lambda_1 \Delta T_t + \lambda_2 D^T_t + \rho_1 \Delta W_t + \rho_2 \Delta E_t + \delta_1 (FLSA)_t + \delta_2 N_t + \varepsilon_{5t}$$

The annual per cent change in weekly work hours per worker in year t is ΔH_t. As before, ΔT_t is

[21] See Reder (1957). The 40 hour work week has become the norm not only for manufacturing production workers. According to the 2021 Current Population Survey, 48.5 per cent of all wage and salary workers report usually working exactly 40 hours: https://www.bls.gov/cps/cpsant .

the per cent change in trade union membership in year t over the previous year, D^T_t is the membership of trade unions as a per cent of non-agricultural employment in year t, ΔW_t is the per cent change in the real hourly compensation of manufacturing workers in year t , and N_t is the dichotomous variable for the year 1934 to account for the application of the National Recovery Act's codes that stipulated a reduction in hours of work.

$(FLSA)_t$ is another dichotomous variable in equation (5) : it takes the value of unity in 1938 when the Fair Labor Standards Act came into effect and in all subsequent years when the Department of Labor was charged with enforcing the Act.[22] When estimated to the annual observations from 1901 to 2019, the $(FLSA)_t$ variable takes the value of zero in all years before 1938. The estimate of δ_1 measures the difference between the annual per cent change in hours during the years from 1938 to 2019 and the per cent change in hours in the years from 1901 to 1937.

To account for cyclical movements in hours, equation (5) includes ΔE_t, the per cent annual change in the employment of manufacturing production workers in year t .[23] Insofar as cyclical changes in the demand for labor are reflected in the use of the input of labor, both employment and hours per worker will be affected in which case ρ_2 will be positive.

The presence of ΔW_t in equation (5) recognises Lewis' argument described earlier. If it applies to these observations, then ρ_1 will be negative. Increases in property income would reinforce

---

[22] At least in the 1970s, non-compliance with the overtime pay regulations was "a non-trivial problem" (Ehrenberg and Schumann 1982). In 1943, 94 percent of employees in manufacturing were covered by the provisions of the FLSA (Weiss (1944), p. 463)

[23] This cyclical indicator is preferred to the unemployment rate (which was used as the cyclical indicator for describing the movement in real wages above), because ΔE_t relates to the same manufacturing workers as those specified for ΔH_t . However, annual values of the employment of manufacturing production workers are not available before 1900 and, therefore, it could not be used for the real wage regressions that went back to 1898.

this preference for shorter hours, but annual observations over these years on the nonlabor income of manufacturing workers are unavailable.

Descriptive statistics on the variables in equation (5) for the years from 1901 to 2019 are provided in Table 8 and least-squares estimates of equation (5) fitted to these years are given as equation (5a) in Table 9.[24] The positive coefficient attached to $(FLSA)_t$ in equation (5a) implies that work hours increased by a little more than one per cent per year more in the years when the Fair Labor Standards Act was in operation than in the years before it came into effect. This is consistent with the interpretation of the scatter diagram in Figure 10 of a mild upward trend in hours between 1946 and 2019 and the decline in hours from 1900 to the mid-1930s. The passage of the Fair Labor Standards Act marks the end of the reductions in the hours worked by the typical manufacturing production worker.[25]

According to equation (5a), movements in employment co-vary positively with movements in hours, consistent with the notion that changes in the demand for labor are reflected both in movements in employment and in weekly hours of work per worker. Both of the trade union bargaining variables in equation (5a) exert a negative influence on hours and the value of the F^ statistic testing the null hypothesis that unionism (in the form of the estimated coefficients on ΔT_t and D^T_t) did not contribute to the reduction in hours is rejected.

---

[24] Note the difference between the period of fit of the equations describing movements in real wages and the period of fit of the equations describing changes in hours of work. This is because accurate annual information of the average weekly hours of work of these workers are unavailable before 1900 so equation (5) cannot be estimated back to 1898 as are the real wage equations.

[25] The minimum value of weekly hours in the 20th century for these workers is 34.4 in 1934,the year in which the National Industrial Recovery Act required a reduction in hours, but the hours in 1938 when the FLSA was passed was close to this at 35 hours.

This inference remains when equation (5) is fitted to a trimmed set of observations, trimmed by omitting the four years in which the maximum and minimum values of ΔT_t and D^T_t are registered . This is shown by equation (5b) in Table 9 under "trimmed". In equation (5b) the effects of $(\Delta E)_t$ and the dichotomous non-market variables, $(FLSA)_t$ and N_t remain relevant in describing the changes in hours.

Equation (5a) is the result of fitting equation (5) to all the observations from 1901 to 2019 and yet the narrative above concerning the Fair Labor Standards Act suggested the environment for the determination of hours of work was different in the years before the passage of the Act from the years when the Act was in effect. The equations listed as (5c) , (5d), (5e), and (5f) in Table 9 report the consequences of estimating equation (5) to four sub-periods: from 1901 to 1919; from 1920 to 1937; from 1938 to 1979; and from 1980 to 2019.

From 1901 to 1919

As Whaples (1990, p.393) observed of these years, "workers' demands for shorter hours were often advanced with greater fervor than demands for higher wages. The shorter-hours movement galvanized organized labor. It was the spark that helped found the first national labor union in the 1860s and the American Federation of Labor in the 1880s, the major issue in the steel strike of 1919, and remained important into the 1930s."

Equation (5c) fitted to the 1901-1919 period delivers the least ambiguous results of the equations in Table 9 : these were years during which average weekly hours fell from 55 to 46 hours,[26] union density doubled (from 7.8 per cent in 1901 to15.7 per cent in 1919), and real wages

[26] Whaples (1990, p.394)uses information from the Census of Manufacturing in 1909 and 1919 to show that , "In 1909 less than one-twelfth of American manufacturing workers labored 48 hours or less each week (eight hours per day, six days per week); in 1919 nearly half did."

in 1919 were almost one-and-a-half times their level in 1901. At the same time, the employment of these manufacturing production workers was growing: their employment in 1919 was over eighty per cent greater than it was in 1901.

1920-1937

After 1919 and for much of the subsequent two decades trade unions were on the defensive: in most of the years the years of the 1920s and 1930s, trade union density was below that in 1919 until after the National Labor Relations Act in 1935. As mentioned above, employers used management-controlled company unions and signed commitments of workers (yellow dog contracts) to obstruct the unionization of their workers. In addition the severe contraction of the economy in the first half of the 1930s with the accompanying decline in the demand for labor caused not only deep cuts in employment but also reductions in hours of work.

These forces are evident in the estimates of equation (5d) of Table 9, In that equation, the codes of the National Industrial Recovery Act reduced hours by about nine percent, a value apparent in the observations themselves.[27] According to the equations whose estimates are reported in Table 9, in the years from 1920 to 1937, the null hypothesis that the two trade union indicators exert no influence on movements in the hours of work of these workers cannot be rejected according to conventional criteria . The estimates for the years from 1920 to 1937 support Lewis' argument that increases in real wages tend to reduce hours and real wages were higher in 1937 than they were in 1920. This was the only period during which changes in hours conform to Lewis' reasoning.

Consider the eight 15 year periods between 1900 and 2019 and determine whether periods during which the per cent change in wages is high are also periods when the per cent decline in hours

[27] Average weekly hours were 37.6 in 1933 and 34.4 in 1934: [(34.4-37.6)/37.6] 100 = -8.51 %.

is high. The scatter diagram relating the compound annual change in hours $[G(H)]_t$ to the compound annual change in real wages $[G(W)]_t$ is Figure 11. The correlation coefficient between $[G(H)]_t$ and $[G(W)]_t$ is -0.274 and not significantly different from zero.

Analogously, relate the per cent compound annual change change in hours $[G(H)]_t$ to the per cent compound change in union density $[G(D)]_t$ as in Figure 12, The correlation coefficient between $[G(H)]_t$ and $[G(D)]_t$ is -0.485 but not significantly different from zero. The values of $G(H)_t$ and $G(D)_t$ in the top right-hand corner of Figure 8 correspond to the 15 year period from 1930 to 1944. If this pair of observations of $G(H)_t$ and $G(D)_t$ is omitted, the resulting correlation coefficient is -0.931 which is significantly less than less than zero.[28]

III. CONCLUSIONS

From the perspective provided by history, using information provided by two components of his well-being, the typical American manufacturing production worker's 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 improved has diminished over time: the real value of his hourly compensation has risen trivially over the last forty years while his time at work stopped falling eighty years ago and, indeed, has risen a little since then. These changes are summarized in Table 12. The values of the percent compound annual changes in the 15 year periods between 1900 and 2019 are given in Table 13; they constitute the entries to the scatter diagrams in Figures 2, 8, 11, and 12.

---

[28] Considering variations in both $[G(W)]_t$ and $[G(D)]_t$ together in a regression accounting for variations in $[G(H)]_t$ does not alter these conclusions.

Of course, manufacturing is far from being the entire economy and it has experienced a well-known contraction in recent decades. (See the values of $G(E)_t$, the per cent annual compound change in the employment of manufacturing workers in Table 13.) This contraction is not unprecedented: the relative decline in the employment of these workers from 1980 to 2019 has been 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 . Trade union density was rising in the early 1930s; it was falling between 1980 and 2019.[29]

A purpose of this paper has been to investigate the correlates of changes in real wages and changes in weekly hours. In the case of wages, taking the period from 1898 to 2019 as a whole, movements in labor productivity in manufacturing industry by themselves are not highly correlated with movements in real wages both when examining annual observations and when constructing compound annual growth rates of fifteen years each. [30] A meaningful association was revealed since 1939 although, even in these years, only a small fraction of the variance in real wages was removed by movements in productivity. This was unexpected in view of the widespread belief and almost

---

[29]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.

[30] In addition, the observations from 1900 to 2019 were divided into 24 groups of five non-overlapping years and the arithmetic mean values of ΔW_t , ΔX_t , ΔT_t , and D^T_t were calculated within each group. When pooling all 24 values of these variables, the links between the change in real wages and the other variables were the same as those reported using the other methods of organizing the observations.

exclusive attention to labor productivity to account for real wage increases.

The weak link estimated here between changes in real wages and changes in labor productivity finds some support in Dew-Becker and Gordon's (2005) analysis of the growth of incomes and of productivity from 1954 to 2005. Their focus is not on manufacturing but on the non-farm private business sector, but they also find at times a mis-match between the growth in real incomes and the growth in productivity. Although they refer to the weakness of trade unions in recent decades, they suggest that measures of the growth in median real incomes overlook the increase in income inequality and especially the increasing skewness of the income distribution. Essentially much of the increase in income has been enjoyed by a very small fraction of income-earners.

This paper has suggested that, if the typical firm does 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 that trade union bargaining power can exploit this. A few economists in the past alluded to this. For example, 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, however, is not unique since a great many other factors affect wage movements among industries". This has been confirmed here and trade unionism appears to be one of those other factors.

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 trade unionism. Moreover, when indicators of trade union bargaining power were held constant, a positive association between labor productivity and real wages became more discernible for the entire period.

One possible interpretation of this is that an increase in labor productivity was not sufficient to raise wages; a necessary condition for an increase in productivity to translate into an increase in real wages was for trade unions to be an actual or virtual pressure on management. When unionism was less of a force (as in the years since 1980) a gap appears between the growth of wages and the growth in labor productivity. This result implies that, in the first half of the 20th century, movements of manufacturing production workers' income as a share of total income in manufacturing will be associated with the bargaining power of trade unions. This is an eminently testable proposition.

In the case of working hours, with little assistance from statutory legislation before the 1930s[31] and principally through the agitation of workers and their agents, trade unions, and in the face of the resolute opposition of employers, the work hours of manufacturing production workers fell from an average of 55 hours in 1900 to 35 hours in 1938. These reductions were amplified by the implosion of demand in the 1930s. After 1938, in the subsequent 38 years, the average weekly hours of these workers rose from 35 hours to 40.2 hours in 1974 . By 2018- 2019 they had risen further to 41.9 hours.

A consistent finding is that hours tend to lengthen in a boom and fall in a business contraction (whether or not real wages are held constant) indicating that movements in hours are

[31] In the 19th century, some states introduced regulations on the market hours of work of women although often without setting aside resources to enforce them (Cahill (1932, p. 96). In 1892, the U.S. Congress stipulated that "all laborers and mechanics" employed by the Federal government and its contractors work no more than eight hours per day. Again, lack of enforcement became an issue. The Adamson Act of 1916 defined the standard work day of railroad employees engaged in inter-state commerce. Until the National Industrial Recovery Act and then the Fair Labor Standards Act, most manufacturing workers are believed to have been untouched by statutory legislation.

partly driven by variations in the demand for labor. This is not at all surprising but the role of the demand for hours is often ignored in the cross-section studies.[32] For these manufacturing workers, changes in wages bear a small and inconsistently-signed association with changes in hours.

The Federal government played an important role in these changes. The National Industrial Recovery Act's mandates had an immediate effect on both real wages and on hours although, in retrospect, the Act's effect on hours can be seen as a continuation of the path that hours had followed since the mid-19th century. The NIRA's impact on real wages is clearly visible but, again, real wages had been rising before the Act and they rose further after the Act.

The overtime wage premium contained in the Fair Labor Standards Act has resulted in a remarkable concentration on 40 hours in the distribution of hours of work. This may have created a focal point around which employers could silently collude and abstain from competing with one another, much as has been suggested regarding the Federal minimum wage (Shelkova (2015)).

Above all, the National Labor Relations Act of 1935 gave a boost to unionism which, in turn, affected both wages and hours of work. Of course, the Act did not come out of the blue and was the product of "the grievances of employees and their loss of faith in business leadership" (Freeman 1967, pp.279-80).

In none of the estimated equations in which the dependent variable is the change in real wages does the estimated combination of right-hand side variables remove more than one-half of the variation in real wages. There is much more to be learned about the movements in the real wages of these workers. Similarly, there is much room for other variables to account for changes in weekly

---

[32] Bry (1959) reported this association and the tendency for movements in hours to precede movements in employment.

hours of work since the beginning of the 20th century.

REFERENCES

Ashenfelter, Orley, "Comparing Real Wage Rates", *American Economic Review* 102(2), April 2012 :617-642

Ashenfelter, O.C., G.E. Johnson, and J.H.Pencavel , "Trade Unions and the Rate of Change of Money Wages in United States Manufacturing Industry" , *Review of Economic Studies* 39(1) January 1972:27-54

Bernanke, Ben S. "Employment, Hours, and Earnings in the Depression: An Analysis of Eight Manufacturing Industries" *American Economic Review* 76(1), March 1986:82-109

Bernstein, Irving, *The Lean Years: A History of the American Worker 1920-1933*, Houghton Mifflin, Cambridge, Mass. 1960

Booth, Alison and Martin Ravallion, "Employment and the Length of the Working Week in a Unionized Economy in which Hours of Work Influence Productivity" *Economic Record* 69 (207), December 1993 : 428-36

Bry, Gerhard "The Average Workweek as an Economic Indicator", National Bureau of Economic Research Occasional Paper no.69, 1959

Cahill, Marion, *Shorter Hours: A Study of the Movement since the Civil War*, Columbia University Press,, London 1932

Devine, Janice M., "Cost-of-Living Clauses: Trends and Current Characteristics" *Compensation and Working Conditions,* U.S. Bureau of Labor Statistics December 1996.

Dew-Becker, Ian and Robert J. Gordon, “Where Did the Productivity Growth Go? Inflation Dynamics and the Distribution of Income”, *Brookings Papers on Economic Activity*, 2, 2005: 67-127

Douglas Paul H.”Shop Committees: Substitute for, or Supplement to, Trades-Unions?”*Journal of Political Economy* 29(2) 1921 : 89-107

Douglas, Paul H., *Real Wages in the United States, 1890-1926* Boston,: Houghton Mifflin, 1930

Dunlop, John T. “Productivity and the Wage Structure” *Income, Employment, and Public Policy: Essays in Honor of Alvin H. Hansen*, W.W. Norton & Compnay, 1948, pp. 341-62

Dunne, Timothy, Lucia Foster, John Haltiwanger, and Kenneth R. Troske, “Wage and Productivity Dispersion in United States Manufacturing” *Journal of Labor Economics* 22(2) April2004:397-429

Ehrenberg, Ronald G. and Paul L. Schumann, “Compliance with the Overtime Pay Provisions of the Fair Labor Standards Act”, *The Journal of Law and Economics* 25(1) April 1982: 159-181

Freeman, Richard B., “Spurts in Union Growth: Defining Moments and Social Processes” in Michael Bordo, Claudia Golden, and Eugene White eds., *The Defining Moment: The Great Depression and the American Economy in the Twentieth Century* , Univ. of Chicago Press 1997 : 265-95

Friedman, Gerald. “U.S. Historical Statistics: New Estimates of Union Membership the United States, 1880-1914" *Historical Statistics: A Journal of Quantitative and Interdisciplinary History* 32(2), Spring 1999:75-85

Gordon, Robert J. and Hassan Sayed, “A New Interpretation of Productivity Growth Dynamics in the Pre-Pandemic and Pandemic Era U.S. Economy, 1950-2022, National Bureau of Economic Research, Working Paper 30267, July 2022

Hines, A.G., “Trade Unions and Wage Inflation in the United Kingdom 1893-1961, *Review of Economic Studies*, 31(4) October 1964: 221-52

Hirsch, Barry, and David Macpherson, Union Membership and Coverage Database from the CPS, https:///.unionstats.com , 2021

Jacoby, Sanford *Employing Bureaucracy : Managers, Unions, and the Transformation of Work in American Industry, 1900-1945* Columbia University Press, New York, 1985

Jones, Ethel B. “New Estimates of Hours of Work per Week and Hourly earnings, 1900-1957" *Review of Economics and Statistics* 45(4) November 1963: 374-85

Lebergott, Stanley *Manpower in Economic Growth: The American Record since 1800* McGraw Hill, New York 1964

Lester, Richard A. *Economics of Labor* , Macmillan, New York, 1946

Lewis, H.Gregg, “Hours of Work and Hours of Leisure” in L. Reed Tripp, ed., *Proceedings of the Ninth Meeting of the Industrial Relations Research Association*, 1957, Madison, Wisconsin, :196-206

Lewis, H. Gregg, *Unionism and Relative Wages in the United States; An Empirical Inquiry*, University of Chicago Press, Chicago, 1963

Manning, Alan, *Monopsony in Motion: Imperfect Competition in Labor Markets*, Princeton University Press, Princeton 2003

Meyer, Stephen, *The Five Dollar Day: Labor Management and Labor Control in the Ford Motor Company 1908-1921*, State University of New York Press, Albany, 1981

Officer, Lawrence H., *Two Centuries of Compensation for U.S. Production Workers in Manufacturing*, Palgrave Macmillan, New York, 2009

Officer, Lawrence H., and Samuel H. Williamson, "The Annual Consumer Price Index for the United States 1774-present "Measuring Worth 2020
https://www.measuringworth.com/datasets/uscpi/

Ozanne, Robert, *Wages in Practice and Theory: McCormick and International Harvester 1860-1960* University of Wisconsin Press, Madison 1968

Reder, Melvin W. "The Cost of a Shorter Work Week", in L. Reed Tripp, ed., *Proceedings of the Ninth Meeting of the Industrial Relations Research Association*, 1957, Madison, Wisconsin, :207-224

Rees, Albert, and George P. Shultz, *Workers and Wages in an Urban Labor Market,* University of Chicago Press, Chicago, 1970

Rees, Albert, *The Economics of Trade Unions,* University of Chicago Press, Chicago, third edition, 1989

Reynolds, Lloyd G., *Labor Economics and Labor Relations.* Prentice Hall, New York second edition, 1954

Seidman, Joel I., *The Yellow Dog Contract*, The Johns Hopkins Press, Baltimore 1932

Shelkova, Natalya "Low-Wage Labor Markets and the Power of Suggestion" *Review of Social Economy* 73(1) March 2015: 61-88

Stock, James H. and Mark W. Watson, "Has the Business Cycle Changed and Why?", *NBER Macroeconomics Annual 2002,* Vol. 17:159-218, MIT Press, 2003

Troy, Leo, *Trade Union Membership, 1897-1962,* National Bureau of Economic Research, Occasional Paper 92, New York 1965

Troy, Leo, and Neil Sheflin *Union Sourcebook*, Industrial Relations Data Information Services , West Orange, NJ , 1985

Weiss, Harry, "Economic Coverage of the Fair Labor Standards Act", *Quarterly Journal of Economics*, 58(3), May 1944: 460-481

Whaples, Robert, "Winning the Eight Hour Day 1909-1919" *The Journal of Economic History,* 50(2), June 1990:393-406

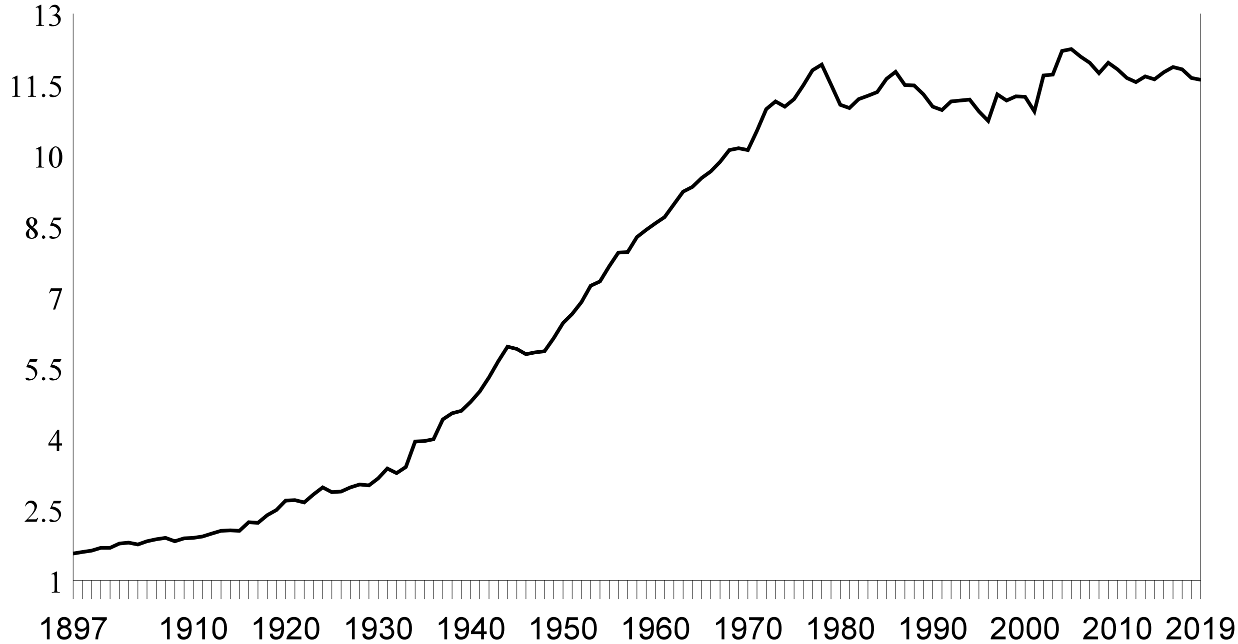
Wolman, Leo, *The Growth of American Trade Unions*, NBER, 1924

Yeh, Chen, Claudia Macaluso, and Brad Herschbein, "Monopsony in the U.S. Labor Market, *American Economic Review*, 112 (7) July 2022: 2099-2188

FIGURES

Figure 1

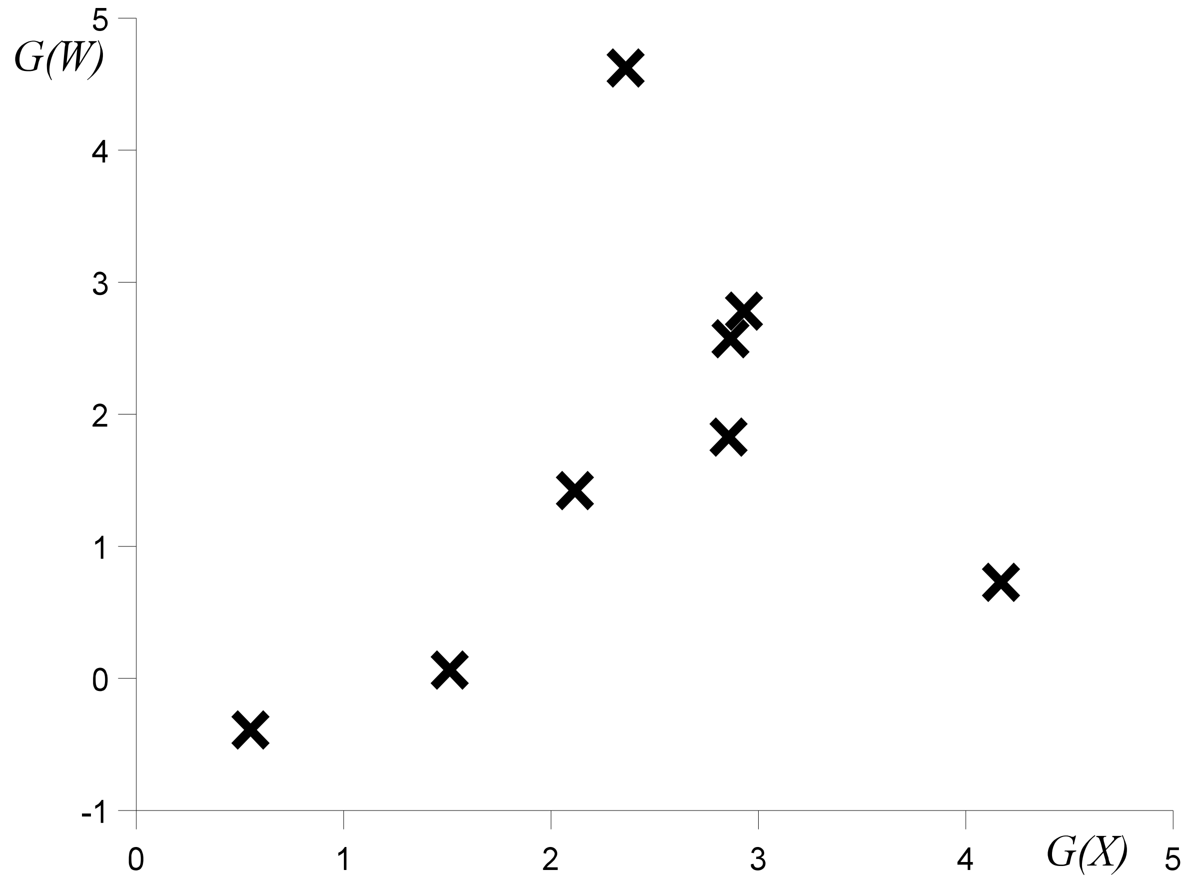
Real Wages of Manufacturing Production Workers from 1897 to 2019



The real wage series is expressed in 1982-84 dollars.

Figure 2

The per cent Compound Annual Growth Rates of Real Wages *G(W)* and of Labor Productivity *G(X)* within eight periods of 15 Years from 1900 to 2019

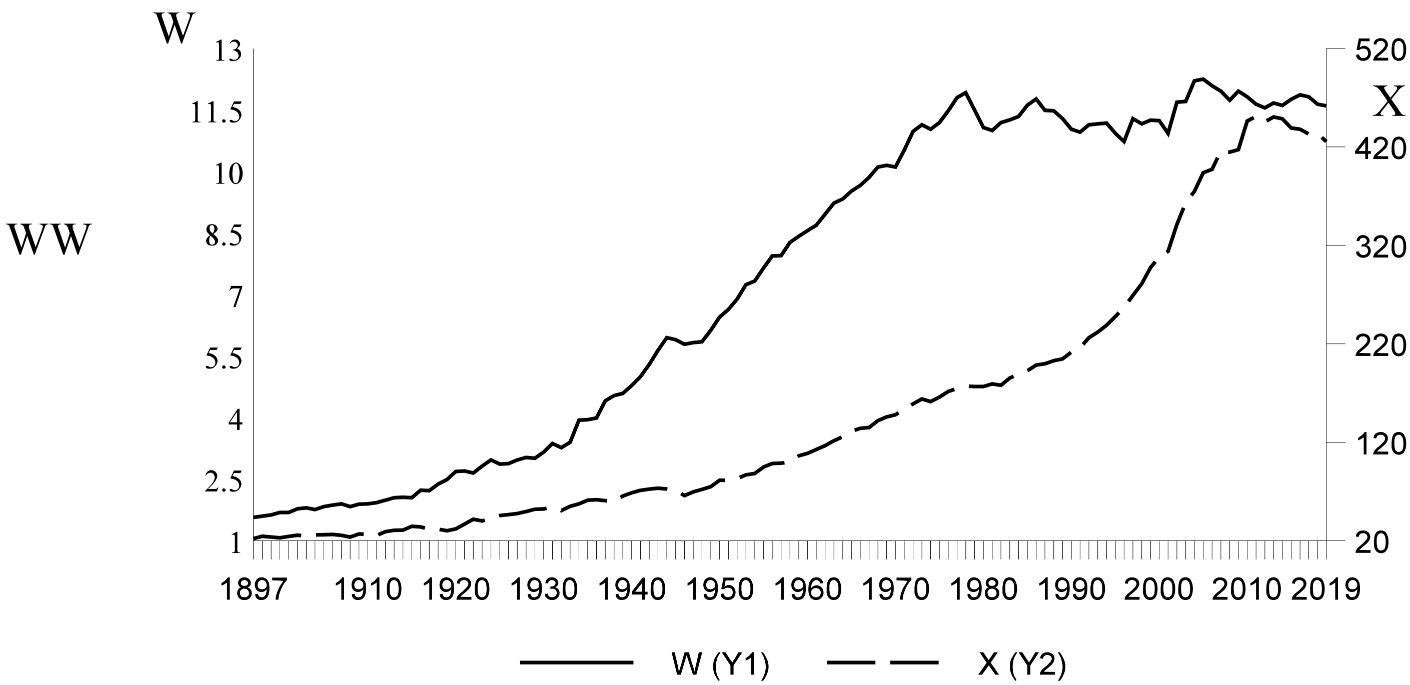


The annual observations from 1900 to 2019 have been divided into eight 15 year periods. Within each of the eight periods the percent compound annual change in real wages $[G(W)]_t$ measured on the vertical axis has been mapped against the per cent compound annual change of labor productivity in manufacturing $[G(X)]_t$ 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)

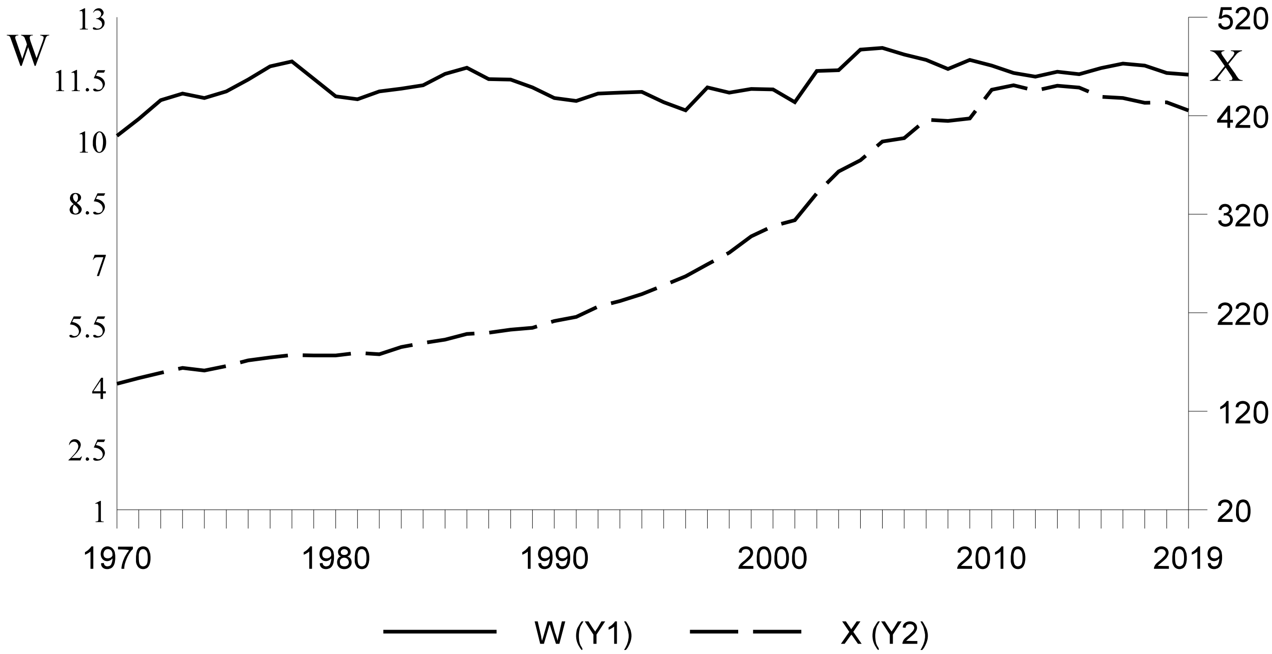
Figure 3

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. It takes the value of 100 in 1958.

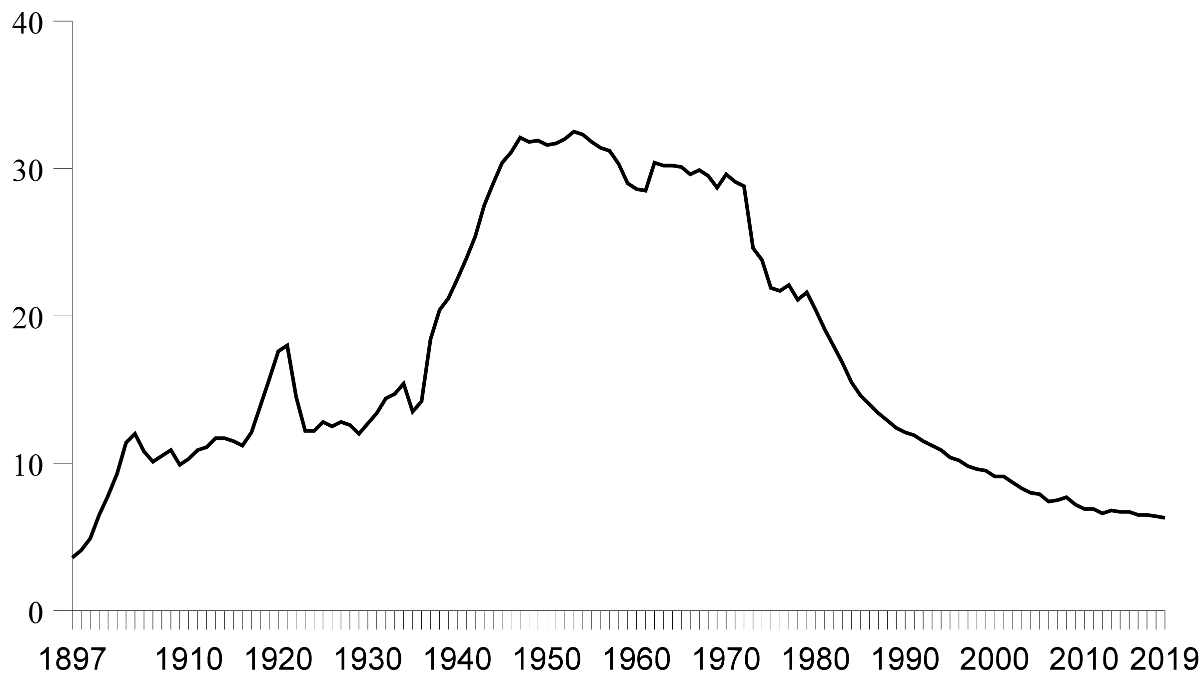
Figure 4
Labor Productivity in Manufacturing and the Real Wages of Manufacturing Production Workers from 1970 to 2019



Please read the notes beneath Figure 2. In Figure 4 the vertical axes retain their relative values shown in Figure 3. Over the fifty years from 1970 to 2019, the minimum value of productivity was 147.9 (in 1970) and the maximum value of productivity was 450.9 (in 2011). Over these years, the minimum value of real hourly compensation was 10.11 (also in 1970) and the maximum value was 12.25 (in 2005). The range (the maximum value minus the minimum value) of labor productivity relative to its median was 1.245. The range of real wages relative to its median was 0.187.

Figure 5

Trade Union Membership as a per cent of Non-Agricultural Employment, D^T_t 1897-2019



The series in the figure expresses total trade union membership as a percent of nonagricultural employment from 1897 to 2019, the density of unions. The observations from 1897 to 1972 are from Troy and Sheflin (1985) 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 6

Annual per cent Change in Trade Union Membership ΔT_t 1898-2019

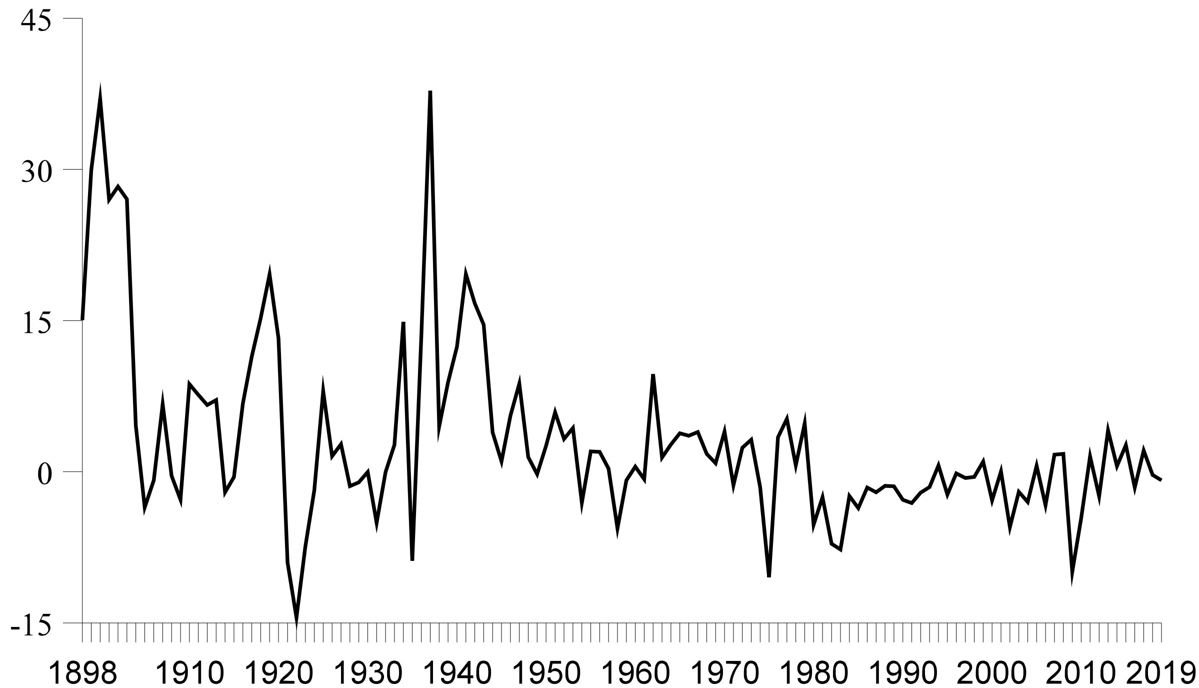


Figure 7

Estimated Trade Union Bargaining Power over Wages, 1898-2019

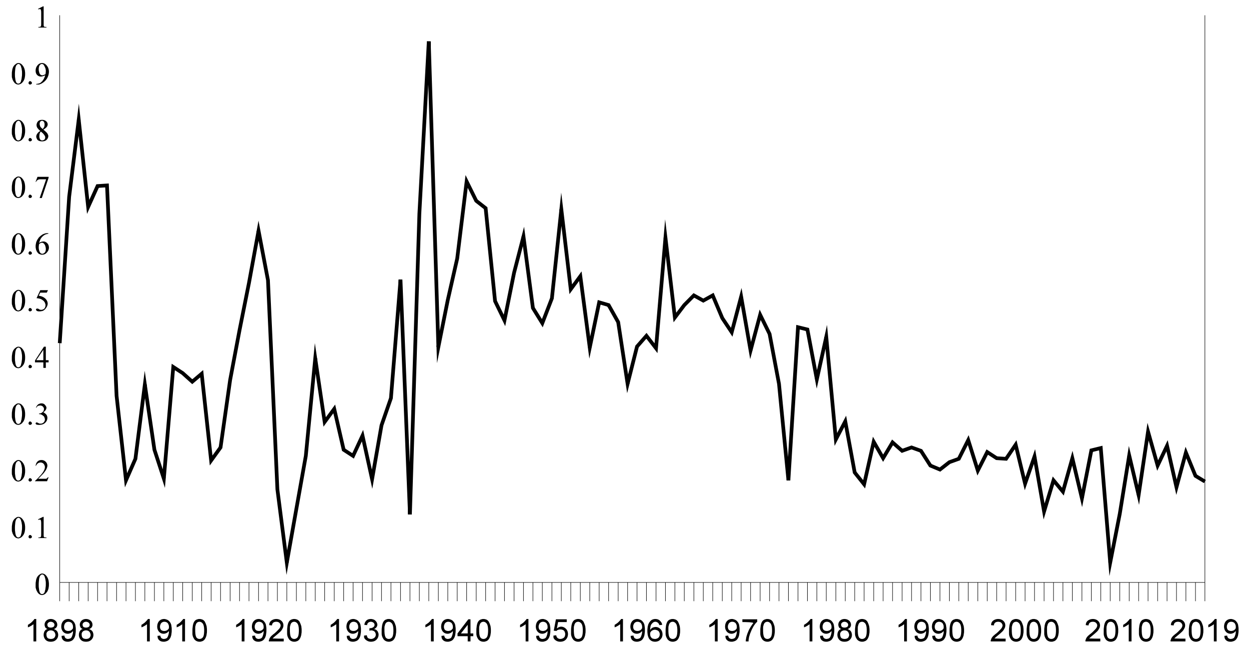
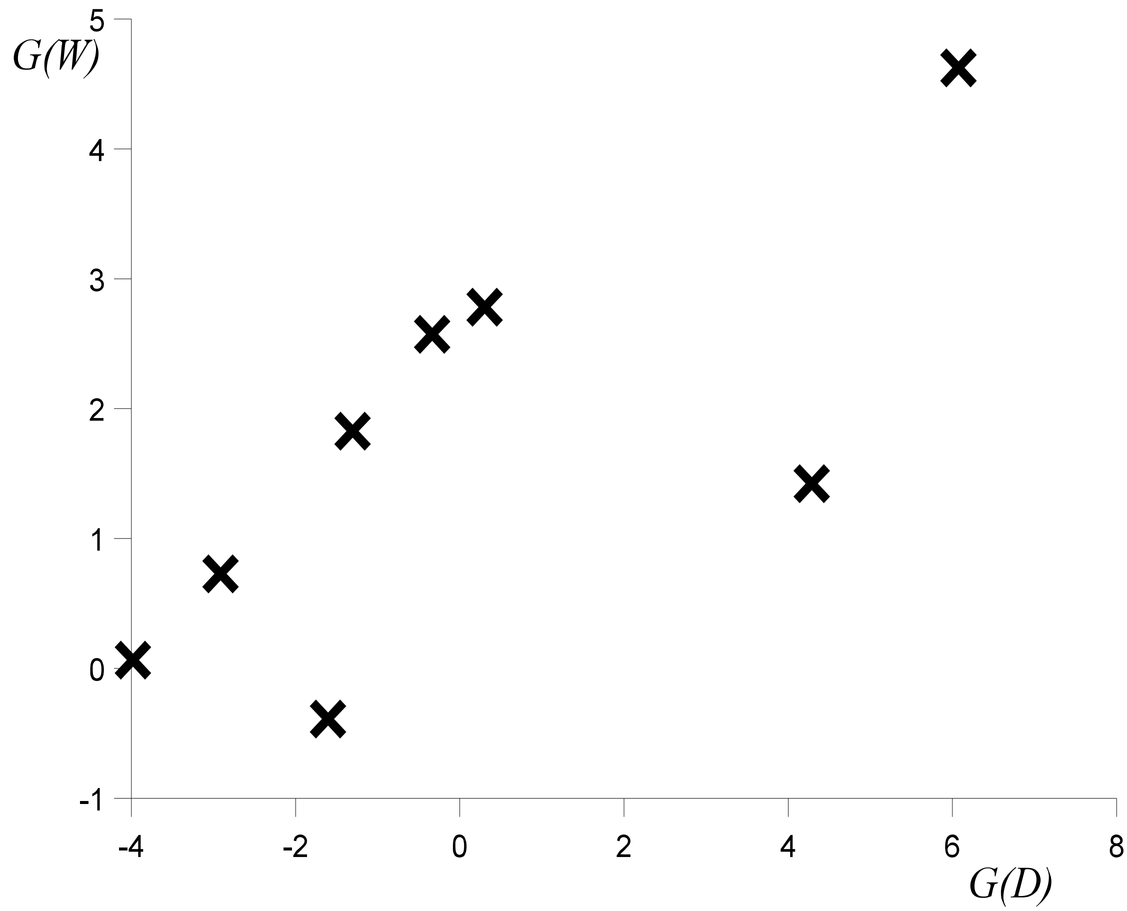


Figure 8

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



Within each of the 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 $[G(W)]_t = 1.682 + \underset{(0.129)}{0.347}\ [G(D)]_t$ with $R^2 = 0.544$

The values of $G(W)_t$ and $G(D)_t$ in the top right-hand corner correspond to the 15 year period from 1930 to 1944. If this period is omitted, the correlation coefficient is + 0.47 .

Figure 9

Annual Average Weekly Hours of Work of Manufacturing Production Workers, 1900-2019

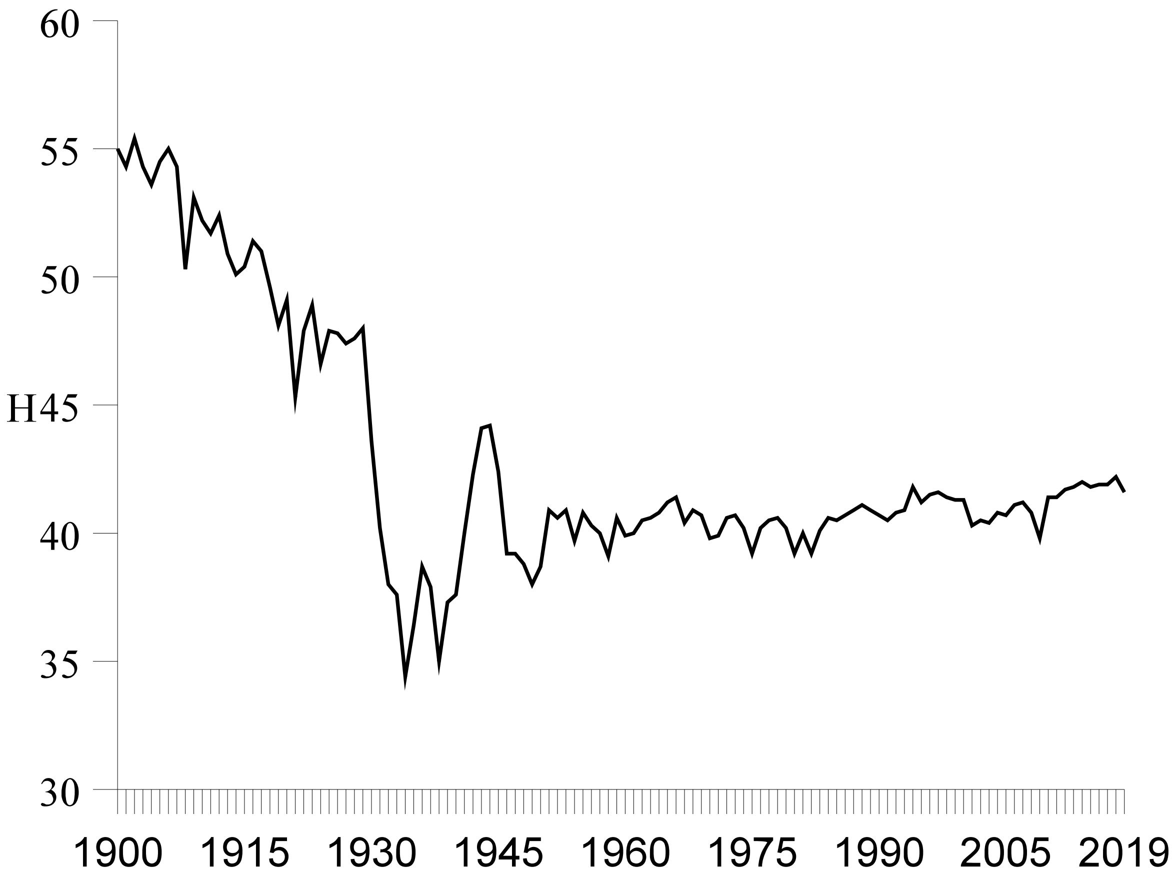


Figure 10

Annual Average Weekly Hours of Work of Manufacturing Production Workers

1946-2019

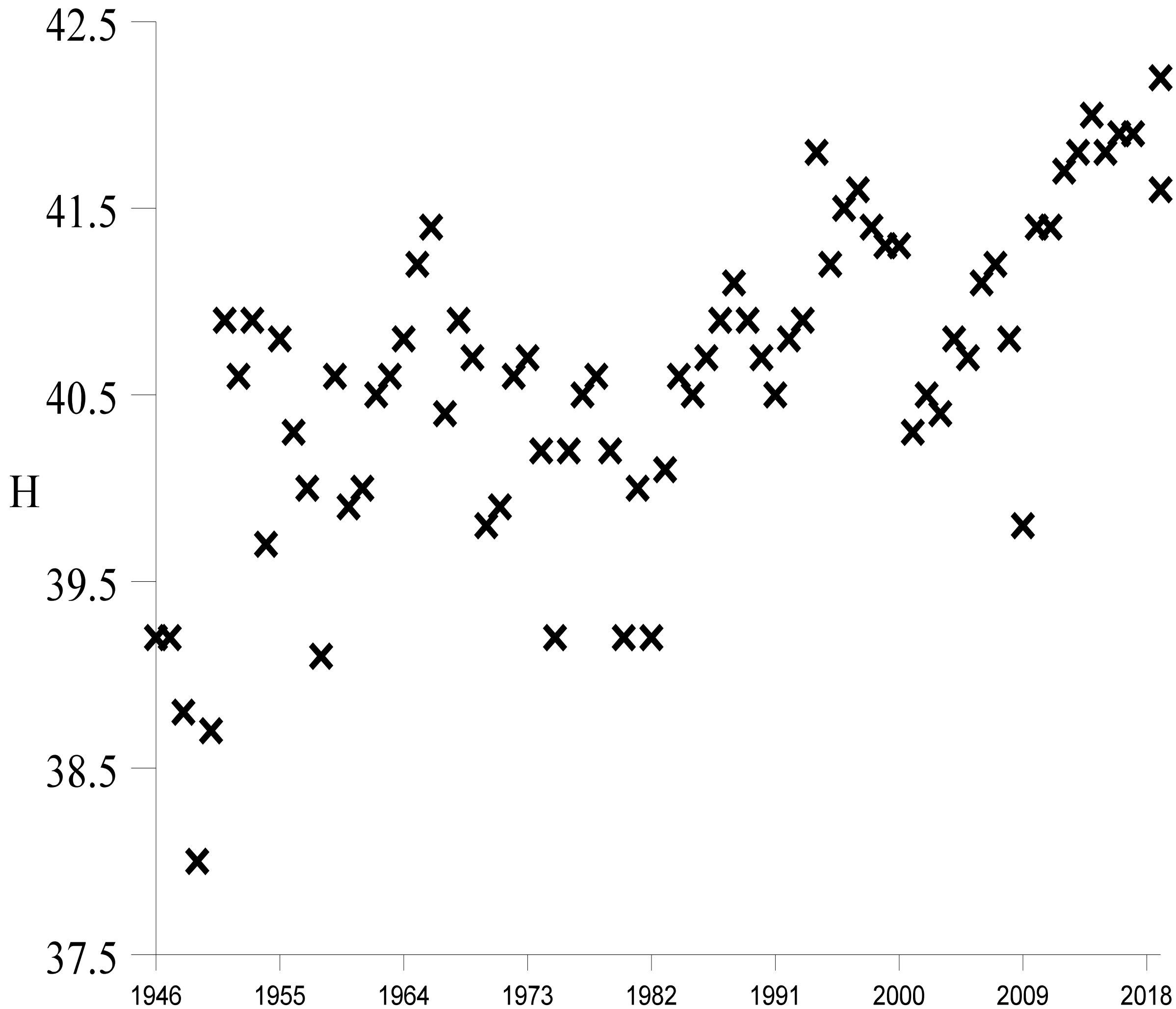
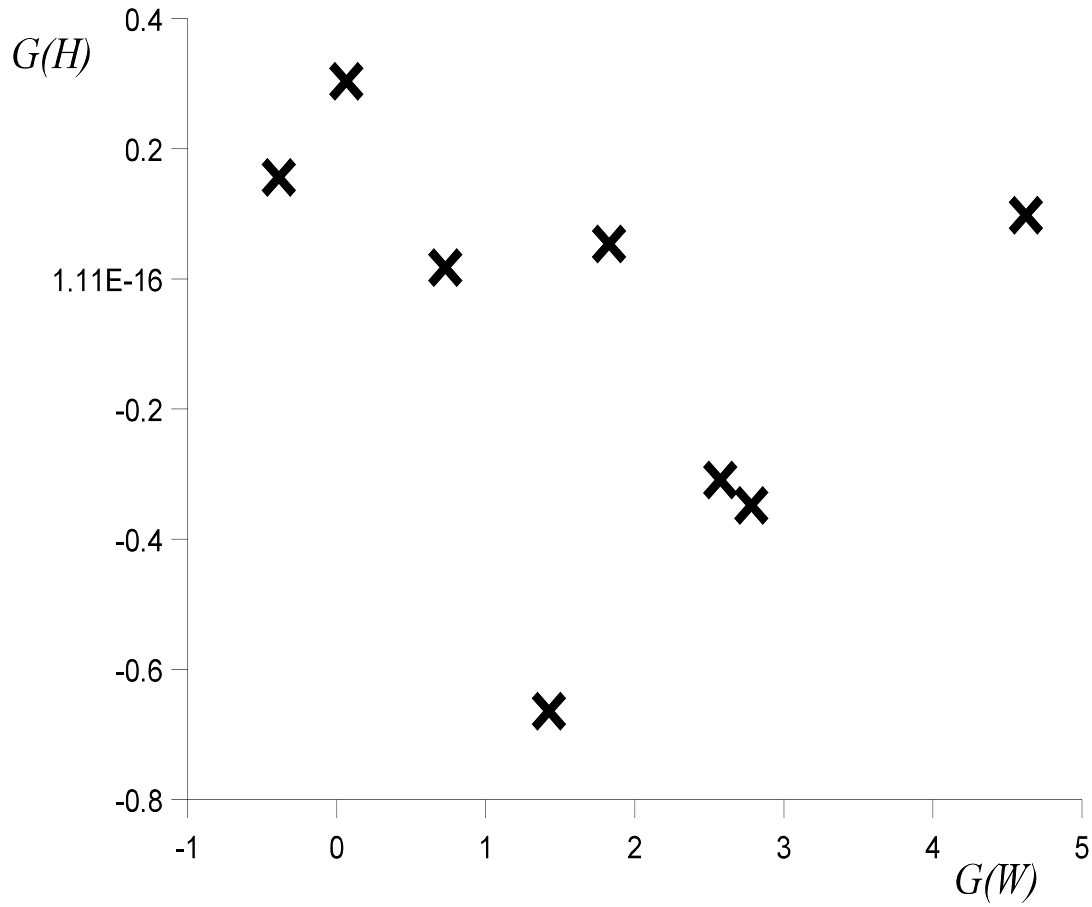


Figure 11
The per cent Compound Annual Growth Rates of Hours $[G(H)]_t$ and of Real Wages $[G(W)]_t$ within eight periods of 15 years

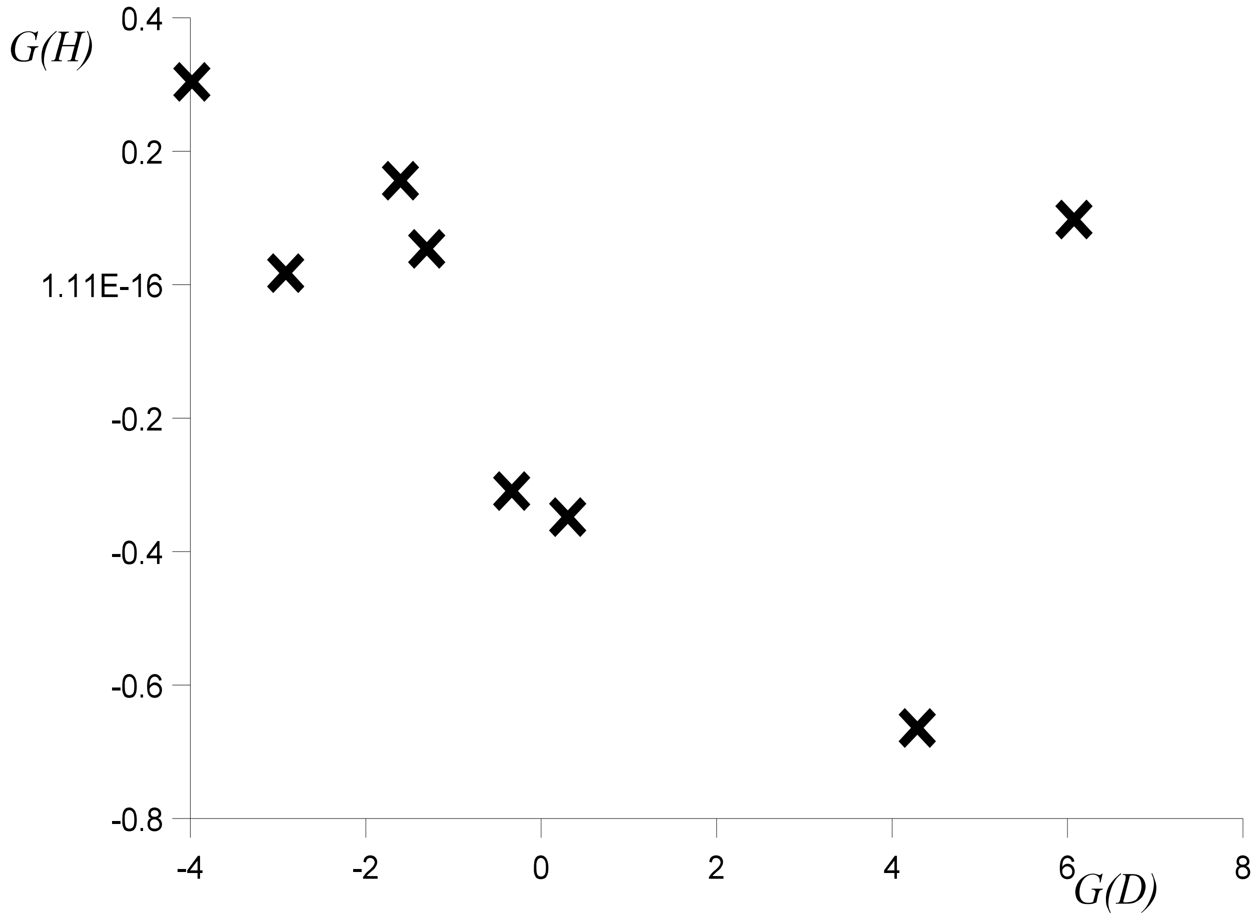


The annual observations from 1900 to 2019 have been divided into eight 15 year periods. Within each of the eight periods the percent compound annual change in hours $[G(H)]_t$ (measured on the vertical axis) has been mapped against the per cent compound annual change in real wages $[G(W)_t]$ (on the horizontal axis). A least-squares regression fitted to these observations yields

$$[G(H)]_t = 0.006 - \underset{(0.078)}{0.054}\, [G(W)]_t \text{ with } R^2 = 0.075$$

Figure 12

The per cent Compound Annual Growth Rates of Hours $[G(H)]_t$ and of Trade Union Density $[G(D)]_t$ within eight periods of 15 years



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 hours $[G(H)]_t$ (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

$$[G(H)]_t = 0.083 - \underset{(0.033)}{0.045}\,[G(D)]_t \text{ with } R^2 = 0.235$$

TABLES

Table 1

The Annual Volatility of Real Wages during Three (Approximately) 40 Year Periods from 1898 to 2019

	σ / μ	*QD/M*	mean of *V(W)*	median of *V(W)*
1898-1937	0.272	0.260	1.081	0.977
1938-1979	0.276	0.255	0.988	0.699
1980-2019	0.033	0.026	0.409	0.301
1898-2019	0.538	0.499	0.829	0.605

σ / μ is the coefficient of variation, that is, the standard deviation (σ) of real wages divided by the arithmetic mean (μ) value of real wages in each period. In any period, when arranging the values of real wages in ascending order of magnitude, the quartile deviation *(QD)* is ½ $(Q_U - Q_L)$ where Q_L is the value of real wages at the lower quartile (or 25th percentile) and Q_U is the value of real wages at the upper quartile (or 75th percentile). *QD/M* is the quartile deviation divided by the median value of real wages. *V(W)* is the variance of the residuals from a regression of each year's real wages (from 1898 to 2019) on a quadratic time trend. The fitted regression is

$$W_t = -0.455 + \underset{(0.256)}{} 0.169\, Y_t - 0.0005\, (Y_t)^2 \qquad R^2 = 0.946$$

$$(0.256) \quad (0.0096) \quad (0.00007)$$

where Y_t is the trend that takes the value of unity in1898 and that increases by unity in each subsequent year .

Table 2

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

	W_t	ΔW_t	X_t	ΔX_t	U_t	D^T_t	ΔT_t
mean μ	7.38	1.698	152.3	2.52	6.54	16.90	3.047
stan. dev. σ	3.97	3.08	132.3	4.14	4.32	8.90	8.83
minimum	1.60	-3.74	22.9	-7.97	1.20	3.6	-14.47
Q_L = 25%	2.99	-0.42	48.65	0.149	4.225	10.15	-1.78
median	8.27	1.29	100.0	2.45	5.5	13.4	0.925
Q_U = 75%	11.25	3.58	203.8	4.68	7.1	25	4.74
maximum	12.25	15.88	450.9	15.31	24.9	32.5	37.8
range	10.65	19.62	428.0	23.28	23.7	28.9	52.27
σ / μ	0.538	1.812	0.869	1.645	0.660	0.527	2.899
QD/M	0.499	1.547	0.776	0.927	0.261	0.554	3.524

W, real wages, are expressed in 1982-84 dollars. X_t the index of labor productivity in manufacturing takes the value of 100 in 1958.

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 $(Q_U - Q_L)$.

Table 3

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

equation & years ⇓	estimated coefficients (and estimated standard errors) on......						
	intercept	ΔX_t	U_t	N_t	R^2	*D-W*	nobs
(1a) 1898-2019	1.494 (0.326)	0.081 (0.067)			0.012	1.77	122
(2a) 1898-2019	1.513 (0.488)	0.069 (0.062)	-0.016 (0.063)	14.410 (2.980)	0.186	1.72	122
(1b) 1898-1938	2.750 (0.671)	-0.022 (0.103)			0.001	2.32	41
(2b) 1898-1938	2.695 (0.879)	-0.038 (0.089)	-0.031 (0.089)	13.031 (3.654)	0.300	2.41	41
(1c) 1939-1979	1.511 (0.438)	0.296 (0.110)			0.159	1.14	41
(2c) 1939-1979	2.177 (0.640)	0.359 (0.112)	-0.153 (0.113)		0.299	1.21	41
(1d) 1980-2019	-0.582 (0.430)	0.278 (0.128)			0.111	2.25	40
(2d) 1980-2019	-1.310 (1.308)	0.278 (0.130)	0.117 (0.198)		0.120	2.24	40
(2 e) 1939-2019	0.394 (0.343)	0.322 (0.093)			0.133	1.31	81
(2f) 1939-2019	1.200 (0.665)	0.356 (0.095)	-0.153 (0.108)		0.154	1.37	81

Estimated standard errors are in parentheses beneath their estimated coefficients. 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 on ⇓	(3a) 1898-2019	(4a) 1898-2019	(4b) trimmed	(4c) 1898-1979	(4d) 1980-2019	(4e) 1980-2019
intercept	0.063 (0.563)	-0.384 (0.667)	-0.087 (0.669)	0.735 (1.038)	0.007 (1.540)	-0.946 (1.349)
ΔT_t	0.125 (0.029)	0.121 (0.027)	0.094 (0.029)	0.102 (0.033)	-0.174 (0.142)	-0.069 (0.086)
D^T_t	0.074 (0.028)	0.074 (0.026)	0.066 (0.027)	0.045 (0.036)	-0.121 (0.098)	-0.053 (0.054)
ΔX_t		0.115 (0.058)	0.133 (0.059)	0.080 (0.066)	0.253 (0.129)	0.270 (0.132)
U_t		0.010 (0.057)	-0.016 (0.058)	-0.009 (0.064)	0.067 (0.233)	0.156 (0.218)
N_t		12.616 (2.724)	13.317 (2.722)	12.791 (2.891)		
R^2	0.172	0.343	0.320	0.316	0.219	0.154
F^	12.342	13.98	8.167	4.95	2.25	0.730
$D\text{-}W$	1.94	2.04	2.03	2.05	2.18	2.25
nobs	122	122	118	82	40	40

Estimated standard errors are in parentheses beneath their estimated coefficients. *F*^ is the calculated F statistic for testing the null hypothesis that the estimated coefficients on ΔT_t and D^T_t are jointly zero. The critical values of the F distribution are approximately 2.35 at the 10% significance level and 3.07 at the 5% level. *D-W* is the Durbin-Watson statistic. "Trimmed" means the equation was fitted with 4 fewer observations; those for the years 1898, 1922, 1937, and 1953 are omitted as outliers. In equation (4e), the economy-wide values of ΔT_t and D^T_t are replaced with the corresponding values for private manufacturing industry. The number of observations is given by "nobs".

Table 5

Descriptive Statistics of Variables Used in the Analysis of Wages from 1898 to1979 and from 1980 to 2019.

	1898-1979 (82 Years)						
	W_t	ΔW_t	D^T_t	ΔT_t	U_t	X_t	ΔX_t
mean μ	5.40	2.51	20.08	5.36	6.7	74.67	2.65
stan. dev. σ	3.35	3.16	8.92	9.80	5.14	46.95	4.74
minimum	1.57	-3.68	3.60	-14.47	1.20	22.6	-7.97
Q_L = 25 %	2.31	0.49	12.05	-0.36	3.825	31.85	0.08
median	4.54	2.05	20.40	3.22	5.15	61.6	2.70
Q_U = 75 %	8.35	3.58	29.55	8.53	6.775	103.1	4.83
maximum	11.92	15.88	32.50	37.8	24.9	177.1	15.3
range	10.35	19.57	28.9	52.27	23.7	154.5	23.28
σ / μ	0.62	1.26	0.44	1.83	0.77	0.63	1.79
QD/M	0.67	0.76	0.43	1.38	0.286	0.58	0.88
	1980-2019 (40 Years)						
	W_t	ΔW_t	D^T_t	ΔT_t	U_t	X_t	ΔX_t
mean μ	11.48	0.043	10.28	-1.69	6.2	313.4	2.25
stan. dev. σ	0.38	2.12	3.78	2.86	1.67	103.5	2.54
minimum	10.73	-3.74	6.3	-9.94	3.7	176.7	-2.09
Q_L = 25 %	11.17	-1.36	7.13	-2.88	4.9	209.8	0.48
median	11.52	-0.22	9.30	-1.56	5.8	302.8	1.96
Q_U = 75 %	11.75	0.96	12.17	0.17	7.25	419.22	3.81
maximum	12.25	6.95	20.4	4.11	9.7	450.9	8.70
range	1.52	10.69	14.1	14.05	6.0	274.2	10.79
σ / μ	0.031	49.30	0.368	1.69	0.269	0.330	1.128
QD/M	0.025	5.37	0.316	0.98	0.203	0.346	0.852

See notes beneath Table 2.

Table 6

Descriptive Statistics of Average Weekly Hours of Work from 1901 to 2019, from 1901 to 1919, from 1920 to 1937, from 1938 to 1979, from 1946 to 1979, and from 1980 to 2019

	(i)	(ii)	*(iii)*	*(iv)*	*(v)*	*(vi)*
	1901-2019	1901-1919	1920-1937	1938–1979	1946-1979	1980-2019
mean μ	42.87	52.14	43.52	40.19	40.15	40.99
stan. dev. σ	4.828	2.340	5.124	1.583	0.779	0.718
minimum	34.4	46.1	34.4	35	38	39.2
Q_L = 25 %	40.2	50.65	38.1	39.7	39.7	40.6
median	40.9	52.2	45.95	40.35	40.35	41.0
Q_U = 75 %	44.2	54.3	47.9	40.8	40.7	41.53
maximum	55.4	55.4	49.1	44.2	41.4	42.2
range	21	9.3	14.7	9.2	3.4	3.0
nobs	119	19	18	42	34	40

“nobs” means the number of observations

Table 7

The Annual Volatility of Weekly Hours of Work in Three (Approximately) 40 Year Periods

	σ / μ	*QD/M*	mean of *V(H)*	median of *V(H)*
1900-1939	0.133	0.090	11.506	3.547
1940-1979	0.032	0.012	2.756	1.709
1980-2019	0.018	0.011	1.631	1.274
1900-2019	0.115	0.062	5.298	1.822

σ / μ is the coefficient of variation, the standard deviation (σ) divided by the mean (μ) of hours in each period.

QD/M is the quartile deviation divided by the median of hours . In each period, when arranging values of hours in ascending order of magnitude, the quartile deviation *(QD)* is defined as ½ $(Q_U - Q_L)$ where Q_U is the value of hours at the upper quartile (or 75th percentile) and Q_L is the value of hours at the lower quartile (or 25th percentile) of the hours distribution.

V(H) is the variance of the residuals from a regression of each year's hours of work (from 1900 to 2019) on a quadratic time trend. The fitted regression is

$$H_t = \underset{(0.649)}{55.341} \; - \underset{(0.025)}{0.431} \, Y_t + \underset{(0.0002)}{0.0028} \, (Y_t)^2 \qquad R^2 = 0.781$$

where Y_t is the trend that takes the value of unity in1900 and that increases by unity in each subsequent year .

Table 8

Descriptive Statistics of Variables used in the Analysis of Hours per Worker from 1901 to2019

	1901-2019 (119 Years)							
	H_t	ΔH_t	D^T_t	ΔT_t	W_t	ΔW_t	E_t	ΔE_t
mean μ	42.87	-0.1865	17.30	2.435	7.568	1.678	10,279	0.857
stan. dev.σ	4.83	3.09	8.763	7.906	3.890	3.109	2,801	7.116
minimum	34.4	-9.17	6.3	-14.47	1.69	-3.739	4,706	-23.46
Q_L = 25 %	40.2	-1.36	10.45	-1.92	3.22	-0.435	8,056	-1.69
median	40.9	0.227	13.5	0.64	8.56	1.243	11,355	0.692
Q_U = 75 %	44.15	0.982	26.45	4.408	11.26	3.522	12,608	4.912
maximum	55.4	6.571	32.5	37.8	12.25	15.88	14,458	21.792
range	21	15.74	26.2	52.27	10.56	19.62	9,752	45.255
σ / μ	0.113	16.56	0.506	3.247	0.514	1.853	0.272	8.303
QD/M	0.048	5.15	0.593	4.945	0.470	1.592	0.200	4.774

See notes beneath Table2.

Table 9

Least-Squares Estimates of the Hours Equation (5)

estimated coefficients on ⇓	1901-2019 (5a)	trimmed (5b)	1901-19 (5c)	1920-37 (5d)	1938-79 (5e)	1980-2019 (5f)	(5g)
intercept	-0.736 (0.431)	-0.825 (0.448)	8.187 (3.288)	-8.045 (6.309)	0.601 (1.891)	0.393 (0.552)	0.185 (0.056)
ΔT_t	-0.103 (0.027)	-0.086 (0.031)	-0.106 (0.042)	-0.046 (0.087)	-0.182 (0.070)	-0.157 (0.091)	-0.006 (0.062)
$D^T{}_t$	-0.017 (0.023)	-0.020 (0.024)	-0.847 (0.290)	0.615 (0.455)	-0.037 (0.067)	-0.028 (0.056)	0.007 (0.029)
ΔW_t	0.046 (0.072)	0.069 (0.075)	0.204 (0.192)	-0.358 (0.227)	0.280 (0.123)	0.128 (0.089)	0.112 (0.090)
ΔE_t	0.361 (0.029)	0.351 (0.031)	0.239 (0.090)	0.400 (0.077)	0.420 (0.053)	0.251 (0.065)	0.162 (0.070
N_t	-12.743 (2.174)	-13.053 (2.224)		-10.231 (4.373)			
$(\text{FLSA})_t$	1.177 (0.450)	1.306 (0.474)					
R^2	0.627	0.618	0.730	0.751	0.760	0.323	0.203
*F^*	7.81	4.665	7.16	0.92	3.39	1.60	0.04
D-W	2.14	2.19	1.90	1.58	2.577	2.675	2.60
nobs	119	115	19	18	42	40	40

Please read the notes beneath Table 2. The trimmed equation omits the years 1922,1937, 1953, and 2018 from the years from 1901 to 2019. In equation (5g), the economy-wide values of ΔT_t and D^{Tt} are replaced with the corresponding values for private manufacturing industry.

Table 10

Descriptive Statistics of Variables used in the Analysis of Weekly Hours per Worker : Years from 1901 to 1919 and from 1920 to 1937

	H_t	ΔH_t	ΔT_t	D^T_t	W_t	ΔW_t	E_t	ΔE_t
	Years from 1901 to 1919 (19 years)							
mean	52.14	-0.880	8.770	11.2	1.982	2.104	6,353.6	3.825
stan. dev.	2.34	3.034	10.309	1.656	0.216	3.078	1,117.1	6.496
minimum	46.1	-7.366	-3.537	7.8	1.69	-3.684	4,706	-10.238
25 %	50.65	-1.840	-0.468	10.4	1.83	0.244	5,381	0.707
median	52.2	-1.273	6.764	11.1	1.9	1.604	6,327	4.892
75 %	54.3	1.136	13.338	11.7	2.055	3.628	6,889	7.944
maximum	55.4	5.567	28.3	15.7	2.49	8.780	8,617	18.05
range	9.3	12.933	31.84	7.9	0.8	12.464	3,911	28.29
$\mid \sigma / \mu \mid$	0.045	3.448	1.175	0.148	0.109	1.463	0.176	1.698
QD/M	0.037	1.169	1.021	0.548	0.059	1.055	0.119	0.667
Years from 1920 to 1937 (18 years)								
mean	43.5	-0.946	2.50	14.106	3.23	3.337	7,546	0.759
stan. dev.	5.124	5.321	11.942	2.042	0.520	4.974	980.8	11.421
minimum	34.4	-9.17	-14.47	12.0	2.65	-3.367	5,351	-23.46
25 %	38.175	-5.28	-4.262	12.63	2.87	0.277	7,014	-5.895
median	45.95	-0.523	-0.035	13.45	3.02	2.573	7,901.5	2.695
75 %	47.88	2.614	6.69	14.65	3.39	6.141	8,176	9.441
maximum	49.1	6.508	37.8	18.4	4.41	15.88	8,791	16.63
range	14.7	15.68	52.27	6.4	1.76	19.25	3,440	40.09
$\mid \sigma / \mu \mid$	0.118	5.625	4.78	0.145	0.161	1.491	0.130	15.05
QD/M	0.106	7.547	158.7	0.075	0.086	1.140	0.074	2.85

Table11

Descriptive Statistics on Variables used in the Analysis of Weekly Hours per Worker: Years from 1938 to 1979 and from 1980 to 2019.

	Years from 1938 to 1979 (42 years)							
	H_t	ΔH_t	ΔT_t	D^T_t	W_t	ΔW_t	E_t	ΔE_t
mean	40.19	0.186	3.473	28.12	8.234	2.331	12,519	1.445
stan. dev.	1.583	3.061	5.476	3.849	2.276	2.189	1,539	7.281
minimum	35	-7.652	-10.47	20.4	4.54	-3.523	7,478	-14.936
25 %	39.73	-1.228	0.683	24.8	5.99	1.088	12,057	-2.402
median	40.35	0.247	2.948	29.55	8.345	2.303	12,608	1.884
75 %	40.78	1.247	4.712	31.175	10.11	4.048	13,568	4.985
maximum	44.2	6.571	19.624	32.5	11.92	6.415	14,458	21.79
range	9.2	14.223	30.094	12.1	7.38	9.938	6,980	36.726
Years from 1980 to 2019 (40 years)								
mean	40.99	0.094	-1.693	10.28	11.48	0.043	11,020	-1.126
stan. dev.	0.718	1.298	2.861	3.783	0.379	2.119	1,827	3.529
minimum	39.2	-2.49	-9.94	6.3	10.73	-3.74	8,077	-13.574
25 %	40.57	-0.48	-2.88	7.125	11.175	-1.36	8,944	-1.601
median	41	0.24	-1.56	9.3	11.52	-0.216	12,045	-0.214
75 %	41.53	0.718	0.17	12.18	11.745	0.961	12,545	0.855
maximum	42.2	4.02	4.11	20.4	12.25	6.953	13,667	5.775
range	3	6.508	14.05	14.1	1.52	10.69	5,590	19.349

Table 12

Changes in the values of Real Wages and Weekly Hours between certain Initial and Terminal Years

Real Wages			Weekly Hours		
Initial year	Terminal year	Ratio of Terminal year to Initial year	Initial year	Terminal year	Difference between Terminal and Initial year
1900	2000	6.65	1900	2000	-13.7
1900	1980	6.55	1900	1938	-20
1900	2019	6.86	1946	2000	2.1
1980	2019	1.05	1946	2019	2.4

Table 13

The per cent annual compound change in real wages $G(W)_t$, in labor productivity in manufacturing $G(X)_t$, in trade union density $G(D)_t$, in the weekly hours of manufacturing workers $G(H)_t$, and in the employment of manufacturing production workers $G(E)_t$ in eight 15-year periods between 1900 and 2019

years	$G(W)_t$	$G(X)_t$	$G(D)_t$	$G(H)_t$	$G(E)_t$
1900-1914	1.424	2.116	4.288	-0.664	3.004
1915-1929	2.782	2.931	0.304	-0.348	1.842
1930-1944	4.624	2.360	6.075	0.098	4.612
1945-1959	2.573	2.866	-0.336	-0.309	-0.207
1960-1974	1.829	2.857	-1.304	0.054	1.083
1975-1989	0.064	1.512	-3.981	0.304	0.129
1990-2004	0.729	4.170	-2.912	0.0175	-1.625
2005-2019	-0.389	0.551	-1.604	0.156	-0.8245

APPENDIX
SOURCES AND CONSTRUCTION OF OBSERVATIONS

Real Average Hourly Compensation in 1982-84 Dollars

From 1898 to 2006, annual observations are from Officer (2009), Table 7.2, p.170. For the years from 2007 to 2019, I used the BLS index of employer costs for employee compensation (ECEC) for manufacturing workers in production, transportation, and material moving occupations per hour worked for the fourth quarter of each year. The nominal values are given in column (1) below. The price deflator (1982-84 = 1.0) is in column (2). The resulting series for real hourly compensation from 2007 to 2020 is in column (3). For each year, this is the value in column (1) divided by the value in column (2) below.

Year	(1)	(2)	(3)
2007	24.28	2.03	11.96
2008	24.77	2.11	11.74
2009	25.12	2.10	11.96
2010	25.18	2.13	11.82
2011	25.72	2.21	11.64
2012	26.10	2.26	11.55
2013	26.84	2.30	11.67
2014	27.28	2.35	11.61
2015	27.75	2.36	11.76
2016	28.25	2.38	11.87
2017	28.60	2.42	11.82
2018	28.87	2.48	11.64
2019	29.58	2.55	11.60
2020	29.51	2.54	11.62

Hours of Work

Average weekly hours of work from 1900 to 1950 are from Jones (1963) and from 1950 to 2019 from the Current Employment Statistics (CES) survey of the Bureau of Labor Statistics, U.S. Department of Labor.

Trade Union Membership

For the years from 1897 t0 1972, the information on *T/E* and ΔT is drawn from Troy and Sheflin (1985). From 1973 to 2019, the figures on union membership and union density are based on responses to questions asked in the Current Population Survey and conveniently organised by Barry Hirsch and David Macpherson at https:www.unionstats.com .

Employment

A series on manufacturing production workers is available on the BLS web site which covers the years 1909, 1914, 1919, and then annually to 1939. For the missing years, I regressed the BLS series on production workers (call this *EBLS*) on Lebergott's (1964) employment in manufacturing observations (call this *ELEB*) for the years 1909, 1914, 1919 and 1920-38: *EBLS* = 19.0605 + 0.8058 (ELEB) with an R^2 statistic of 0.957 and, from this fitted regression, I predicted production worker employment in 1900, 1908, 1910-13, and 1915-1918. From 1939 to 2019 I used production worker employment from the Current Employment Statistics survey on the Bureau of Labor Statistics web site.

Labor Productivity in Manufacturing

Observations on manufacturing output per worker hour are based on John W. Kendrick's research outlined in *Productivity Trends in the United States* , Princeton University Press, Princeton, 1961, Appendix D contains a thorough description of the problems in constructing such a series from 1899 to 1954. His series from 1891 to 1965 is given in the U.S. Department of Commerce, Bureau of the Census, *Long-Term Economic Growth 1860-1965 A Statistical Compendium*, Series A165 and A166 (pages 190-191) published in October 1966 . From these a series on labor productivity can be constructed that has a base of 100 in 1958. After 1958, per cent annual changes in manufacturing labor productivity are available online at the Office of Productivity and Technology at the U.S. Department of Labor, Bureau of Labor Statistics.

Per Cent Unemployment Rate

From 1897 t0 1899, the source is Stanley Lebergott (1964) Table A-15 p. 522. From 1900 to 1939, the source is Lebergott Table A-3, p. 512. From 1940 to 2019, the annual observations on the unemployment rate are on the U.S. Bureau of Labor Statistics web pages.