Wages, productivity, and work intensity in the Great Depression

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Abstract:

We show that U.S. manufacturing wages during the Great Depression were importantly determined by forces on firms' intensive margins. Short-run changes in work intensity and the longer-term goal of restoring full potential productivity combined to influence real wage growth. By contrast, the external effects of unemployment and replacement rates had much less impact. Empirical work is undertaken against the background of an efficient bargaining model that embraces employment, hours of work and work intensity.

JEL Classification: J24, J31, N62

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1 Introduction

This paper concerns two countervailing influences on wage determination in U.S. manufacturing during the Great Depression. The first is work intensity. The suddenness and severity of the downturn in 1929 would have caught many firms unawares and a transition phase would have involved drawing up plans - involving employment, capital and organisational adjustments - to restore production efficiency. During this initial period, plant and labor utilisation in many firms would almost certainly have fallen below pre-Depression norms. A critical issue is whether an excess supply of labor on firms' intensive margins served to depress wage rates. The second influence concerned the need to regain full potential productivity. Once the scale of the problem had been evaluated and production plans drawn up and executed, company survival would have dictated the need to achieve, as speedily as possible, optimal productive performance. For workers whose jobs survived the adjustment period, the wage determination process would reflect these longer-term goals. We would expect reductions in work intensity to be relatively short lived with the need to restore company fortunes treated with some urgency. Such reactions are well summarised by Baily (1983). "When firms fear for their own existence they do not conserve excess workers. Instead they encourage managers and production workers alike to increase efficiency and prevent bankruptcy".

There is contemporary evidence that sections of the business community and business press required an adjustment lag of about one year before beginning to grasp the full potential seriousness of the unfolding economic events that began in late 1929 (Temin, 1976). To the extent that firms were uncertain about the duration and depth of the economic downturn, their initial responses may have been to preserve stocks of labor and capital while using intensive margin adjustments as the main buffer. One well-documented adjustment mode in this latter respect was recourse to quite radical reductions in hours of work (Bernanke and Powell, 1986). Another, for which evidence is somewhat less direct, was to allow a relaxation of work intensity. For example, Bernanke and Parkinson (1991) find qualified support for the hypothesis that inter-war short-run increasing returns to labor stemmed from firms' propensities to hoard labor.[1] It is important to emphasise that hours alone did not capture the utilisation of the labor input on the intensive margin during this period. Take the hypothetical example of a firm that in 1928 required 40 weekly effective working hours per worker consisting of 5 days at 8 hours per day. Ignore possibilities of fluctuations in effort over the workday or workweek. Suppose that in 1929 desired average hours fall to 24 per week. One solution may be to require the same productive hourly work intensity per worker over a 3- day workweek. Hourly productivity would remain unchanged.[2] But workers may strongly resist a 40 percent reduction in weekly earnings. As stated by Bernanke (1986, p.89): "..it may not be possible to cut weekly earnings as sharply as hours and still meet the reservation utility constraint." In this event, the firm may then allow actual paid weekly hours to exceed desired weekly hours in which case measured hours would misrepresent the level of hours effectively worked. In general, reductions in plant utilisation are likely to involve decisions over whether to reduce weekly hours and/or work intensity per hour.

As firms became more fully aware of the extent of the crisis confronting them, any tendency to slacken productive performance would have been superseded by deep employment reductions combined with a strong commitment to company survival by those who kept their jobs. Labor and total factor productivity declined steeply between 1929 and 1933 and then

[1] This type of response is likely to have been especially prevalent among firms with high sunk costs of human capital investments (Oi, 1962). In line with this expectation, hours' reductions were greater among unskilled workers in the early 1930s (Margo, 1998).

[2] Bernanke (1986, p.89) suggests that, to a degree, this is may have happened within the iron and steel industry. Firms found it efficient to operate on a part-time basis, working their employees a few days of the week on 'spread-work' schedules (see also Daugherty *et al.*, 1937, p.165). Note that this might have enabled firms to pay constant or rising real hourly wages although, as emphasised by Bernanke, weekly earnings were bound to suffer.

recovered strongly between 1934 and 1937 (Cole and Ohanian, 1999). Of course, many factors would have contributed to these observations, but they are at least consistent with the above distinction between short-term reductions in work intensity followed by the need to establish full production potential. The work here shows that these two types of productivity effect considerably influenced the wage determination process during the Depression years. Where work intensity fell due to short-term uncertainty over the dimension of the downturn, the resulting excess supply of effective working hours served to dampen wage growth.[3] It had a relatively speedy and short-lived effect, however. By contrast, longer-term potential productivity growth had a significantly positive impact on wages.

Our theory is stimulated by earlier arguments that bargaining relationships between managers and workers embraced a broader agenda than merely attempting to reach agreements on market-clearing rates. Representations of wider interests are suggested in the discussion of the relevance of explicit and implicit contracts in the Depression by Baily (1983) and the arguments by Bernanke (1986) that wage and working time determination was constrained by considerations of workers' preferences and reservation utilities. We take the view that since labor productivity and work intensity were of crucial importance in this period, bargaining between the parties would have encompassed these variables. In a wider context, Johnson (1990) has explored the integration of work intensity into the bargaining process. In parallel, both our theory and empirics are strongly influenced by earlier research in which the wage determination process incorporates both intensive and extensive margin considerations (Taylor, 1970; Vanderkamp, 1973; Darby et al., 2001). Excess supply of labor at given wage rates would be expected to be only partially proxied by unemployment measures. Adding the

[3] While nominal wage inertia is generally recognised to have been strong in the early Depression period, manufacturing wages declined by about 2 percent during the first 17 months (O'Brien, 1989).

gap between actual and potential hours of existing workers provides a more complete representation

The empirical work is based on seven U.S. manufacturing industries and utilizes a data set originally constructed and analysed by Bernanke and Parkinson (1991).

2 An efficient bargain

In order to motivate our empirical approach to wage determination, we develop an efficient bargain between a firm and a risk-neutral union. We assume that the bargain embraces a wide spectrum of production and work activity; this includes the wage, employment, hours of work, the degree of work intensity, and capital. It is convenient to set up the bargaining agenda in terms of a 'typical' workweek.

The firm's production function is given by

$$(1) \qquad Q = F(\theta, h, N, K)$$

where Q is output, θ is average work intensity, h is average paid-for weekly hours, N is the size of the workforce, and K is capital stock. Work intensity is an index, with $0 \leq \theta \leq 1$. Essentially, including θ in the production function serves to convert paid-for into effective hours worked. We assume $F' > 0, F'' < 0$ and $F(0,0,0,K) = 0$, or the skills of the workforce are essential for the firm to undertake production.

Ignoring fixed costs of employment for simplicity[4], profit is expressed

$$(2) \qquad \pi = pF(\theta, h, N, K) - yN - CK$$

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[4] Thus, we discount the possibility that the union and the firm may negotiate the level of worker quality and associated training costs. For extensions along these lines see Hart and Moutos (1995).

where p is the product price, y is average weekly earnings, and c is the user cost of capital. Specifically, y = wh where w is the average hourly wage rate.

On the union side, positive utility derives from wage earnings, while disutility stems from greater work intensity over the workweek and from the loss of leisure. Assuming fixed disutilities of work intensity and hours, union utility is expressed

$$(3) \qquad \mathrm{V = N\ u(y} - \gamma\theta \mathrm{h} - \beta \mathrm{h}) + \mathrm{(M - N)\ u(y^*)}$$

where u is individual utility, M is total union membership, y* is weekly compensation in alternative employment and β and γ are constants.[5] If the parties fail to strike a bargain, union utility at the threat point is $\overline{\mathrm{U}} = \mathrm{Mu(y^*)}$.

The union is risk-neutral - i.e. $u' > 0, u'' = 0$ - and so the union's rent from an employment relationship is expressed

$$(4) \qquad \mathrm{V}\text{-}\overline{\mathrm{U}} = \mathrm{N(y} - \gamma\theta\mathrm{h} - \beta\mathrm{h}\ -\ \mathrm{y^*)}\,.$$

The generalised Nash bargain (Svejnar, 1986) is the solution to the problem

$$(5) \qquad \max_{\mathrm{y},\theta,\mathrm{h,N,K}} J = \pi(y,\theta,\mathrm{h,N,K})^{1-\alpha}(\mathrm{V} - \overline{\mathrm{U}})^{\alpha}$$

where α represents relative union strength, with $\alpha \in \{0,1\}$.

From the first-order conditions, we obtain

$$(6) \qquad \frac{\mathrm{pF_h}}{\mathrm{N}} = \beta + \gamma\theta$$

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[5] Slightly more explicitly, we can write work-related utility as Nu{y - $\delta\theta$h - β(1 - θ)h} where δ and β are parameters. This divides the workweek into effective hours worked, θh, and additional hours worked, (1 - θ)h. Disutility from the first part stems from the degree of work intensity. The second part represents non-work activity but still adds to disutility because workplace attendance is required. In general, we might expect that $\delta > \beta$. In the equivalent expression in (3) $\gamma = \delta - \beta$.

or the average marginal product of hours is equal to the cost of employing an extra hour. This cost is equal to the marginal disutility of hours worked. Similarly, we obtain

(7) $$\frac{pF_\theta}{N} = \gamma h$$

i.e. the average marginal product and marginal disutilities of effort are equated.

As for capital, the model generates the familiar condition

(8) $$pF_K = c$$

i.e. the marginal product of capital is equated to user cost.

Optimal employment is achieved by equating marginal value product to a worker's opportunity cost of work, or

(9) $$pF_N = \gamma\theta h + \beta h + y^*.$$

Of key importance to present developments, the equilibrium wage[6] is given by

(10) $$y = \alpha\frac{pQ}{N} + (1-\alpha)pF_N.$$

If workers have no bargaining power, or $\alpha = 0$, the firm is on its demand curve, with marginal product equal to the marginal cost of an additional worker. At the other extreme, $\alpha = 1$, the firm receives zero profit.

Combining (9) and (10) produces

$$y = \alpha\frac{pQ}{N} + (1-\alpha)(\gamma\theta h + \beta h + y^*)$$

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[6] The first-order condition, J_N=0, from (3), is given by $\pi^{-\alpha}U^{\alpha}(1-\alpha)(pF_N - y) + \pi^{1-\alpha}U^{\alpha-1}\alpha U/N$ =0. Multiplying through this expression by $\pi^{\alpha}U^{-\alpha}$ and re-arranging produces equation (10).

and this can be written in hourly terms as

$$(11) \qquad w = \varphi_0 + \varphi_1 \frac{pQ}{Nh} + \varphi_2\theta + \varphi_3 w^*$$

where w* is the outside hourly wage (=y*/h)[7], and φ's are parameters.

This is our core wage equation: the wage rate is dependent on hourly productivity, hourly work intensity and the outside hourly wage. Following our earlier arguments, we replace the productivity term in (11) by a measure of potential productivity (see below) in order to reflect the longer-term impact of this variable on the wage.

3 Estimation

Here, we describe how we define work intensity and the outside wage. We also present our estimating wage equation that distinguishes between long-run effects, as represented by equation (11), and short-run dynamics.

Following Fair (1985), we define work intensity as

$$(12) \quad \theta = \frac{\phi}{\phi^*}$$

where ϕ = Q/Nh is actual hourly productivity – or output per paid-for worker hours - and ϕ^* is potential hourly productivity. Our measure of ϕ^* replaces the hourly productivity term in equation (11) and is intended to capture the influence of longer-run movements in productivity on the bargained wage. The outcome $\phi = \phi^*$ implies $\theta = 1$ or the firm is operating at maximum work intensity. In this case, actual and paid-for hours of work coincide. This is assumed to occur at the cyclical peak points of ϕ $(=\phi^*)$. If $\phi < \phi^*$, actual

[7] The outside wage is expressed in terms of 'inside' weekly hours. It seems not unreasonable to assume that, in comparing inside and outside hourly earnings, workers will deflate by hours currently experienced.

productivity falls short of potential productivity. Only ϕ is provided by the data. A time series of ϕ^* is imputed by fitting log-linear segments between successive peak points.

The value of the expected outside union wage, w* in (11), results from two components weighted by their probability of their occurrence. First, the value of the expected wage obtained if the worker is re-employed. Second, the replacement rate received if the worker is unemployed. The probability of gaining employment should relate negatively to the rate of unemployment. For simplicity, we capture the fallback wage by the linear approximation

$$(13) \quad w^* = \bar{w} + \eta_1 u + \eta_2 r$$

where $\bar{w}$ is the average wage in the economy, u is unemployment, r is the replacement ratio and η's are parameters.

Based on the data provided by Darby (1976), our replacement ratio is determined by the wage of an emergency worker, funded through various New Deal programmes, and the probability of obtaining a job as part of the emergency labor force. Again, assuming a simple linear approximation, we have

$$(14) \quad r = a_0 + a_1 WEM + a_2 PEM$$

where *WEM* is the relative wage of an emergency worker and *PEM* is the probability of obtaining work on the emergency programmes (given by emergency workers employed by federal government, including major work relief programs, as percentage of unemployed plus emergency workers).

Our wage equation contains two key features. First, it captures the long-run relation between wages, potential productivity, work intensity, and unemployment. Second, we incorporate data determined dynamic influences that separate nominal wage and price changes in order to capture possible nominal inertia. The complete specification is given by

$$(15)\quad \Delta\ln(W)_t = b_0 + \Sigma b_{1i}\Delta\ln W_{t-i} + \Sigma b_{2i}\Delta\ln Pc_{t-i} + \Sigma b_{3i}\Delta\ln(\theta)_{t-i} + b_{4i}\Sigma\Delta\ln(U)_{t-i}$$
$$+ b_5\ln(W/(\lambda Pc+(1-\lambda)Pi))_{t-1} + b_6\ln(\phi^*)_{t-1} + b_7\ln(\theta)_{t-1} + b_8\ln(U)_{t-2}$$
$$+ b_9 WEM_t + b_{10} PEM_t + b_{11} STRIKE_t + b_{12} NRA_t + \text{seasonals} + v_t$$

where W is the nominal wage; Pc is consumers' expenditure deflator; θ is work intensity, U is the standard measured unemployment rate, Pi is the output price deflator, λ is an estimated parameter, and ϕ^* is potential productivity. *STRIKE* is intended to capture the resurgence of the labor movement after the New Deal and takes the value 0 up to 1935 and then is the number of man days idled by strikes. *NRA* covers any wage impact of the National Recovery Act and is set to 1 from 1933:4 – 1935:2 and to zero otherwise; v is an error term. Nominal wages, potential productivity, work intensity and the output price deflator are measured on an industry specific basis. All other variables are whole economy measures.

Our definition of the real wage is $\ln(W/(\lambda Pc+(1-\lambda)Pi))$. The price deflator comprises a weighted average of the whole consumer price deflator Pc and the industry specific output price Pi. The weight attached to Pc, λ, determines the relative importance of consumer prices in wage determination, and is directly estimated.

4 Results

Data are from Bernanke and Parkinson (1991), and we present estimates for 7 of their 10 industries. These are Leather, Lumber, Petrol, Paper and Pulp, Rubber, Steel, and Textiles.[8]

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[8] We omit two industries - Non Ferrous Metals and Sand, and Clay and Glass - because their data are available for a significantly shorter sample period. We also excluded Autos. Data for automobile production showed a pronounced cyclical pattern, which evolved over time and probably stemmed from the release of new models on an annual basis, a practice that continued throughout the Depression. We attempted to seasonally adjust this

The original data are monthly. However, we follow Bernanke and Parkinson's approach of temporally aggregating monthly to quarterly observations in order to reduce the effects of possible measurement error or temporal misalignments in data from different primary sources.

Figure 1 shows estimates of actual and potential productivity using Fair's trends-through-peaks methodology (upper graphs) and the resulting estimates of work intensity (lower graphs). In estimation, we do not use data beyond 1939 so as to avoid the impact of WWII on measured productivity. The calculated trends represent potential productivity (ϕ*) and are based on logged series, so productivity grows at a constant rate between successive peaks. The Paper and Pulp and Textile industries display downward spikes in measured productivity and work intensity that best fit with *a priori* expectations. These occur quite markedly at the time of the Depression and, again, at the recession that began in 1937. Leather is quite similar although in this case the Depression impact appears to have been delayed by one year. Steel also shows a delayed response though in this case the influence of the Depression is less clearly differentiated from other periods of productivity downswings. The Depression is clearly *the* major period of productivity decline in Petrol. By contrast, productivity movements in Lumber and Rubber do not appear to be unduly influenced by the early Depression[9], although Rubber does show a downward productivity movement in 1937.

production data prior to calculating productivity, potential productivity and work intensity. However, our resulting time series proved to be unconvincing, reflecting the difficulty in separately identifying the extent of product cycles and their affects as opposed to the impact the Depression.. A marked peak in productivity was estimated immediately prior to 1929. Productivity plummeted during the Depression, thereafter, there was a marginal recovery, but essentially productivity remained flat and well below the prior peak.

[9] While Bernstein (1987) does report short-run downturns in product demand in these two industries in the early 1930s, secular influences were clearly very strong. A slow growth in the housing market, due to immigration restrictions, together with a low rate of population growth were clearly important factors in Lumber. Also, there was a growing substitution of metal products for timber used in construction. (see Fabricant (1940)). In Rubber, the continual improvement in tyres, mounting foreign competition, and a slow development in alternative uses for the product combined to shrink the market.

Estimates of equation (15) are shown in Table 1. We adopted the general-to-specific methodology (see, for example, Hendry 1994). The general specifications for each industry incorporated sufficient lags of the differenced terms so as to be consistent with an absence of significant serial correlation. These specifications constitute a benchmark against which parsimonious representations were tested. The table reports the final equations for each industry and the coefficients represent significant contributions to wage changes.

Where contemporaneous price and wage intensity changes are included as explanatory variables there is a potential violation of the weak exogeneity assumption implicit in least squares estimation. Hence, in these cases, instrumental variable estimation is used. The instruments consist of lagged changes in prices, wage intensity and hours. In addition, the equations contain three seasonal dummies. To save space, the seasonal parameter estimates are not shown. However, we note that they were jointly significant in every case except for the Rubber equation in which the seasonals were both individually and jointly insignificant, ($F(3, 54) = 0.789$), and hence deleted. In three cases - Rubber, Textiles and Steel - we also included separate, (0, 1, -1, 0) dummy variables (one in each equation) to capture outliers that otherwise would generate non-normality in the residuals. Again, the corresponding parameter estimates are not reported to preserve space.

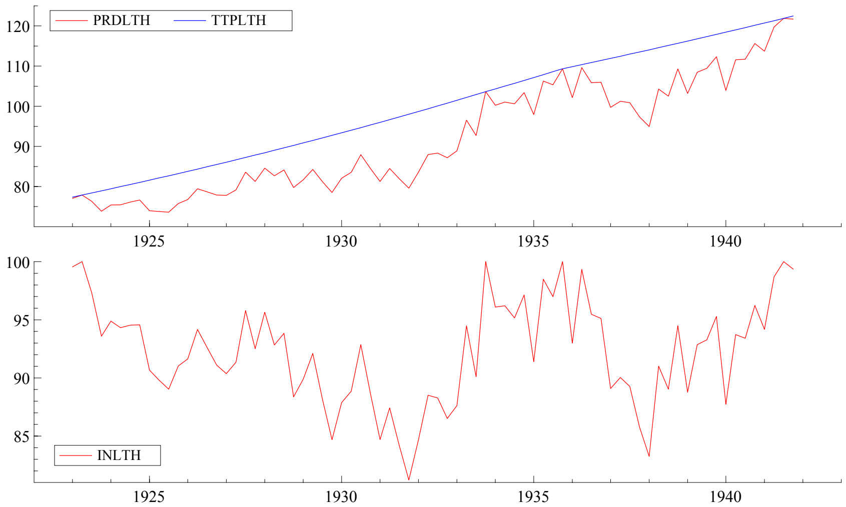
There are two major areas of interest in the results.

(i) <u>Internal and external measures of excess labor supply</u>

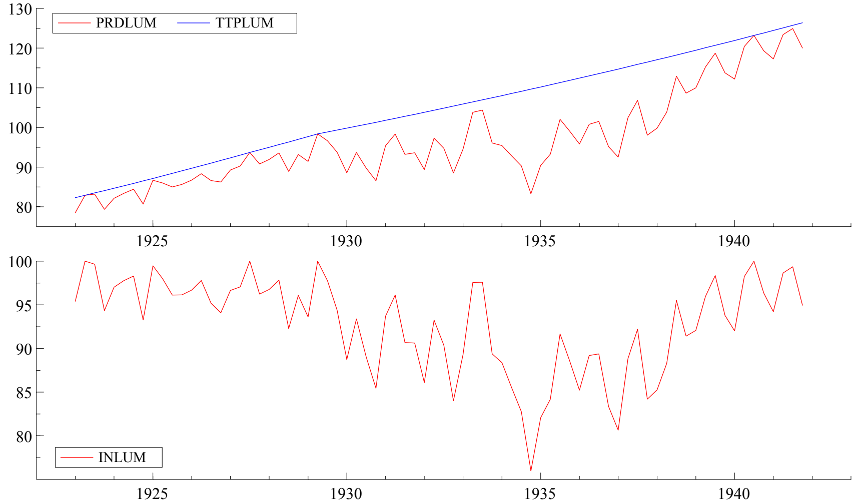
Work intensity is measured as the gap between actual and potential hours' efficiency. Changes in potential productivity only occur slowly over time, so reductions in work intensity tend to be caused by a drop in product demand that is not matched by a full adjustment in the stock of employment. Changes in work intensity have a significant impact on wage adjustments in six

Figure 1: Actual and Potential Productivity and Work Intensity in Seven Manufacturing Industries, 1921-1942

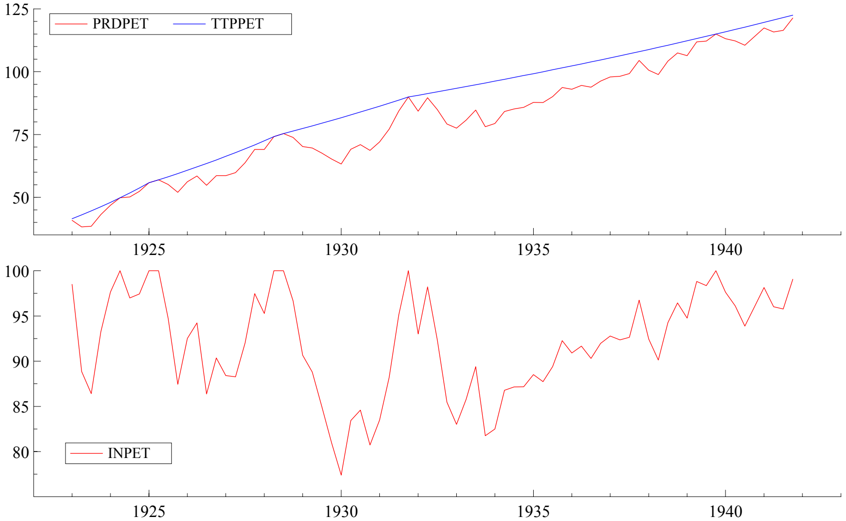
LEATHER



LUMBER



PETROL



PAPER & PULP

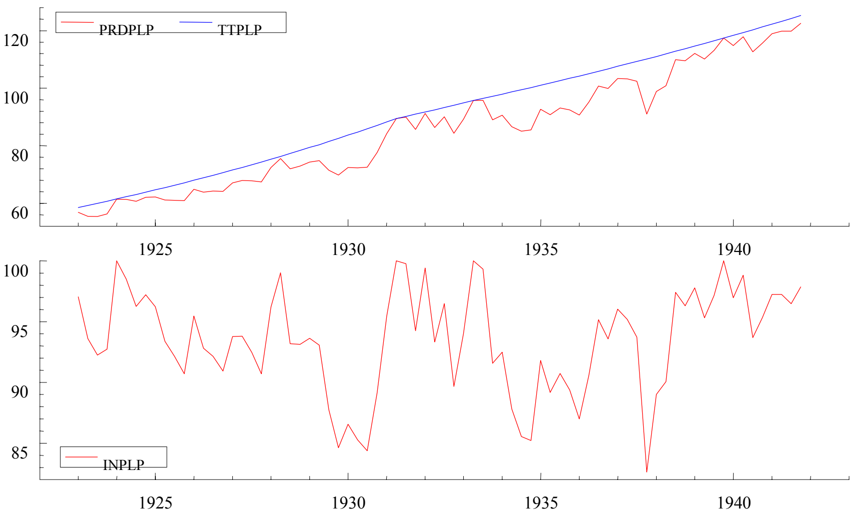
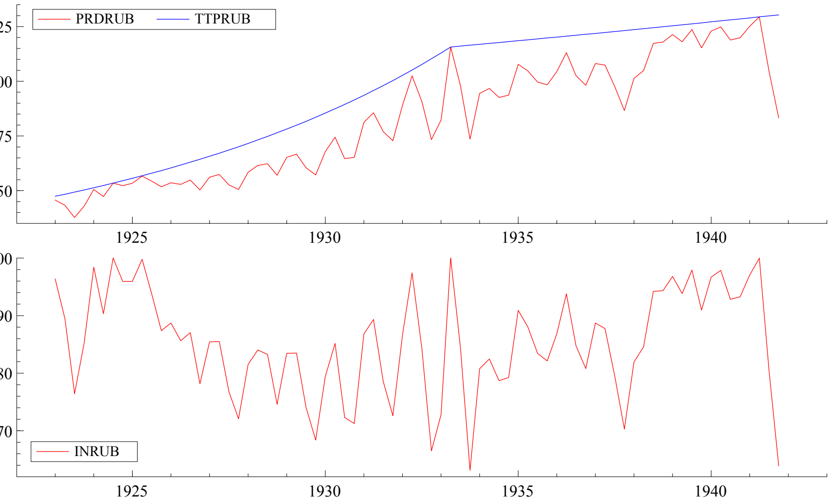
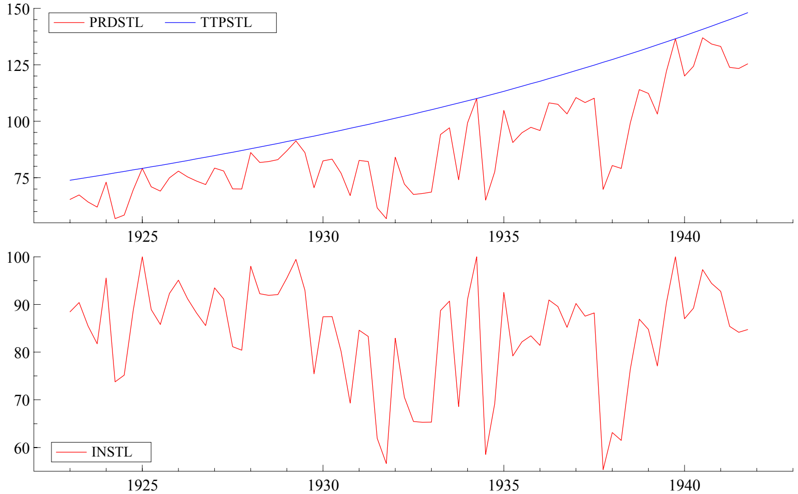


Figure 1 [continued…]

RUBBER

STEEL


PRDRUB
TTPRUB
INRUB
125
100
75
50
70
80
90
1925
1930
1935
1940


PRDSTL
TTPSTL
INSTL
150
125
100
75
60
70
80
90
1925
1930
1935
1940

TEXTILES

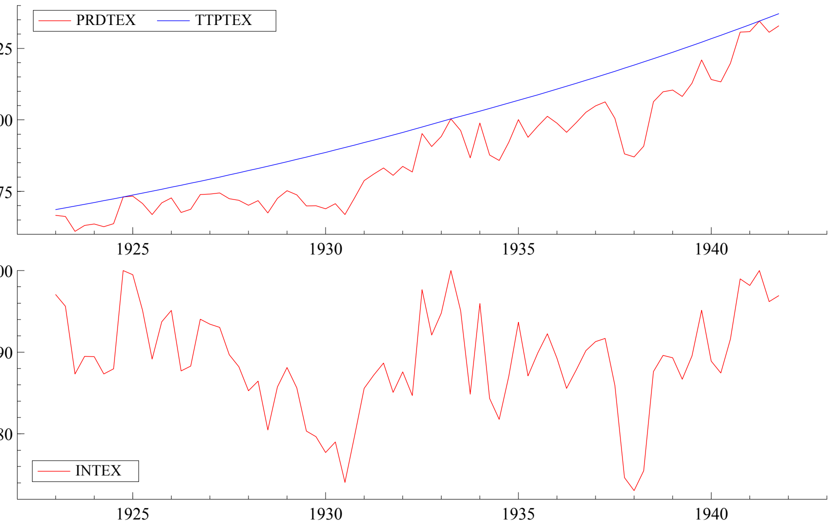

PRDTEX
TTPTEX
INTEX
125
100
75
80
90
1925
1930
1935
1940

Table 1: Estimated Wage Equations
The dependent variable is $\Delta\ln(W)$, sample period used in estimation is 1924:1-1939:4, data are quarterly, t-statistics are given in brackets.

	LEATHER	LUMBER	PETROL	PULP	RUBBER	STEEL	TEXTILES
$\ln(W-P)_{t-1}$	-0.305 (4.1)	-0.262 (3.5)	-0.103 (2.7)	-0.155 (2.9)	-0.151 (2.4)	-0.670 (7.7)	-0.499 (7.7)
Weight on Pc, λ	0.215 (1.1)	0.349 (1.9)	0.946 (4.7)	0.602 (1.7)	0.839 (5.6)	0.316 (3.9)	0.645 (5.1)
$\ln(\phi^*)_{t-1}$	0.084 (1.8)	0.262 (*)	0.092 (2.5)	0.119 (3.1)	0.068 (1.6)	0.538 (6.1)	0.232 (4.0)
$\Delta\ln(Pc)_{t-i}$	0.350 $(4.0)_t$		0.802 $(3.2)_{t-1}$	0.985 $(2.8)_t$	0.619 $(2.4)_{t-1}$	-0.724 (2.2)	0.907 $(2.0)_t$
$\Delta\ln(Pi)_{t-i}$		0.201 $(3.1)_t$	0.094 $(2.7)_{t-1}$				
$\Delta\ln(W)_{t-i}$		-0.299 $(3.5)_{t-1}$		0.302 $(3.1)_{t-1}$	-0.473 $(4.1)_{t-1}$	0.186 $(2.4)_{t-1}$	0.357 $(4.1)_{t-1}$
$\Delta\ln(W)_{t-i}$						0.141 $(2.0)_{t-2}$	
$\Delta\ln(\theta)$	0.613 $(4.9)_t$	0.294 $(3.5)_t$	0.405 $(3.8)_t$	0.272 $(4.2)_{t-2}$		0.078 $(2.8)_t$	0.149 $(3.1)_{t-2}$
$\ln(\theta)_{t-1}$		0.306 $(5.3)_{t-1}$					
$\Delta\ln(U)_{t-2}$	-0.092 (2.2)						0.098 (2.6)
$\ln(U)_{t-2}$							-0.119 (2.9)
NRA	0.041 (3.3)				0.049 (3.8)	0.063 (4.7)	0.048 (3.7)
ln(*EMW*)							0.018 (3.4)
STRIKE x 10^3					0.127 (2.6)	0.201 (3.9)	
$Rbar^2$ or $Grbar^2$	0.622	0.805	0.297	0.390	0.398	0.797	0.771
Sargan	$\chi^2(20)$ 16.99	$\chi^2(16)$ 15.59	$\chi^2(19)$ 18.35	$\chi^2(8)$ 5.169	n.a.	$\chi^2(19)$ 25.32	$\chi^2(7)$ 5.080
Serial Corr.LM1	$\chi^2(1)$ 2.587	$\chi^2(1)$ 0.288	$\chi^2(1)$ 0.031	$\chi^2(1)$ 0.429	$\chi^2(1)$ 0.082	$\chi^2(1)$ 3.250	$\chi^2(1)$ 2.827
LM4	$\chi^2(4)$ 3.541	$\chi^2(4)$ 3.700	$\chi^2(4)$ 2.001	$\chi^2(4)$ 0.862	$\chi^2(4)$ 5.394	$\chi^2(4)$ 8.217	$\chi^2(4)$ 3.799
LM8	$\chi^2(8)$ 3.964	$\chi^2(8)$ 9.789	$\chi^2(8)$ 10.13	$\chi^2(8)$ 7.958	$\chi^2(8)$ 12.60	$\chi^2(8)$ 10.75	$\chi^2(8)$ 12.32
Normality	$\chi^2(2)$ 2.938	$\chi^2(2)$ 1.731	$\chi^2(2)$ 4.315	$\chi^2(2)$ 0.263	$\chi^2(2)$ 2.563	$\chi^2(2)$ 1.928	$\chi^2(2)$ 0.140
Heteroscedast.	$\chi^2(1)$ 2.040	$\chi^2(1)$ 6.332	$\chi^2(1)$ 19.08*	$\chi^2(1)$ 5.564*	$\chi^2(1)$ 1.184	$\chi^2(1)$ 10.18*	$\chi^2(1)$ 0.223
Reset	$\chi^2(1)$ 0.024	$\chi^2(1)$ 4.138	$\chi^2(1)$ 7.688*	$\chi^2(1)$ 4.019*	$\chi^2(1)$ 8.019*	$\chi^2(1)$ 12.18*	$\chi^2(1)$ 0.862

The variable definitions, using Bernanke and Parkinson's data, are: nominal wage = pay/(emp.ahw) , converted into an index 1937=100;
real wage = nominal wage/cpi; productivity = iip/(emp.ahw); trend productivity – defined as trend through peaks – see charts, is included in the estimated equations.
Diagnostics: In the case of regressions estimated by OLS the R-bar^2 is reported. For those regressions including contemporaneous $\Delta\ln(Pc)$ and/or $\Delta\ln(\theta)$ estimation was by IV and Pesaran and Smith's Generalised R-bar-squared is reported instead. Sargan's statistic for a general test of misspecification of the model and the instruments is reported for each IV regression. The tests for Serial Correlation, Normality and Heteroscedasticity are standard. The Reset test is Ramsey's test of functional form, based on the squared fitted values. $^+$ indicates that rejection of H_0 at the 10% level of significance.

of the seven industries. Furthermore, where work intensity plays a significant role, this is predominantly captured via an impact of the change in work intensity on wages, rather than through the level of the variable. Four equations contain terms in the contemporaneous change in work intensity, $\Delta\ln(\theta)_t$, which is instrumented as noted above. Only in the Lumber industry does the *level* of work intensity enter significantly[10], and only in the Rubber industry did we fail to identify a significant effect from work intensity.[11]

The pulp industry revealed itself to be remarkably adaptable. Whilst output fell and bankruptcy was rife, there is evidence that the surviving producers became adept at developing new products[12] and anticipating market changes (Bernstein, 1987, p85.). These changes addressed head on the need to eliminate under utilisation and to restore potential productivity. Both effects come through strongly in the Pulp results in Table 1.

By contrast, we only found a significant impact of external excess labor supply, as represented by the unemployment rate, in Leather and Textiles. In the former industry, the estimated lag structure clearly indicates that work intensity has a more immediate impact on wages, with the impact from changes in the unemployment rate somewhat delayed.

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[10] This may owe something to the marked secular decline in this industry which predated the Great Depression and which in part reflected a shift in demand away from wood and toward concrete and steel for use in construction. In contrast to say the pulp industry, the lumber industry did not diversify into new products until the war.

[11] As indicated in Section 1, it is possible that work intensity could be maintained even though there is a sharp drop in product demand not matched by an employment fall. If employees work fewer days per week, or hours per day, then they could work at their productive 'norms' over a shorter working week. Tyre manufacture dominated the Rubber industry at this time. Nelson (1988) discusses the close physical proximity of the main producers, and the commonality in the technology. He suggests that human capital was industry- rather than firm- specific. Firms experienced high labor turnover, and responded by providing career employment plans, company sponsored housing, social centers etc. A 6-hour day was introduced as a way of retaining employees in key positions. "While the six hour day was an ad hoc response to the depression, it was consistent with…[Goodyear's] larger goals…[One of which] as to maintain a cadre of experienced employees…[in order to] take maximum advantage of the revival, as…in 1922" (Nelson, 1988, p. 114). This reduction in working time may well have served significantly to offset the need to reduce the degree of work intensity.

[12] The creation of new product lines included paperboard containers (which were increasingly substituted for wooden products), cheaper grades of writing paper, paper towels, tissues and various medical products.

Unemployment enters the model, along with the replacement ratio (r), through the fallback wage equation (13). In turn, r is dependent on the relative wage of an emergency worker (WEM) and the probability of obtaining work on an emergency programme (PEM) through equation (14). With the exception of PEM in the Textile regression, we found no significant effects from these latter variables. This latter result is entirely consistent with the findings reported in Bernanke (1986).

(ii) Potential productivity, consumer and producer prices, and competition

The estimates in Table l indicate that potential productivity has a strongly significant influence on wages in five of the seven industries. In the case of the Leather, significance is limited to the 10% level, or more precisely, the relevant p-value is 0.078. In the case of Rubber, the potential productivity term is statistically insignificant.

It is useful to compare the coefficient on lagged potential productivity (row 3) with that on the lagged real wage (row 1). If these coefficients are equal in size and opposite in sign, this implies that a given increase in potential productivity will lead to the same increase in real wages in the long-run, *ceteris paribus*. The summary table below reports the freely estimated long-run coefficients on productivity. The bottom row shows the result of testing the null hypothesis that wages grow exactly in line with productivity, with the relevant probability value in square brackets[13].

[13] When discussing the estimated weights on consumer prices in Table 3 we present confidence intervals rather than the results of a particular hypothesis test. In the case of the long run effect of productivity on wages, the parameter of interest is a the ratio of two parameters in the estimated equation. As such, it is not feasible to calculate standard confidence intervals. In fact, two approximations have been suggested in existing literature. First, the delta method, as used by Fuhrer (1995). This uses a Taylor series expansion to approximate the distribution of the non-linear function. Second, the Fieller (1954) method which is based on performing hypothesis tests on all possible values of the true mean – the set of possible values that is not rejected at the 5% level of significance constitutes the 95% confidence interval. This latter approach has been used to good effect in recent work by Staiger, Stock and Watson (1996). However, we have chosen not to take this approach here, since the main hypothesis of interest is whether wages kept pace with productivity improvements, so we restrict our interest to the test of a unit long-run coefficient.

Table 2 – The estimated long run impact of potential productivity on real wages

	LUMBER	PETROL	STEEL	PULP	TEXTILE	RUBBER	LEATHER
Freely est[d]	1.06	0.89	0.80	0.77	0.46	0.45	0.28 (not signif)
t-test of unit coef.	0.43[.67]	0.68[.50]	2.72[.01]	1.60[.12]	5.66[.00]	0.68[.50]	4.27[.00]

In the first two industries, Lumber and Petrol, real wage and potential productivity growth closely match one another. In a further two, Steel and Pulp, wage growth almost matches productivity growth, and in three of these cases (excluding Steel) a unit long-run coefficient cannot be rejected by the data. By contrast, in the Textiles, Rubber[14] and Leather industries our estimates suggest that wage growth did not keep pace with growth in potential productivity.

For two of these last three industries, there are strong explanations of the short fall of the wage relative to potential productivity. In the Textiles industry, exposure of established producers to increased competition appears to have dampened wage growth below what we would have expected on the basis of growth in potential productivity. In particular, Davies *et al*., (1972) note that fierce competition from expanding textile mills in Southern states had been a key factor in driving down prices and remuneration in the older established mills, well before the Depression years. In the 1930s the industry faced "fundamental alterations… not only in the sector's geographical location within the United States and around the world but also the industry's role within American manufacturing" (Bernstein, 1987). The Rubber industry benefited from large productivity gains during our sample period, largely as a result of automated tyre cutting. However, the consequent increased durability of tyres was combined with the depressed demand from a weakened Autos industry. (In general, the

[14] Though the coefficient in the Rubber equation is so poorly determined that the imposition of a unit coefficient is data admissible.

Depression had a greater impact on demand for durable goods such as Autos.) In addition, the late 1920s and early 1930s marked a significant increase in foreign competition in the Rubber industry, particularly from Malaysia. These factors would have acted to moderate wage growth even in the face of substantial advances in potential productivity.

Table 3 – Estimated weight on consumer prices and 95% confidence intervals

	LEATHER	STEEL	LUMBER	PULP	TEXTILES	RUBBER	PETROL
$\hat{\lambda}$	0.215	0.316	0.349	0.602	0.645	0.839	0.946
upper 95%	0.590	0.475	0.712	1.306	0.900	1.138	1.350
lower 95%	-0.160	0.156	-0.013	-0.101	0.390	0.539	0.542

Table 3 shows the estimated weights, λ, in equation (15), together with the associated 95% confidence intervals. The higher the estimated values of λ, the greater the relative influence of whole economy consumer prices – as opposed to industry specific output prices – in determining wages. Three industries stand out. Consumer prices appear to be more important than producer prices in the Rubber[15] and Petroleum industries, in so far as the whole 95% confidence intervals in these cases are concentrated above 0.5. By contrast, the producer price is more important in the Steel industry, with the estimated weight significantly below 0.5.[16] Of the remaining industries, Textiles exhibits some skewness toward consumer prices. In remaining cases of Leather, Lumber, and Pulp, it is harder to disentangle a differential impact on wages from consumer and producer prices.

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[15] In the Rubber industry both costs of production and the wholesale price of rubber fell. The wages paid followed the lesser movements in the general level of consumer prices, so the real wages were maintained at a level higher than they would otherwise have been.

[16] As discussed by Bernanke (1986), the severe cutback in the workweek in the iron and steel sector may well have constrained firms from cutting earnings on a pro rata basis. Attempts to maintain earnings at minimum levels may well have reduced the sensitivity of wages to consumer prices.

5 Concluding comments

The most significant and rapid response mechanism available to firms during the initial stages of the Great Depression was reductions in average working hours. However, two factors combined to prevent a fully offsetting internal response. First, short-term uncertainty over the severity of the downturn served initially to prevent radical departures from normal production activity. Second, and perhaps more important, workforce utility constraints resulted in lower weekly earnings reductions than desired by firms. The result was a positive gap between paid-for and actual hours of work. We attempt to examine the implications of this excess labor supply on wage determination. We find that decreases in work intensity served to dampen short-run wage growth across the manufacturing sector. Indeed, this source of wage impact was considerably more important than its external market equivalent, the rate of unemployment. But once expectations had been formed concerning the full severity of the downturn, firms could not afford to ignore the need to attain their full productive potential. Attempting to restore peak productivity helped to stimulate wage improvements among those workers who managed to retain their jobs.

Changes in both wage intensity and the need to re-establish potential productivity had important impacts on wage determination during the Great Depression. Combining the two provides a more complete picture of the workings of the labor market during this seminal period.

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