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EMPLOYMENT, HOURS, AND
EARNINGS IN THE DEPRESSION:
AN ANALYSIS OF EIGHT
MANUFACTURING INDUSTRIES

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**Employment, Hours, and Earnings in the Depression:
An Analysis of Eight Manufacturing Industries**

ABSTRACT

This paper employs monthly, industry-level data in a study of Depression-era labor markets. The underlying analytical framework is one in which, as in Lucas (1970), employers can vary total labor input not only by changing the number of workers but also by varying the length of the work-week. This framework appears to be particularly relevant to the 1930s, a period in which both employment and hours of work fluctuated sharply. With aggregate demand treated as exogenous, it is shown that an econometric model based on this framework, in conjunction with some additional elements (notably, the adjustment of workers' pay to permanent but not transitory variations in the cost of living, and the effects of New Deal legislation) can provide a good explanation of the behavior of the key time series. In particular, the empirical model is able to explain the puzzle of increasing real wages during a period of high unemployment.

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Introduction

Seismologists learn more from one large earthquake than from a dozen small tremors. On the same principle, the Great Depression of the 1930s would appear to present an important opportunity for the study of the effects of business cycles on the labor market: In no other period for which we have data do output, labor input, and labor compensation exhibit such severe short-run variations.

Despite this apparent opportunity, modern econometric analyses of labor markets have typically made little use of pre-World War II data. There are some important exceptions: In the class of papers that assume continuous labor market equilibrium, the best known example is by Lucas and Rapping (1969). This extremely influential piece was followed by Darby (1976), who basically supported the Lucas-Rapping approach, and by Altonji and Ashenfelter (1980) and Altonji (1982), who were critical of it. Among papers that allow for market disequilibrium, work by Rosen and Quandt (1978) and Ashenfelter (1980) should be noted.¹ However, none of the papers cited, I think it is fair to say, is the definitive study of 1930s labor markets. They share at least two deficiencies in this regard:

First, all of this work has used annual and highly aggregated data. This reflects the fact that none of the papers is focused on the 1930s per se but include pre-war data only as part of a longer-period study. Since none of the papers uses data from before 1929, any conclusion drawn about the pre-war period is based on at most ten or eleven observations.

Second, none of the papers mentioned has been particularly successful in rationalizing the movements of the key Depression-era time series. For example, none of the papers even addresses the radical fluctuations in the length of the work-week during this period, a phenomenon which the present research will argue is a quite important part of the overall story. Probably the most difficult unsolved puzzle, however, is the behavior of the real wage: Real wages rose steadily in 1930-31, even as output and employment fell sharply. There were further large rises in real wages in 1933-34 and 1937, although unemployment remained high.

Why real wages should rise when the demand for labor is presumably very low is difficult for any existing approach, equilibrium or disequilibrium, to explain: On the equilibrium side, Lucas and Rapping (1972) admitted in a reply to Rees (1970) that their model could not explain the relation of wages and employment for the period from 1933 until the

war; they did claim success for 1929–33. However, as Rees (1972) noted in his rejoinder, even this more restricted claim requires that the negative effect of falling nominal wages and prices on labor supply in 1929–33 strongly dominate the positive effect of the steadily rising real wage.

How could deflation have reduced labor supply even though real wages were rising? The original Lucas–Rapping explanation appears to be that falling nominal wages and prices depressed current labor supply by raising workers' expectations of inflation (expectations are assumed to be adaptive in the log of the price level) and lowering *ex ante* real interest rates. In light of Lucas (1972), an alternative rationale for this effect of deflation is that workers mistakenly interpreted the fall in money wages as a (local?) decline in real wages. The first explanation is hard to maintain, especially given that, *ex post*, real interest rates in 1930–33 were the highest of the century. The second explanation relies on an extremely slow diffusion of information about wages and prices. In either case, it seems unlikely that the impact of falling wages and prices would be strong enough and persistent enough to explain the data.²

The disequilibrium, or Keynesian, explanation for the behavior of real wages in the 'thirties (at least in 1930–33) is that nominal wage "stickiness" and the sharp deflation combined to create an unplanned increase in real wages; higher real wages forced firms up their labor demand curves, adding to unemployment.³ Now it cannot be denied that money wages are more "inertial" than prices (in the sense that they exhibit less high-frequency variation), although the economic interpretation of this fact is in dispute. Indeed, the present paper will conclude that the inertia of nominal wages must be given some role in the explanation of real wage behavior. However, the problem with the Keynesian story as a complete explanation, in my view, is the *degree* of unexplained wage rigidity that must be accepted in order to rationalize such a long period of labor-market "disequilibrium". For example, for their 1930–73 sample, Rosen and Quandt estimated that up to four years are required to eliminate *half* of an initial discrepancy between the actual wage and its equilibrium path.⁴

How can we decide how much wage-stickiness is "reasonable"? Modern Keynesians have frequently argued that we must take existing labor market institutions (such as non-indexed labor contracts) as "given" in our analyses of wage and labor market adjustment

(see, e.g., Fischer (1977)). If this principle is applied to the 1930s, it becomes apparent that the very slow rates of wage adjustment attributed by Keynesians to that period are inconsistent with what we know of pre-war labor market institutions and practices. Space constraints preclude a full documentation of this claim, but a few points can be made: 1) Profitability in the 1920s in manufacturing (the sector studied in this paper), and survival in the 1930s, depended on vigorous cost-cutting (the 1920s in particular were a period of highly competitive cost competition); in this spirit, firms seemed quite willing to cut wage rates sharply whenever they thought conditions warranted (as in 1921–22 and 1931–33). Wage rates were typically set unilaterally by the firm and could be varied frequently, if desired. There were also many ways of changing effective wages without reducing wage rates; e.g., elimination of bonuses, reclassification of workers, even firing workers and then re-hiring them at a lower wage (Dunn (1929), pp. 125-128.) 2) The labor movement in manufacturing was almost completely quiescent between 1923 and the later New Deal⁵, and employers fought worker attempts to install collective bargaining energetically—sometimes ruthlessly—and effectively. 3) The relatively low skill levels of the majority of workers⁶, plus the ample supplies of willing replacements⁷, reduced worker bargaining power still further. 4) Before the New Deal, government played relatively little role in labor markets, either as a regulator of labor market practices (an exception was the child labor laws) or as a provider of social insurance. Interventions by the courts in the labor market were most often on the side of employers (see Bernstein (1960), ch. 4). All of these factors reduce the plausibility of extremely rigid nominal wages as the primary explanation of 1930s real wage behavior.

The present paper gives a new structural analysis of Depression-era labor market performance, with particular attention to rectifying the two problem just cited. Instead of aggregate annual data, I employ monthly data for each of eight manufacturing industries. I also extend the sample period back to 1923, which gives more than two hundred time series observations for each industry. This previously unexploited data set (described in more detail in Section I and in the appendix) appears to be a rich source of information.

My treatment of the real wage issue is somewhat eclectic. However, the central insight motivating my approach is one due to Lucas (1970). Lucas noted that if firms vary hours of work or rates of capacity utilization (the intensive margin) as well as the number of workers

or machines (the extensive margin), then the cyclical behavior of the measured real wage is less restricted than when only the extensive margin is used. This observation seems particularly germane to the Depression, a period in which hours of work in some industries dropped by more than half. I show in this paper that an econometric model based on Lucas's insight, in conjunction with some additional elements (notably, the adjustment of workers' pay to permanent but not transitory variations in the cost of living, and the impact of government legislation) can give a good explanation of real wage behavior in the 1930s. This model (which may be of independent theoretical and empirical interest; see Section II.g) also improves our understanding of the determination of employment and hours of work during this period.

It should be stressed at the outset that this paper focuses on the labor market, not on the economy on the whole. This reduction to a partial equilibrium has the advantage of not requiring a commitment to any specific explanation of pre-war fluctuations in aggregate demand. In particular, I do not rule out (indeed, I firmly accept) the possibility that the fall in aggregate demand during the 'thirties was the result of major market failures outside the labor market. (See my 1983 paper for a discussion of the effects of the general financial collapse on the economy.) Thus, in analyzing labor markets with what is essentially a market-clearing approach, I am not committed to any claim that the level of output or employment during the 1930s was efficient. Taking aggregate demand as given also has certain econometric advantages; see below.

The paper is organized as follows: Section I discusses the data set and documents a few facts, notably the apparently perverse behavior of real wages and the large fluctuations in weekly hours. A partial equilibrium model of the labor market which builds on the insight of Lucas (1970) is described in Section II. An empirical analysis which uses this model as the starting point is discussed in Section III. Section IV reports results from some useful simulation exercises. Section V considers an alternative, more dynamic specification of the supply side of the model. Section VI concludes.

I. The Data: A Preliminary Look

As noted in the Introduction, a virtue of the present research is that it brings to bear a new and more extensive data set. In this section I first briefly describe this data set.

(The data appendix has more details. Also see the discussion in Bernanke and Powell (forthcoming).) I then point out some basic empirical observations which motivate the model developed in subsequent sections.

The data set constructed for this research includes, for each of eight manufacturing industries, *monthly* observations on the following variables:

1. Production
2. Price of output (wholesale)
3. Employment (of wage-earners)
4. Hours of work per week (per wage-earner)
5. Average hourly earnings (of wage-earners)

The sample period runs from January 1923 to December 1939. The data from the 1920s were included so that the Depression might be studied in a broader context, including a period of "normalcy". It is unfortunate that it was impossible to extend the sample even further back (see appendix).

The eight manufacturing industries covered, with measures of their relative importance, are listed in **Table 1**. (Tables and figures are at the end of the text.) The industries are diverse with respect to type of output (producers of durables, nondurables, and semidurables are represented), market structure, stage of development, geographical location, and the skill composition and demographics of the labor force. The choice of industries was not arbitrary; this was the largest set for which complete and reasonably consistent data series could be found. In particular, the desire to have series on weekly hours restricted me to industries regularly surveyed, beginning in the early 1920s, by the National Industrial Conference Board. (The Bureau of Labor Statistics, which surveyed many more industries, did not collect hours data before 1932.) Also, a number of candidate industries were eliminated by the requirement that the industrial production series be based on a measure of the physical volume of output (e.g., tons of iron), not imputed by using measures of inputs.⁸

It will be useful to have a compact summary of the cyclical properties of some of these data. To obtain such a summary, I employed a simple technique closely related to the National Bureau of Economic Research's traditional reference cycle approach (see,

e.g., Burns and Mitchell (1946)). I will refer to this technique as the “standardized cycle approach”. To construct a set of standardized business cycles, I began with the official NBER datings of turning points (Burns (1969)). For this period, the turning points were

<i>Peak</i>	<i>Trough</i>
May 1923	July 1924
October 1926	November 1927
August 1929	March 1933
May 1937	June 1938
(February 1945)	

Each of the cycles was divided into nine stages: The initial and terminal peak months were designated stages I and IX, respectively, and the trough month was designated stage V.⁹ The months between the initial peak and trough were divided as evenly as possible¹⁰ into stages II to IV; similarly, the period between the trough and the terminal peak was broken into stages VI to VIII. (Obviously, except at peaks and troughs, the length in months of a “stage” depends on the duration of the complete cycle.)

The next step was to select a list of basic and derived variables whose cyclical behavior was to be summarized. For each industry, each of these variables was first deseasonalized, then the average value of each variable during each stage of each cycle was calculated. Finally, the average values at each stage were normalized relative to the value of the variable at the initial peak of the cycle (which was set equal to 100.0). This “standardization” procedure makes it easy to compare the behavior of variables between cycles.¹¹

Table 2 reports the results of this procedure for three of the industries and for a selected set of variables. (Because the sample ends in December 1939, the final cycle is incomplete.) The three industries were chosen so as to include one producer of durables (iron and steel), one of nondurables (paper and pulp), and one of semidurables (leather tanning and finishing); otherwise, there was nothing “special” about the selected industries. The variables displayed are 1) the Federal Reserve index of industrial production (“output”); 2) employment of wage-earners; 3) length of the work-week (“hours of work”); 4) average hourly earnings (“wages”); 5) average hourly earnings, deflated by the cost of living (“real wages”); and 6) average hourly earnings, deflated by the product price (“product wages”).

Table 2 summarizes quite a bit of information. For example, consider the production

and employment columns: Although the great severity of the 1929-37 cycle is well-known, one observes here that even the "milder" pre-war cycles were quite pronounced, especially for durable goods industries.

Of particular interest in Table 2, however, is the behavior of real wages. The "perverse" wage behavior alluded to in the Introduction can be easily seen: Except for the 1937-39 cycle in iron and steel, in which the real wage dipped slightly, in each of the three industries and in each cycle (including the two mild cycles in 1923-29) the real wage *rose* as production and employment fell. The tendency towards real wage countercyclicalities in the pre-war period has been confirmed more formally by Bernanke and Powell, who studied the same data using vector autoregression and frequency domain techniques.¹² This countercyclicality is equally apparent if indexes of wage rates¹³ are used instead of average hourly earnings to measure real wages; it also seems to hold for the manufacturing sector as a whole (see, e.g., Stockman (1983)). The tendency of real wages to rise despite high unemployment is especially striking during the major Depression cycle (1929-37): Real wages rose during the initial downturn (1930-31). They rose sharply again in 1933-34 and 1937, despite unemployment rates of 20.9% in 1933, 16.2% in 1934, and 9.2% in 1937 (according to Darby's (1976) correction of Lebergott's (1964) figures). In contrast, Bernanke and Powell found some evidence of real wage procyclicalities in similar data for the postwar period.¹⁴

Under the consensus view¹⁵ that pre-war business cycles were driven by fluctuations in aggregate demand, not aggregate supply, the behavior of real wages during this time is something of a puzzle. In the simplest supply-demand framework, if a recession can be represented as a downward shift in the current demand for labor, and the supply of labor is relatively stable, one would expect a decline in real wages as output and employment fall. Even the more sophisticated intertemporal substitution or Keynesian models (as discussed in the Introduction) have difficulty in fully explaining this behavior of wages.

A model in which countercyclical real wage behavior can be rationalized (in the weak sense that the model has no implication for the cyclical behavior of wages) has been set forth in a short paper by Lucas (1970).¹⁶ The key feature of that model is that firms can vary not only the number of workers and machines they employ, but the number of hours per period which the workers and machines work. Firms face stable wage schedules which define what workers must earn to be willing to accept a work-week of a certain

length. The optimization over the number of workers and the length of the week is well-defined. However, the first-order condition that determines the work-week depends on the *marginal wage*, i.e., the increment to total earnings required to induce workers to work a marginal hour. This marginal wage will not necessarily be systematically related to the *average wage*, i.e., total earnings divided by total hours of work, which depends on the infra-marginal properties of the wage schedule. Thus the cyclical behavior of the average wage (which is the conventionally measured real wage) can be shown not to be restricted by the theory.

Given Lucas's observation, one may wonder if variations in the work-week could be an element in the explanation of the behavior of the real wage during the pre-war period. The columns headed *Hours of work* in Table 2 reveal readily that short work-weeks were indeed an important way of cutting back labor input in downturns. The magnitude of the work-week reductions, which was impressive, appears to have been a result not only of the severity of pre-war cycles but also (as documented by Bernanke and Powell) of a greater reliance of pre-war employers on short weeks instead of layoffs as a means of reducing labor input. The cut-backs in hours were long as well as deep: For example, in iron and steel the hours of work (which were about fifty-five hours per week in the late 1920s) did not average as much as forty hours weekly in any year from 1932 to 1939, and for long periods were considerably less.

Variations in hours were thus quite significant; indeed, the persistence of short work-weeks is something of a puzzle in itself. In what follows I investigate how the two phenomena, countercyclical real wages and variable hours of work, may be related. The next section develops a model in which, as in Lucas (1970)¹⁷, the distinction between the number of workers and the hours of work is important. This model forms the basis (with the imposition of specific functional forms and some additional elements) for the subsequent empirical analysis of these data.

II. The Supply and Demand for Workers and Hours of Work: A Model

a. Setting

Since my data are for individual manufacturing industries, for concreteness in what follows I will consider the supply and demand of labor for a "primary" (manufacturing)

sector. Each primary sector is to be thought of as being surrounded by its own “secondary” or alternative sector, in which people work at agriculture, trade, or services, or are not formally employed. The demand for the output of primary sectors is assumed to be more cyclically sensitive than the demand for secondary-sector output. Primary sectors are also assumed to be separated on some dimension (geographical or otherwise) from other primary sectors and thus do not compete directly with each other for workers. (This last assumption seems to be realistic for the 1930s; while there was much movement of workers between manufacturing and the secondary sector, few workers moved from one manufacturing sector to another. See, e.g., Bakke (1940), p. 242.)

To re-emphasize: Discussions below of the supply or demand for labor refer *only* to the primary sector. The secondary, less cyclical sector is not explicitly modelled.

b. The supply side

In this model we shall be concerned with the determination of both 1) the length of the work-week, and 2) the number of workers employed, not just the total number of hours worked. Thus, on the supply side, we shall have to consider both the willingness of the individual worker to increase hours of work *and* the sensitivity of the participation rate to the returns available in the primary sector. Let us first examine the supply of hours of work by an individual worker, worker i . I will characterize the individual’s supply curve of hours indirectly, through a function describing his reservation level of earnings for each level of hours worked. (This is the analogous construct to Lucas’s (1970) wage schedule, $w(s)$.) Let E_{it} be the nominal earnings received by worker i in period t , H_{it} be the number of hours worked by i in t , and θ_{it} be a set of unspecified exogenous indicators known to worker i in t . Let COL_t be the period- t cost of living, which will be assumed for now to be public knowledge. Now define the *earnings function*

$$E_{it}(H_{it}, COL_t, \theta_{it}) \tag{2.1}$$

to be the minimum (nominal) earnings necessary to induce worker i to work H_{it} hours (in the primary sector) in period t , given the cost of living COL_t and indicators θ_{it} .

I have begun by introducing the earnings function to emphasize that it is a very general concept, well-defined for almost any specification of the worker’s preferences and

environment. However, I will here make a number of restrictive assumptions in order to derive the earnings function for a specific, particularly simple case. I assume first that the worker has a temporally separable utility function, with within-period utility

$$U_i = U_i(C_{it}, \bar{H} - H_{it}) \quad (2.2)$$

C is consumption and $\bar{H} - H$, the complement of hours of work, is leisure. I assume also that the worker cannot borrow or lend, but simply consumes his earnings each period ($C_{it} = E_{it}/COL_t$). With these two assumptions I rule out some complexities that occur when workers can intertemporally substitute consumption and leisure; but see Section V below. Finally, suppose that the worker has a reservation level of utility U_{it}^* , which he is able to obtain in the secondary or alternative sector. (Here, U_{it}^* is the datum affecting the worker's labor supply, i.e., $\theta_{it} = U_{it}^*$.) In this case the earnings function can be constructed period by period; it is defined by

$$U_i(E_{it}(H_{it}, COL_t, U_{it}^*)/COL_t, \bar{H} - H_{it}) = U_{it}^* \quad (2.3)$$

for $H_{it} > 0$; $E_{it} = 0$, otherwise. That is, the earnings function is an indifference curve in (E, H) -space. With normal curvature assumptions on the utility function, (2.3) implies that the earnings function will be increasing and convex in hours, as well as increasing in the reservation level of utility. See **Figure 1**.

An important feature of the earnings function defined in (2.3) is that there is a discontinuity at zero hours: No payment is required to induce zero hours, but the earnings function is positive as hours approach zero from the right. The implicit assumption underlying this feature is that a worker who works any positive amount of hours in the primary sector must leave the secondary sector completely, i.e., there is no moonlighting. Although the existence of the jump at zero hours is important for obtaining countercyclical real wages, it should be emphasized here that the no-moonlighting assumption is much stronger than I need. With moonlighting, the earnings function will take lower values for small H than is suggested by (2.3), because workers will be able to make use of the extra time; however, as long as there is any fixed cost associated with moving between jobs, or simply a cost of going to work, the discontinuity in the earnings function will exist.

Consider now the second component of labor supply, the supply of individual workers (i.e., the primary sector participation rate). I model labor supply to the primary sector as increasing in the utility level offered by that sector. This can be motivated simply as follows: Assume that workers are alike in their productivity and in their utility functions, but that they differ in their secondary sector opportunities (or in other factors that affect reservation utility, such as dislike for primary-sector types of work). Specifically, let

$$U_{it}^* = \gamma_t \Omega_i \quad (2.4)$$

where γ_t is a purely time-dependent scalar and Ω_i is an individual-specific constant. The distribution function of Ω_i in the population is $G(\Omega_i)$; $G(0) = 0$ and $G(\infty) = \bar{N}$, where \bar{N} is the total population of potential workers. Assume that the reservation utilities of individual workers are private information, so that workers must be treated identically.¹⁸ Then, if the primary sector wishes to employ N workers, it must provide each worker with a utility equal to at least $\gamma_t G^{-1}(N)$. Alternatively, the supply curve of workers in period t , $N_t^*(U_t^*, \gamma_t)$, can now be defined by

$$N_t^*(U_t^*, \gamma_t) = G(U_t^*/\gamma_t) \quad (2.5)$$

The total cost to the primary sector of employing N workers for H hours each in period t can be written

$$NE(H, COL_t, \gamma_t G^{-1}(N)) \quad (2.6)$$

Per-worker earnings E can now be seen to depend positively on the level of primary-sector employment N and the index of alternative opportunities γ , as well as on hours of work H and the cost of living COL .¹⁹

c. *The demand side*

We now examine the behavior of the representative firm in the primary sector, firm j . The price of the firm's output is taken as given; thus, to calculate the firm's derived demand for labor, we need only to specify the production function.

The usual specification of the production function assumes that employment and the number of hours each employee works enter multiplicatively, e.g., as

$$Q_{jt} = F(L_{jt}, X_{jt}) \quad (2.7)$$

where Q_{jt} is the output of firm j in t , L_{jt} is simply total worker-hours (i.e., $L_{jt} = N_{jt}H_{jt}$, where N_{jt} is firm employment and H_{jt} is the length of the work-week), and X_{jt} is a vector of non-labor inputs. However, as Feldstein (1967) and Rosen (1968) have noted, the assumption that employment and hours worked enter multiplicatively may not be a good one: For example, lengthening the work-week by a given percentage may affect output differently than increasing the number of workers by the same percentage.²⁰ Since here I particularly want to focus on the distinction between hours of work and the number of workers, I follow Feldstein in specifying the production function as

$$Q_{jt} = F(N_{jt}, H_{jt}, X_{jt}) \quad (2.8)$$

This is more general than (2.7) if the assumption is maintained that (say, for technological reasons) each worker in the firm has a work-week of the same length.

The profit maximization problem for firm j can be written

$$\max_{\{N, H, X\}} pF(N_j, H_j, X_j) - N_j E(H_j, COL, U^*) - r(X_j) \quad (2.9)$$

where p is the output price, $r(X_j)$ is the cost of X_j , and the time subscripts are suppressed. U^* , the reservation utility of the marginal worker, depends on sectoral employment N , not firm employment N_j , and is parametric to the firm; its determination will be discussed in a moment.

The relevant first-order conditions are

$$pF_N = E \quad (2.10)$$

$$pF_H = N_j E_H \quad (2.11)$$

where now the capitalized subscripts denote differentiation (with respect to firm-specific variables) and the notation has been abbreviated further, in the obvious way. Equation (2.10) says that the firm should hire extra workers up to the point that their marginal revenue product each week just equals their weekly earnings. (2.11) says that the marginal benefit of increasing the length of the firm's work-week, H_j , should be set equal to the marginal cost, which is the number of workers employed times the increment to their earnings required to get them to work the extra time.

The second-order conditions are

$$pF_{NN} < 0 \quad (2.12)$$

$$pF_{HH} - N_j E_{HH} < 0 \quad (2.13)$$

$$\Delta = \det \begin{pmatrix} pF_{NN} & pF_{NH} - E_H \\ pF_{NH} - E_H & pF_{HH} - N_j E_{HH} \end{pmatrix} > 0 \quad (2.14)$$

which are assumed to hold.²¹

This treatment of the number of employees and the length of the shift as separate inputs allows for an explicit analysis of firm preferences for, say, layoffs instead of work-sharing as a way of reducing labor input when demand falls. By implicit differentiation we obtain

$$\frac{dN_j}{dp} = \frac{1}{\Delta} (F_N(N_j E_{HH} - pF_{HH}) + F_H(pF_{NH} - E_H)) \quad (2.15)$$

$$\frac{dH_j}{dp} = \frac{1}{\Delta} (-pF_H F_{NN} + F_N(pF_{NH} - E_H)) \quad (2.16)$$

where $\Delta > 0$ is given in (2.14). The second-order conditions imply that the expressions in (2.15) and (2.16) will normally be positive, that is, they will be positive unless E_H greatly exceeds pF_{NH} .²² Thus, we may expect firms to react to depressed demand with both layoffs and work-sharing, as indeed they did in the Depression.²³

It is also possible to calculate how the firm's input demands will respond to a change in the reservation level of utility U^* . By implicit differentiation

$$\frac{dN_j}{dU^*} = \frac{1}{\Delta} ((pF_{HH} - N_j E_{HH})E_{U^*} + N_j(E_H - pF_{NH})E_{HU^*}) \quad (2.17)$$

$$\frac{dH_j}{dU^*} = \frac{1}{\Delta} ((E_H - pF_{NH})E_{U^*} + pN_j F_{NN} E_{HU^*}) \quad (2.18)$$

E_{U^*} , which is equal to $\frac{COL}{U_C}$, is known to be positive. E_{HU^*} is positive if $U_{CC}U_H - U_{CH}U_C < 0$, which will be true for example if consumption and leisure are complements or weak substitutes. Under the same assumption that guaranteed above that employment is not an inferior input, i.e., that $E_H - pF_{NH}$ is not large positive, we can conclude from (2.17) that $dN_j/dU^* < 0$, or that the firm's demand for workers decreases as their reservation utility U^* rises. If $E_H - pF_{NH}$ is not large positive, (2.18) says that hours per employee will also decline as reservation utility rises.

d. Sectoral equilibrium

Determination of equilibrium employment and hours in the primary sector is now straightforward. We have seen that the supply of employment increases with the level of utility U^* available in the primary sector, while the demand for employment can be expected to decrease with U^* . If there are n firms in the primary sector, the equilibrium level of reservation utility, call it U^{**} , satisfies

$$N_t^s(U_t^{**}, \gamma_t) = \sum_{j=1}^n N_{jt}^d(U_t^{**}, p_t) \quad (2.19)$$

This level of utility is just enough to make the marginal worker indifferent between the secondary and primary sectors; inframarginal workers obtain a surplus in equilibrium.

Given U^{**} , p , and the N_j 's, we may think heuristically of firms choosing hours of work H_j according to condition (2.11). (Of course, strictly speaking everything is determined simultaneously.) This is represented in **Figure 2**, which shows H_j^* being chosen at the level at which the per capita total revenue product curve (pF/N_j , written as a function of H_j) is parallel to the earnings function. Since the earnings function is an indifference curve, workers do not care what level of hours the firm chooses: Different firms in the industry (if they have different production functions) may well choose different work-weeks in equilibrium. Indeed, since "wages" are simply average hourly earnings, and since earnings functions are not rays through the origin (recall the discontinuity at zero), firms using different work-weeks may also be paying different wages in equilibrium. This result, which would be paradoxical in the traditional model, poses no problem here; workers comparing jobs look not at the wage but at the total utility (the combination of earnings and hours of work) available.

Although workers are indifferent to the point on the earnings function selected by the firm, Figure 2 suggests an interesting observation. Note that a ray from the origin (OA) intersecting the earnings function at H_j^* cuts through the earning function from below. This implies that, as might often be the case, the average wage (E/H) exceeds the marginal wage (E_H) at equilibrium hours. Thus, workers would happily work more hours *at the average wage*. That they are “constrained” not to do so is not the result of any market failure or disequilibrium, but of the difference between the marginal and average wage.

e. Countercyclical real wages

It is straightforward to generate countercyclical real (average) wages in this set-up. Since the primary sector is by assumption cyclically sensitive, declining aggregate demand will cause the relative price of its output to fall. Without loss in generality, assume that the cost of living COL is unchanged while the output price p falls.

If N_j and H_j are normal inputs (i.e., the expressions in (2.15) and (2.16) are positive) firm (and industry) usage of both will fall as demand falls. For the moment, ignore the decline in N_j and consider only the effects of falling H_j :

Falling hours of work can be represented as a movement to the left on the earnings function (cf. Figure 1). The reduced demand for hours will unambiguously reduce the *marginal wage*, E_H . However, the effect of falling hours on the *average wage* (and the average real wage, since COL is fixed) is ambiguous. The necessary condition for average wages to rise as hours fall is that the elasticity of earnings with respect to hours be less than one. This would be satisfied, for example, if U^* is not close to zero and the marginal disutility of labor does not increase quickly (i.e., the earnings function is close to linear, with a positive intercept). (To anticipate, the empirical results do typically confirm that this elasticity is less than one.)

The intuitive story underlying countercyclical real wages is as follows: A fall in industry demand causes employers to shorten the work-week. (The use of short work-weeks is rationalized in the current setting on static efficiency grounds, e.g., it may be technologically more efficient to run the factory part-time with a full complement of workers than to operate full-time with a skeleton crew. In a more explicitly dynamic set-up, as discussed in the next section, the preference for short time may also reflect a labor-hoarding motive.)

Workers will be benefited by the shorter hours of work, but will dislike the reduction in weekly earnings arising from short work-weeks. The rate at which firms can reduce weekly earnings as the work-week falls depends on workers' preferences and reservation utilities. Especially at low levels of work and earnings, when consumption is highly valued relative to leisure, it may not be possible to cut weekly earnings as sharply as hours and still meet the reservation utility constraint. Thus the wage (i.e., hourly earnings) may rise even as labor demand and work-weeks fall.

The iron and steel industry, as described by Daugherty *et al.* (1937) provides an illustration of these points. The work-week dropped extremely sharply during the 1930s in this industry. This occurred both because firms found it efficient to cut production by running certain operations only part-time, and because firms' desires to maintain their work-forces relatively intact led them to adopt "staggered" or "spread-work" schedules under which many workers worked only a few days a week (pp. 163-5). The problem posed by short work-weeks for most workers was the obtaining of a basic sufficiency of income: It was estimated that in 1932-33 the weekly earnings of the average steelworker (not to mention the lowest paid) was less than half of that needed to reach a standard of "minimum health and decency" for a family of four (pp. 155-7). Moreover, "in most iron and steel communities there [were] few other opportunities for supplemental employment and income" (p. 167). Firms must have recognized that their ability to keep cutting total earnings as the work-week shortened was limited, since if workers could not attain a subsistence level in the mill town they would be forced to try elsewhere. Thus real hourly earnings in iron and steel rose, or fell relatively slightly, as the work-week was cut.

The above discussion has emphasized the possibility that, *ceteris paribus*, a reduction in the work-week may tend to raise the real wage. This effect of falling hours of work will be offset to the degree that lower demand for industry output also results in lower primary-sector employment N . Declining demand for employment, as well as any reduction in secondary-sector opportunities which result from the general downturn, will lower the equilibrium reservation utility level U^{**} . Lower U^{**} translates into a downward shift of the earnings function, which implies lower average wages for a given H . The net impact of the decline in the demand on average wages will depend on the relative strength of the various influences. In general, as in Lucas (1970), the cyclical behavior of the wage will be

unrestricted.

An interesting implication of this analysis is that economies which rely more heavily on short work-weeks (rather than employment reductions) as a way of reducing labor input are more likely to have countercyclical real wages. Using the same data as this paper, plus a matched data set for the post-war period, Bernanke and Powell verified that Depression-era manufacturing industries did indeed exhibit both a greater relative reliance on variations in the work-week and greater countercyclicality in wages than did their post-war counterparts.

f. Skilled and unskilled workers

Until now we have assumed that workers are alike with respect to the production process. In the empirical work it turns out that the changing skill mix over the cycle is of some importance. We consider this issue briefly now.

Suppose there are two types of workers, skilled and unskilled. Assuming that skilled and unskilled workers have systematically different opportunities in the secondary sector, or that they differ in number, they will have different supply functions. We can write the two supply functions in a given period, in the obvious analogy to (2.5), as $N_1^*(U_1^*, \gamma_1) = G_1(U_1^*/\gamma_1)$ and $N_2^*(U_2^*, \gamma_2) = G_2(U_2^*/\gamma_2)$, where the indexes 1 and 2 denote skilled and unskilled workers respectively, and time and firm subscripts are suppressed. The corresponding earnings functions for the two groups are $E_i(H_i, U_i^*)$ where $U_i^* = \gamma_i G_i^{-1}(N_i)$ and $i = 1, 2$. Normally, if $H_1 = H_2$, we expect to observe only N_i such that $E_1 > E_2$; that is, skilled workers earn more than unskilled.

On the demand side, assume that skilled and unskilled workers must be used in fixed coefficients, but that the ratio of skilled to unskilled falls as the length of the work-week (a proxy for the scale of production) expands.²⁴ Specifically, assume that if a firm is running the factory H hours per week, then a fraction $g_1(H)$ of its workers must be skilled and a fraction $g_2(H)$ unskilled, where $g_1 + g_2 = 1$ and $g_1(H)$ is decreasing in H . Then the firm's production function can still be written as in (2.8). Moreover, under the assumption that the skilled and unskilled must work the same number of hours, it is possible to write an average earnings function for the firm

$$\bar{E}(H, COL, U_1^*, U_2^*) = \sum_{i=1}^2 g_i(H) E_i(H, COL, U_i^*) \quad (2.20)$$

where as before the U_i^* depend on total sectoral employment but are parametric to the firm.

The firm's optimization problem is not substantially complicated by the extension to skilled and unskilled workers (under the convenient assumptions that have been made): The firm finds optimal hours and total employment in precisely the same manner as in II.c above, except that the average earnings function \bar{E} defined in (2.20) is used in place of the simple earnings function E . The division of employment into skilled and unskilled is then found by applying the ratios $g_1(H^*)$ and $g_2(H^*)$ to the optimal level of total firm employment.

The point of this digression is to highlight the effect of the changing skill mix on the properties of the empirically observed, average earnings function \bar{E} . Earnings functions defined for workers with identical utilities and productivities, e.g., the E_1 and E_2 , must be increasing, convex functions of hours, for $H > 0$. However, since the low-skilled and low-earnings fraction of the work-force varies procyclically, the *average* earnings function \bar{E} will be flatter and have a lower elasticity than *either* E_1 or E_2 taken separately. This has two implications: First, the empirically observed earnings function may not be convex in hours.²⁵ Second, as was shown above, a lower elasticity of the earnings function increases the probability of observing countercyclical real wages. Thus cyclical variation of the skill mix may be an additional factor contributing to the solution of the wage puzzle.

g. Implications for the standard approach

The model set forth in the preceding sections may seem outlandish to users of the standard labor market model (in which total worker-hours supplied and demanded are simply written as functions of the real wage). I claim, however, that the present model has a stronger prior claim than does the standard approach to being the correct way to model aggregate labor markets. The problem with the standard model is that, contrary to its major premise, workers are in fact typically not able to vary their labor supply continuously with respect to a parametric real wage; instead, they must choose among "packages" of total compensation, hours of work, and other job attributes offered by employers. The economic reason for the prevailing arrangement, as suggested above, is that there are usually economies or diseconomies of "bundling" of worker-hours: Supplying one hour of work each

to eight different employers is not the same to a worker as supplying eight hours to a single employer. Similarly, employers are not indifferent between receiving one hour of work from eight different workers and receiving eight hours from one worker. As long as economies or diseconomies of bundling worker-hours exist, the standard model cannot be literally correct.

Inappropriate use of the standard model can lead to misconceptions. For example, the debate between supporters and defenders of the Lucas–Rapping intertemporal substitution hypothesis has centered on the time series properties of the real wage (see, e.g., Altonji and Ashenfelter (1980)). However, if the approach of the present paper is correct, rather than the standard model, then the behavior of the real wage is largely irrelevant to that debate.

Another example concerns the estimation of labor supply elasticities: Suppose workers have identical utility functions, given by

$$U = (E_t/COL_t) - \phi H_t \quad (2.21)$$

That is, the marginal utility of consumption (equal to real earnings) and the marginal disutility of hours of work are constant. The labor supply elasticities of these workers (in the conventional sense) are infinite. But what will researchers using aggregate data and assuming the standard model find? Suppose that the model of the present paper actually applies, and that reservation utilities U_{it}^* are distributed in the population as assumed in Section II.b above. Then it is easy to show that the aggregate real wage w_t is given by

$$w_t = \frac{\gamma_t G^{-1}(N_t)}{H_t} + \phi \quad (2.22)$$

Note that $\partial w/\partial N > 0$, $\partial w/\partial H < 0$. The observed relationship between worker-hours and the wage thus depends on whether N or H is more variable. Suppose, at one extreme, that the work-week is institutionally fixed: Then the econometrician regressing total worker-hours against the wage will find a positive (although not infinite) elasticity, since all variation in worker-hours is attributable to changes in employment. At the other extreme, suppose that work-weeks but not employment vary. Then the estimated aggregate labor supply curve will be *backward-bending*. The econometrician may well be concerned about the “instability” over time of his estimates, and their lack of relation to labor supply

elasticities found in micro-level panel data. The problem, however, does not lie with data or identification problems, but with the use of the wrong model.

III. Empirical Implementation

This section specifies an empirical model and reports the results of its estimation for each of the eight manufacturing industries. The estimated model is based closely on the analysis of the previous section but contains substantive additional elements as well.

a. Specification of the supply side

The supply side in this model is summarized by the earnings function faced by each primary sector (manufacturing industry), as in (2.6). Average weekly nominal earnings received by wage-earners in an industry have been shown to depend on four elements:

- 1) the length of the industry work-week H (now assumed to be the same for all firms)
- 2) industry employment N
- 3) factors affecting workers' reservation utilities, γ
- 4) the cost of living COL

Hours and employment for each industry and the economy-wide cost of living are directly observed. The most difficult problem is to identify monthly determinants of workers' reservation utilities. Two factors which I expected to be important here were the level of government relief and the strength of the labor movement. As measures of these factors I constructed two (monthly) variables, *EMERGWORK* and *UNIONPOWER*. (A list of all variables used in estimation is given in **Table 3**, below.) *EMERGWORK* is the log of the number of "emergency workers" employed by the Federal government, including all of the major work relief programs. *UNIONPOWER* attempts to capture the resurgence of the labor movement after the favorable legislation of the New Deal: This variable is set equal to zero until May 1935, the month the Wagner Act was passed. (The labor movement was extremely weak between 1923 and 1935; see note 5.) Starting with May 1935, *UNIONPOWER* is set equal to the cumulative number of man-days idled by strikes (in the economy as a whole²⁶). The idea here is that strikes are an investment in the capital good of union credibility, which in turn affects the level of earnings workers are able to demand. (There is in fact a close correlation in this period between strike activity and the major new union recognitions and contracts that were achieved.)

The basic earnings function that I estimated was of the form

$$\begin{aligned} \widetilde{EARN}_t = & \alpha_0 + \alpha_H HRS_t + \alpha_E EMPLF_t \\ & + \alpha_W EMERWORK_t + \alpha_U UNIONPOWER_t \\ & + \alpha_N NRA_t + COL_t + \alpha_t t \end{aligned} \quad (3.1)$$

where

$$\begin{aligned} \widetilde{EARN}_t = & \log(\text{nominal weekly earnings} - \\ & \text{cost of living} * INTERCEPT) \end{aligned} \quad (3.2)$$

and where the variables are as in Table 3. Equation (3.1) says that the log of nominal weekly earnings (less an intercept term, to be discussed in a moment) is a positive function of the log of hours worked per week, *HRS*; a positive function of the log of industry employment (normalized by national labor-force), *EMPLF*; a positive function of workers' reservation utilities, as measured by *EMERWORK* and *UNIONPOWER*; and is related one-for-one to the log of the current cost of living *COL* (i.e., there is no money illusion or imperfect information about price levels). Also included in the equation are a time trend (to capture secular influences on reservation utilities, like demographics or wealth accumulation); and a dummy for the National Recovery Act period of September 1933–May 1935 (*NRA*), during which legislation affecting wages and hours may have had a direct impact on earnings.

The dependent variable of (3.1), which is defined in (3.2), is not simply the log of nominal weekly earnings, but the log of nominal weekly earnings less an expression which is constant when measured in real terms. This is in order to conform to a basic premise of the theory, that there is a discontinuity in the earnings function at zero; i.e., workers require some minimum pay "just to come to work". I did not expect to be able to estimate a value of the constant term *INTERCEPT* from the data, since sample values of hours worked are never very near zero and the earnings function is likely to be non-linear in a relatively unrestricted way. Instead, for each industry I arbitrarily set *INTERCEPT* equal to the real value of six hours' pay at the rate paid in June 1929; i.e., the "fixed cost of coming to work" was assumed to be equal to one hour's real pay for each day in the standard

work-week. The exact value chosen for *INTERCEPT* was not at all crucial; I tried values from zero to twelve hours' pay without affecting the qualitative nature of the results.

Equation (3.1) was estimated, and "worked" fairly well empirically, in the sense that the estimated coefficients were of the right sign and were statistically significant. However, the estimated equations also had low Durbin-Watson statistics and did not perform particularly well in simulations. After some examination of the data, I recognized that the restriction in (3.1) that nominal earnings must be directly proportional to the current cost of living is not a good one. If this constraint were correct, it would imply that the high-frequency variation of earnings should be similar to that of the cost of living. In fact, the usual result that nominal labor compensation variables are "smoother" than price-level variables holds in these data.

To capture this smoothing effect, I assumed that nominal earnings respond only to the "permanent" component of cost-of-living changes, in the sense of Muth (1960). That is, nominal earnings are proportional not to *COL* but to *COL**, where *COL** is defined by

$$COL_t^* = \lambda_P COL_t + (1 - \lambda_P) COL_{t-1}^* \quad (3.3)$$

Alternative interpretations of this assumption are that earnings are set each period on the basis of adaptive forecasts of the cost of living (cf. Lucas and Rapping (1969)); or that costs of rapidly adjusting wage rates cause employers to attempt to smooth out the effects of cost-of-living changes (cf. Rotemberg (1982)).

The final earnings function therefore was (3.1), with *COL** replacing *COL*. A Koyck transformation of this equation, using (3.3), yields an observable model. Non-linear estimation methods were used so that estimates of the original parameters α_H , α_E , α_W , α_U , α_N , α_t , and λ_P could be obtained. These results are discussed in conjunction with the demand-side results below.

b. Specification of the demand side

The primary constituent of the demand side of the model is the production function *F*. To obtain a specific functional form for *F*, I assumed that employment and hours of work aggregate as a generalized CES:

$$Q_t = B(\alpha e^{\theta_N t} N_t^{-\rho} + (1 - \alpha) e^{\theta_H t} H_t^{-\rho})^{(-k/\rho)} \quad (3.4)$$

where B, α, ρ, k, g_N and g_H are parameters. This formulation allows for non-constant returns to scale and factor-augmenting technical change. Explicit dependence of output on the capital stock and other non-labor factors is suppressed because of lack of data; the hope is that these effects can be adequately represented, for the purposes of our short-run and medium-run analyses, by the exponential trend terms. (I experimented with quadratic as well as linear exponential trends in the estimation, without a significant effect on the results.) The expression (3.4) was chosen basically because it rationalizes simple log-linear relationships that have been shown to be empirically successful in other applications. Note however, that if the capital stock follows a time trend, then (3.4) is more general than some standard specifications, e.g., the Cobb-Douglas form estimated by Feldstein (1967).

With this specification, the first-order condition for employment (2.10) can be written as

$$n_t^* = \beta_{n0}^* + \beta_{nq}^* q_t - \beta_{ne}^* (e_t - p_t) + \beta_{nt}^* t \quad (3.5)$$

where n^* is the log of employment; q is the log of output; $e - p$ is the log of weekly earnings divided by the output price; and the coefficients are defined by

$$\begin{aligned} \beta_{n0}^* &= \log(k\alpha B^{-\rho/k}) / (1 + \rho) \\ \beta_{nq}^* &= (k + \rho) / (k(1 + \rho)) \\ \beta_{ne}^* &= 1 / (1 + \rho) \\ \beta_{nt}^* &= g_N / (1 + \rho) \end{aligned} \quad (3.6)$$

n_t^* may be thought of as the desired level of employment in period t ; that is, it is the level of employment that exactly satisfies the first order condition. We may suspect, however, that (3.5) will not be successful empirically, because costs of adjustment will prevent this relation from holding instantaneously (especially in monthly data, such as these). A possible response to this is to make the underlying model explicitly dynamic and solve the resulting maximum problem, as in Sargent's (1978) study. Such an approach can become extremely complicated, however; and, as Sargent noted, it is not likely to reduce the need for auxiliary ad hoc assumptions. Here I follow the bulk of the previous work in simply assuming gradual adjustment of employment toward the desired level. That is, if n_t^* is the desired level of employment defined by the first order condition, I assume that

firms adjust actual employment n_t according to

$$n_t - n_{t-1} = \lambda_n(n_t^* - n_{t-1}) \quad (3.7)$$

where λ_n is the speed of adjustment. Given (3.7), a Koyck transformation of (3.5) gives an equation for actual employment of the form:

$$n_t = \beta_{n0} + \beta_{nq}q_t - \beta_{nc}(e_t - p_t) + \beta_{nt}t + \beta_{nn}n_{t-1} \quad (3.8)$$

where

$$\begin{aligned} \beta_{n0} &= \lambda_n \beta_{n0}^* \\ \beta_{nq} &= \lambda_n \beta_{nq}^* \\ \beta_{nc} &= \lambda_n \beta_{nc}^* \\ \beta_{nt} &= \lambda_n \beta_{nt}^* \\ \beta_{nn} &= (1 - \lambda_n) \end{aligned} \quad (3.9)$$

Similarly, with the given production function the first order condition (2.11) for desired hours of work becomes

$$h_t^* = \beta_{h0}^* + \beta_{hq}^*q_t - \beta_{hc}^*hcost_t + \beta_{ht}^*t \quad (3.10)$$

where h^* is the log of hours, $hcost$ the log of the marginal cost of hours of work (as obtained from the earnings function; see below), and the coefficients are defined by the obvious analogies to (3.6).

As there are costs to adjusting employment levels, it seems reasonable that there may be costs to rapid adjustment of the length of the work-week. These include the costs of reorganizing production schedules and of inducing workers to rearrange their personal schedules. Assuming that the length of the work-week adjusts slowly lead to a specification for hours analogous to (3.8):

$$h_t = \beta_{h0} + \beta_{hq}q_t - \beta_{hc}(hcost_t) + \beta_{ht}t + \beta_{hh}h_{t-1} \quad (3.11)$$

where the coefficients are defined analogously to those in (3.9), and λ_h is the rate of adjustment of hours²⁷.

Equations (3.8) and (3.11) may be viewed as representative-firm demand functions for employment and hours of work (length of the work-week). In both cases demand is positively associated with the level of production and negatively related to a cost variable. Except for the inclusion of the cost variables and the specification of separate equations for employment and hours, (3.8) and (3.11) are quite conventional short-run labor demand functions; see for example Brechling (1965), Ball and St. Cyr (1966), Smyth and Ireland (1967), and the survey in Fair (1969), as well as Lucas and Rapping (1969).

In the construction of empirical versions of (3.8) and (3.11), several practical issues had to be addressed:

1) A basic question was the treatment of seasonality, which is fairly significant in these data. Fair (1969) has argued against deseasonalization in this context, on the grounds that the factors which explain cyclical movements in employment, etc., should also explain seasonal movements. There is also some danger that deseasonalization may introduce spurious relationships or obscure genuine ones. For these reasons the data were not deseasonalized prior to estimation, and seasonal dummies were not used in the equations. (Note that leaving in seasonal fluctuations causes an essentially spurious deterioration in fit.) I did, however, allow for the possibility that employment and hours demand might respond differently to the seasonal and non-seasonal components of production, as follows: For each industry I constructed a variable $QSEAS$, the "seasonal component of production", as the residual of the deseasonalization of industry output. I then allowed $QSEAS$ and $Q - QSEAS$ (the seasonally adjusted component of production) to enter the demand for workers and hours equations with separate coefficients.

2) At an early stage of my analysis of this data set, I looked at the cross-correlations, at various leads and lags, of the log-differences of output and the labor market variables (employment, hours, earnings). My concern was, given that the data are monthly and that the output and labor variables are from different sources, that there might be an alignment problem. This examination revealed little potential difficulty, except in the relation of the employment and output series: For a few industries, employment seemed more strongly related to output one month ahead than to current output. Given that the other labor series lined up with output, this seemed likely to reflect a genuine economic phenomenon, e.g., hiring in advance of production, rather than a data alignment problem.

In any case, for the employment demand equations, I allowed both current and one-month-ahead production to enter. (Since both seasonal and non-seasonal production were used, this gave a total of four output variables in these equations.) Actual one-month-ahead non-seasonal production was instrumented for rather than treated as exogenous in the estimation of the employment demand equations; thus its estimated coefficients may be interpreted as measuring the impact of one-month-ahead forecasts of output (rather than actual future output) on current employment. One-month-ahead seasonal production was taken to be exogenous, on the grounds that the recurring seasonal component should be perfectly forecasted.

The inclusion of one-month-ahead output did not appear necessary in the hours demand equation.

3) The marginal cost of extending the work-week one hour, $HCOST$, was defined for the empirical application by

$$HCOST = EMP + \widetilde{EARN} - HRS - P \quad (3.12)$$

where \widetilde{EARN} is defined by (3.2) and P is the industry output price. This follows directly from (2.11) and the form of the earnings function (3.1). ($HCOST$ is actually proportional to, not equal to, the marginal cost of increasing the work-week; the factor of proportionality will be absorbed into the estimated coefficient of $HCOST$.)

The marginal cost of adding a worker, PAY , is simply given by $EARN - P$; note that the intercept of the earnings function has no bearing on the construction of this cost variable.

4) Industry codes drawn up under the National Recovery Act imposed some direct constraints on firm employment and hours decisions e.g., through the work-sharing provisions. To allow for this, in the estimation the dummy variable NRA was added to both the employment and hours demand equations.

These considerations, in conjunction with equations (3.8) and (3.11), allow the specification of employment demand and hours demand equations that can be estimated for each industry. (For a list of the independent variables in these two equations, see the left-hand columns of Tables 5 and 6, and the variable definitions in Table 3.) The results of

this estimation will be discussed in III.d below, following a digression on the identification problem.

c. Identification

The earnings equation and the two demand equations form a simultaneous system, which raises the standard estimation issues of identification and the availability of instruments. It was evident in this case that, as is often true, a strict application of the criteria for valid instruments would leave no instruments (except the constant and time), no identification, and no hope of proceeding further. In particular, it is difficult to come up with measured exogenous variables that are highly correlated with the fluctuations in the demands for industry outputs.²⁸

After some consideration, I made the tactical decision to treat industry output as exogenous in estimation. Although the assumption of output exogeneity is not ideal, there are a few arguments in its favor (beyond the obvious one of necessity): First, there are many precedents (Lucas and Rapping (1969) and virtually all papers in the traditional literature on the short-run demand for labor make this assumption). Second, and more important, treating output as exogenous seems likely to provide considerable identifying power at a relatively low cost in induced bias: Since the large output swings of the pre-war period are attributable primarily to aggregate demand variation (reflecting forces such as the financial crises and the monetary collapse), the correlation of industry output with disturbances to the industry production function and earnings equation should be relatively small. (Bernanke and Powell's Table 11 shows for these data that, for most industries, output Granger-causes employment and hours; evidence for causality in the other direction is weak.) Output exogeneity should be a particularly acceptable assumption with respect to the industry earnings equations, since labor supply disturbances were probably a trivial component of output variation during this period; this is fortunate, because the earnings equations are the principal innovation and focus of the present research.

Besides output, other variables treated as exogenous included:

- 1) *The cost of living*. A virtue of this paper's industry-level specification is that the cost of living deflates labor cost on the supply side, while the product price is the appropriate deflator on the demand side. The cost of living may therefore be excluded from, and thus help to identify, the two demand equations. Lagged values of the cost of living were also

helpful as instruments.

2) *Government policy variables.* The two variables reflecting New Deal legislation, *NRA* and *UNIONPOWER*, may reasonably be treated as exogenous, or at least as pre-determined with respect to the current period. *NRA* is not excluded from any equation, but *UNIONPOWER* is excluded from the two demand equations and is a particularly useful instrument with respect to the two labor cost variables.

Finally, at some risk of bias in the presence of serial correlation, I treated lagged employment, work-weeks, and earnings as pre-determined variables. Given all of these assumptions, the three estimated equations are well-identified, both in the formal sense and in the sense that sharp estimates are obtained in the sample.

A method of achieving identification that I might have used but did not was the imposition of cross-coefficient restrictions implied by the structural derivations of the various equations. For example, the specified production function implies relationships between the coefficients in the demand for employment and the demand for hours equations. My reason for avoiding this route is that, because of the aggregation of the data, there is no serious reason to believe that such cross-equation restrictions will hold. The demand equations, for example, were derived for a hypothetical individual firm and will not literally apply (because logarithms do not add) to the industry-level data at hand. The strongest justifiable assumption, I believe, is that the qualitative magnitude and sign relationships survive the aggregation process; this is the assumption that underlies my interpretations of the results.

Note that, given that the previous assumptions make the cross-coefficient restrictions inessential to identification, failure to impose them at worst may cause a small loss in efficiency. This is not a serious issue, given the size of the data set.

d. Estimation results

We proceed now to the estimates. The results of estimating the demand equations are in Tables 4 and 5; the earnings function results are in Table 6. Two-stage least-squares was used to correct for simultaneity bias (for the earnings equations, non-linear 2SLS was used). Instruments and variables treated as endogenous are given in the data appendix. Each equation was estimated separately for each industry.

The employment and hours demand equations are modest extensions of the conventional formulation and should be uncontroversial; they will be discussed first. (See **Tables 4 and 5.**) The estimates suggest the following:

First, there appear to be significant costs of adjustment (or some other source of inertia) for both employment and weekly hours of work; i.e., the lagged value of the dependent variable shows up as highly significant in every case. We would expect employment to be more inertial than hours of work, and this is confirmed by the estimates in every industry except automobiles. The rates of adjustment implied by the estimates are rather rapid: On average, the industries are able to eliminate about one-quarter of the gap between actual and desired employment each month, and nearly half of the gap between actual and desired hours. (It is true that these estimates may be biased by the presence of serial correlation of the disturbances; but the normal expectation is that serial correlation will bias estimated speeds of adjustment downward, not upward.)

For both employment and hours demand, the cost variables (*PAY* and *HCOST*) enter with the expected negative signs for each industry (except for one case, in which the coefficient of *PAY* is effectively zero). However, the statistical significance of the cost variable in the employment demand equation is low for some industries. The low significance of *PAY* is possibly due to the use of monthly data, which may obscure the presumably slow substitution between workers and other factors of production. The effect of the cost variable in the hours demand equation, in contrast, tends to be large and is in each case highly statistically significant. The lower inertia of hours of work and its greater sensitivity to short-run cost changes suggest that work-weeks will lead employment in cyclical downturns; this conforms to the findings of Moore (1955), Bry (1959), and Bermanke and Powell.

The effect of production on input demand is broken down, for employment, into the effects of current "seasonal" production, current non-seasonal production, and seasonal and non-seasonal production one month in the future. Not too much systematic emerges from this breakdown; in particular, employment in some industries seems to depend most strongly on current output, while other industries hire "one month ahead". However, although a few negative signs are scattered through the estimated effects of components of production on employment, the total estimated effects of output on employment are, as

expected, positive and strongly significant. (See the last row in Table 4.) In conjunction with the estimated speeds of adjustment, the estimated output effects confirm in some cases, although not all, the familiar finding of short-run increasing returns to labor.²⁹

For hours, it was necessary to consider only current output effects. As can be seen from Table 5, both the seasonal and non-seasonal components of production, and of course their sum, have a strongly significant, positive effect on hours of work. Short-run increasing firms to this factor appear to exist for all industries.

The final estimated parameters show the effects of the NRA codes on industry demands for labor inputs. The results imply that, for the most part, the NRA tended to increase employment and reduce hours. This is consistent with one of the legislation's explicit goals, which was to increase employment through "work-sharing". It also helps to explain the persistence of part-time work during the post-1933 recovery.

The residual serial correlation in the two demand equations appears to be relatively low, although it must be remembered that the Durbin-Watson statistic will be biased by the presence of the lagged dependent variables. (Calculated values of Durbin's h-statistic, which corrects for the lagged dependent variable problem, implied that the hypothesis of *no* serial correlation could be rejected for each equation; however, this statistic gives no information about the extent of serial correlation.) Re-estimation of the demand equation using Fair's method gave qualitatively similar results, except that in a few cases the wrong sign was obtained for the estimated coefficient of *PAY*; because of this sign problem I use the equations estimated without serial correlation correction in the simulations reported below. I also estimated the two demand equations for each industry jointly, so that contemporaneous correlation of residuals could be accounted for; this led to virtually identical results.

In tests for stability across the 1920s and 1930s sub-samples, five of the eight employment equations and four of the eight hours equations failed at the .05 significance level. This is not really surprising, given the stark differences in the economic environments of the two periods. When the demand equations are estimated for the sub-samples separately, however, they do not look grossly different. In particular, estimates for the 1930s sub-sample, as well as for 1923-29 and 1923-33, have the right signs and look very much like the whole-sample results.

Overall, the estimated labor demand equations seem reasonably successful, certainly of sufficient quality to use in simulation exercises. They also lend some support to the treatment of employment and hours as “separate” factors of production.

Estimates of the earnings equations, which make up the “supply side” of the model, are given in **Table 6**. The estimated parameters are those defined in equations (3.1) and (3.3) of the text: The most important are α_E and α_H , which capture the sensitivity of earnings to employment (normalized by the labor force) and to hours of work, and λ_P , which measures the speed of adjustment to cost-of-living changes. I have reported separate estimates for 1923-33 (which avoids the effects of New Deal legislation; that is, $\alpha_N = \alpha_U = \alpha_W = 0$) and for the whole period.

If we look first at the results for 1923-33, we find that overall the results conform closely to the predictions of the theory. First, for a given level of weekly hours there is typically a strong positive relationship between earnings and employment. This is interpretable as a supply relationship; that is, to induce more workers to enter an industry, firms must increase the utility value of the earnings-hours packages they offer. Second, the elasticity of earnings with respect to hours of work is highly significant, positive, and typically less than one³⁰; as argued above, finding this elasticity to be less than one is consistent with countercyclicality of real wages. Finally, nominal earnings adjust only partially to current changes in the cost of living; for the 1923-33 sample, the average rate of adjustment is about 17% per month. Although this is a significant amount of “stickiness”, it is much less than is usually assumed by Keynesians.

One industry that looks somewhat different from the others is automobiles. For both sample periods, the measured sensitivity of earnings to employment is low, while the sensitivity of earnings to hours is the highest of any industry. The earnings function for the automobile industry was even more striking when it was re-estimated without an imposed intercept (i.e., $EARN$ rather than \widetilde{EARN} was used as the dependent variable): In that case, for both sample periods, the elasticity of earnings with respect to employment was almost exactly zero and the elasticity of earnings with respect to hours was almost exactly one. This result (which was quite different from what was obtained for the other industries) would be consistent with an industry policy of setting a flat wage rate, which is not changed

even when the workweek changes, and of rationing the available jobs among applicants. It is worth noting in this connection that Henry Ford was a prominent maverick of this time in wage and employment policies; a fixed, high wage plus job rationing might not be a bad description of his announced strategy for improving worker motivation.

The estimates of the basic parameters for the whole sample (the bottom half of Table 6) are fairly similar to those for 1923-33, although the rate of adjustment of earnings to prices is estimated to be under .1 in three cases (instead of in just one case for 1923-33). The major difference is that the equation for the 1923-39 period also incorporates estimates of the effects of the New Deal on earnings. Briefly, the estimates show, first, that the NRA codes had relatively small but positive effects on weekly earnings. Second, the expansion of union power after the Wagner Act appears to have had a strong positive impact on earnings, raising weekly earnings by about ten per cent or more in six of the industries. (In lumber, the effect of unionization appears to have been positive but negligible; in boots and shoes, workers suffered significant pay *cuts* during the late New Deal.³¹) Finally, government employment programs appear to have had little systematic effect on the earnings of those privately employed in manufacturing.^{32,33}

For both the short and long samples, diagnostic checks did not seem to indicate important amounts of serial correlation. Because of this, and because the nonlinear version of Fair's method imposes some computational costs, I did not make any serial correlation correction.

I performed some additional diagnostic analyses of the estimated equations. Of these, the most interesting were within-sample simulations of the complete model. A few of these are described in the next section.

IV. Simulation Results

Simulations were performed, for each industry and for a number of different sample periods, using various estimated employment demand, hours demand, and earnings equations. All simulations were dynamic, i.e., the coefficients of lagged endogenous variables were applied to the lagged simulated, not actual, values of the variables. Industry output was taken in each case as exogenous; given output (as well as industry prices, the cost of living, and government policy variables), the three-equation model generates paths for

employment, hours of work, and earnings (or wages, i.e., earnings divided by hours).

The model typically did quite well in matching the sample values of the variables, even during the turbulent 'thirties. Yet, cases where the model failed to match the data were perhaps the most instructive, because of the insights gained in studying the reasons for failure. I will illustrate both of these assertions by reporting the results of industry simulations for the critical 1930-33 period. I will also discuss very briefly some simulations of the New Deal.

1. 1930-33

Employment demand, hours demand, and earnings equations estimated for the 1923-33 sub-sample were used to simulate the months between January 1930 and June 1933, the period of the Great Contraction. (Estimates of the earnings equations for 1923-33 are in Table 6; demand equations for this period are not reported. Sub-sample rather than whole-sample estimates were used in these simulations to avoid any coefficient instability associated with the changes wrought by the New Deal.) **Table 7** compares the behavior of actual and simulated values of three endogenous variables (employment, hours of work, and the real wage), for each industry. Reported are mean values, standard deviations, and minimum and maximum values over the period, in each variable's natural units.³⁴ Also reported are the root mean squared errors of simulation, expressed as fractions of the forecasted variables (%RMSE).

Direct inspection of the data plots suggested that the model does rather well in reproducing the 1930-33 period, and, for the most part, **Table 7** confirms this impression. Despite the sharp business-cycle fluctuations of the period, as well as the large seasonal movements, the simulated variables tend to approximate the actual in volatility, and in magnitude and timing of swings. The real wage in particular is predicted with a low %RMSE, although in a few cases the standard deviation of the simulated wage is too low.

One place where the model is relatively unsuccessful (in terms of %RMSE) is in simulating employment and hours in the two durable goods industries (iron and steel, automobiles). This partly reflects the greater volatility of these industries, as well as my inability (because of lack of data) to introduce inventory dynamics into the analysis. However, from inspection of the data it is also evident that, in early 1932, both of these industries consciously adopted policies of work-sharing (i.e., substituting short hours for layoffs). In the

case of iron and steel, even though output and hence simulated employment fell steadily through most of the period, actual employment suddenly increased from an index of 54.7 to an index of 75.7 in one month (January 1932). In the same month, (actual) hours of work per week fell from 40.9 to 29.8. (The work-week was cut similarly in 1932 in automobiles.) This no doubt reflected a desire of these firms to maintain their workforces (or to protect the welfare of their workers, under a generous imputation of motives) in the face of what they hoped would be a temporary decline in demand. In any case, this abrupt change in policy deviates sharply from what is predicted by the model.

Since the model is based on the assumption of competition, the difference between its predictions and the behavior of these two industries may be attributable to the oligopolistic nature of those industries, and their resulting ability to deviate from short-run competitive behavior. However, it is interesting to note that the divergence of these two industries from the predicted paths turned out to be relatively transitory: After the big January 1932 increase in employment in iron and steel, for example, employment in that industry fell steadily and sharply. By early 1933, iron and steel employment had returned to the simulated path. Hours of work returned to the simulated path even more quickly, by August 1932. The same sort of behavior occurred in automobiles. Thus the efforts of industry to preserve their workforces in the face of deepening Depression were quite limited in scope and duration.³⁵

Since the Introduction stressed the failure of earlier models to explain the behavior of real wages during this period, it is worth exploring a bit the capacity of the present model to simulate wage movements. As can be seen either from data plots or from the statistics given in Table 7, the model simulations do a creditable job of tracking the real wage in each of the eight industries. In particular, the tendency of real wages to rise even as output and employment fell is evident in the simulations.

The model has two ways of rationalizing increasing real wages during this period. First, the elasticity of earnings with respect to hours has been found to be typically less than one. The significance of this finding, which may in part reflect the procyclicality of the proportion of unskilled workers, was extensively discussed in Section II above. An additional point may be made here: It was shown in Section II.e that real-wage countercyclicality is more likely if employers respond to reduced demand for output by cutting work-weeks,

rather than by laying off workers. In the static model of Section II, employers' propensities to reduce hours rather than employment depend only on the shape of the single-period production function. However, in the more dynamic model that served as the basis of the estimation, costs of adjustment also play a role in the layoffs versus short hours decision. Specifically, the finding that work-weeks are less inertial than employment suggests that in the early stages of a downturn employers are more likely to cut hours than employment; firms' attempts to maintain their work-forces in the early part of a recession by "sharing the work" thus increase the probability of observing real wage countercyclicality.

The second feature of the model that contributes to rising real wages is the partial adjustment of nominal earnings to current changes in the cost of living. As this was a period of sharp deflation, the lag of nominal earnings behind prices led to an increase in the measured real wage.

Here once again the simulations help us learn something about the model: Although it captures the major wage movements over the period, the model tends to under-predict the wage somewhat in the first six to nine months of 1931 (for some of the industries). Since 1931 was a year of sharp deflation, this suggests that wages had a higher nominal inertia at the beginning of the Depression than is captured by the estimates.

It is perhaps not surprising that the model under-predicts the degree of nominal inertia in 1931, given that it requires the sensitivity of nominal earnings to cost-of-living changes to be the same in all periods: A more realistic approach (but one less easily implemented) would be to assume that the sensitivity to cost-of-living changes depends on recent experience. Since the 1920's were a period of very stable prices, this alternative approach might be able to rationalize the failure of wages to fall immediately in 1931.

As in the case of iron-and-steel and automobile industry work-sharing discussed above, however, the deviation of the simulations from the actual variable paths proved transitory: By the last quarter of 1931, or by early 1932 at the latest, actual wages in each industry were at or below their simulated values.

To see how much the assumption of nominal stickiness contributed to the model's capacity to generate countercyclical real wages over the period as a whole, I conducted the following experiment: I ran the simulations of 1930-33 again, this time assuming perfect adjustment of nominal earnings to the cost of living ($\lambda_P = 1$). All other coefficients

were unchanged. I found that, first, although a rising real wage was still predicted by the simulations, the ability of the simulations to track the actual real wage deteriorated significantly, for most of the industries. In several cases %RMSE increased by half or more; also, the maximum real wage over the period predicted by the simulations tended to be quite a bit lower than what was actually attained. There was also, however, a rather surprising second finding from these simulations: The assumption of perfect wage adjustment to the cost of living had virtually no effect on the ability of the model to track employment and hours. Indeed, on average, fits improved slightly. Lagged adjustment of earnings to prices thus seems to be important for explaining observed real wage behavior in this period, but it may not have great allocative significance.

b. 1933-39

I also carried out various simulations of the New Deal period, 1933-39. While space does not permit a detailed discussion, I briefly report one experiment.

It has often been asserted that New Deal legislation significantly affected post-1933 labor market performance. For example, Weinstein (1981) has attributed much of the slowness of the recovery from Depression to the effects of the National Recovery Act. I cannot effectively address Weinstein's or similar contentions with the present model, because demand and output are taken as exogenous. I can address a much more limited question: Given the path of output, how did the New Deal affect the behavior of labor market variables (in these industries)? To examine this question, I simulated a counterfactual history of 1933-39, in which there was no New Deal, but in which the path of output was the same as in actuality. The earnings equations used were the ones estimated for 1923-33 (which seemed slightly superior to the whole-sample equation, and which contain no terms for the NRA, unionization, or government public works programs). The employment and hours demand equations used were those estimated for the whole sample, as reported in Tables 4 and 5, with the *NRA* dummy set equal to zero. The results of this simulation were compared to the actual paths of the variables.

Even with no New Deal effects, the model predicted an upward trend in real wages for 1933-39; this reflected both the increases in employment and the relative weakness of the recovery in work-weeks (see Table 2). However, this experiment confirmed that the effect of the New Deal on wages was very strong. There were two major wage pushes after

Roosevelt's election that are not well predicted in the counterfactual history: The first of these took place in the last half of 1933 as the NRA codes went into effect, the second in early 1937, at about the time that important Supreme Court decisions affirming the constitutionality of the Wagner Act contributed to a burst of union activity. At the end of 1939, actual wages were almost 30% higher than simulated in iron and steel and 20% higher in automobiles. (Both industries signed major union agreements in 1937.) Wages were 10–20% higher in 1939 than predicted in the other industries, except for shoes (which had big wage increases during the NRA but lost ground later on; see note 31) and lumber (in which wage growth actually remained below the simulated level).

This exercise, together with the simulations carried out for 1930–33, suggests that the best explanation for rising wages in the 'thirties is probably an eclectic one. The effects of short work-weeks, cyclical variations in the skill mix, nominal stickiness, and government actions all made contributions. (It is unfortunate that complex phenomena do not have simple explanations; but there is not much that can be done about it.)

The effect of the New Deal on the patterns of labor usage are also apparent but somewhat less dramatic than the impact on wages. There was a discernable tendency to cut work-weeks and increase employment (i.e., use work-sharing), especially during the NRA. Work-sharing inspired by the New Deal seemed to be quantitatively important in iron and steel, but in most of the other industries the unpredicted amount of work-sharing was relatively small. The total quantity of labor input, as measured by worker-hours (admittedly a flawed measure, given the results of this paper) might have been expected to have been forced down, as the New Deal's high-wage policy induced substitution to non-labor inputs. In fact, total worker-hours employed appears to have been relatively unaffected by the New Deal.

All of this is, of course, for fixed paths of output. To answer the broader question of how the New Deal affected output, a general equilibrium model would be required. It is not evident how such an exercise would come out: The restricted experiment reported here suggests that the New Deal was effective at raising worker incomes (by raising wages without inducing substitution away from labor, and through relief programs). Higher incomes must have increased aggregate demand. But the New Deal also raised unit labor costs and thus prices, which would depress demand. The net impact of the New Deal would depend on

which of these countervailing forces was stronger.

V. A Dynamic Labor Supply Equation

A possible objection to the supply side of the model developed and estimated in this paper is that it is rather static in nature. I have made strong assumptions (that workers cannot borrow or lend, and that they have intertemporally separable utility functions) in order to avoid consideration of the intertemporal substitution of leisure and consumption. In addition, the implicit assumption that there are no mobility costs to moving between the secondary and primary sectors implies that workers need consider only current returns (and not long-run returns) when deciding whether to change sectors. Only the partial adjustment of nominal earnings to cost-of-living changes (in the estimated earnings functions) induces a modest dynamic element.

Although developing a more explicitly dynamic representation of this paper's model of labor supply is not particularly difficult conceptually, there are some substantial problems of empirical implementation. Rather than tackle those here, I propose to do something more limited: I will try to show that one of the more empirically successful models of Depression-era labor supply, the intertemporal substitution model of Darby (1976), can be re-interpreted as a dynamic version of the supply model in this paper. Estimates of a Darby-type model on these data will then be presented. The reasonableness of these estimates, it will be argued, constitutes evidence that the present paper's model of labor supply could survive the transition to a more dynamic specification.

Darby's model of labor supply is an extension of the basic Lucas-Rapping (1969) formulation. Lucas and Rapping argued, it will be recalled, that labor supply (i.e., worker-hours, normalized by the number of households) should depend

- 1) *positively* on the current returns to working
- 2) *negatively* on the long-run, or "normal" returns to working
- 3) *negatively* on the ratio of the "normal" to the current price level

The reasoning should be familiar: 1) High current returns to work increase labor effort by improving the rate of exchange between work and consumption. 2) High long-run returns to work depress current labor supply by making it more profitable to substitute present for future leisure. 3) Finally, assuming that nominal interest rates don't adjust

fully to inflation, an increase in the ratio of the normal to the current price level lowers labor supply by leading workers to anticipate lower real rates of interest.

An important issue in this context, and one that I do not believe has been adequately addressed by the intertemporal substitution literature, is how to measure the returns from working. Lucas and Rapping, and most other authors, have assumed that the real wage is a good proxy for these returns. However, as was discussed in the Introduction, this assumption does not work well for the 1930s.³⁶ One of the contributions made by Darby (1976) was the substitution of full-time-equivalent earnings³⁷ for the wage as the measure of the returns to work. Darby showed that using earnings instead of wages significantly improved the capacity of the model to fit the 1930s.

What is the rationale for using earnings rather than wages as a measure of the returns to work? Darby's argument was that, because the NRA codes required shorter work-weeks, actual hours of work either were under-reported by firms (leading to an upward bias in the measurement of hourly wages) or, possibly, were rationed. For these reasons he expected average earnings per FTE employee to "more accurately reflect the development of wages in the 1930s" [p. 10] than the official wage series.

A problem with Darby's argument is that the NRA codes were in effect for less than two years, but the substitution of earnings for wages seems to be empirically preferable for the entire pre-war period. (See Darby's paper, and the results below.) An alternative explanation for the superiority of the earnings variable follows from the analysis of the present research: It has been suggested here that, in an environment where hours of work are not constant, the correct measure of the returns to working is neither of the variables just mentioned but the total utility of the earnings-hours package offered by the job, perhaps measured relative to the utility of remaining in the secondary sector. An obvious problem, however, is that this utility is not observable to the econometrician; thus we might ask which, if any, of the observables is likely to be correlated with the total utility of a job. The wage is not a good choice; as has been shown at length, wages and the utility of a job can easily move in opposite directions. However, in the case where fluctuations in employment are due primarily to variations in demand rather than supply (the probable situation in the 1930's), the utility from holding a job and earnings will be highly correlated. This is straightforward to show: Increased demand in the primary sector, which increases the

equilibrium utility of workers, will also typically both move the equilibrium earnings function upward and increase hours of work. Thus increased primary-sector demand will also increase earnings. The explanation for the superiority of Darby's specification, therefore, is simply that earnings are a good proxy for the total utility of holding a job, and wages are not.

These considerations suggest that estimating a model in the spirit of Darby (1976) on the present data set may be a valuable exercise. I specify an empirical model as:

$$\begin{aligned}
 EMP_t * HRS_t - LABORFORCE_t &= \beta_0 + \beta_1(EARN_t - COL_t) \\
 &+ \beta_2(EARN_t^* - COL_t^*) + \beta_3(COL_t^* - COL_t) \\
 &+ \alpha_N NRA_t + \alpha_U UNIONPOWER_t \\
 &+ \alpha_W EMERWORK_t + \alpha_t t
 \end{aligned} \tag{5.1}$$

$$\begin{aligned}
 (EARN_t - COL_t)^* &= \lambda_P(EARN_t - COL_t) \\
 &+ (1 - \lambda_P)(EARN_{t-1} - COL_{t-1})^*
 \end{aligned} \tag{5.2}$$

$$COL_t^* = \lambda_P COL_t + (1 - \lambda_P) COL_{t-1}^* \tag{5.3}$$

where an asterisk denotes the "permanent" or long-run component of a variable, and variables definitions are given in Table 3.

Equation (5.1) is a labor supply equation, of the general form first written down by Lucas and Rapping (1969). The dependent variable is total worker-hours supplied to an industry, normalized by Lebergott's aggregate labor force estimates. (Lebergott's annual data was linearly interpolated to obtain a monthly series.) Equation (5.1) follows the discussion above in specifying that the supply of worker-hours to an industry depends differentially on the current and long-run returns to working (where the returns to work are measured by real weekly earnings), as well as on the ratio of the long-run to current cost-of-living. The use of earnings to measure the returns to work reflects Darby's innovation. By the logic of the intertemporal substitution model, the expected signs of the coefficients are $\beta_1 > 0$, $\beta_2 < 0$, and $\beta_3 < 0$.

The labor supply equation (5.1) also contains terms reflecting New Deal government actions. The expected signs of the coefficients are: for α_N , ambiguous (since the NRA codes increased employment but reduced hours); for α_U , negative (since unionization should restrict labor supply below competitive levels; and for α_W , negative (since increased public works programs should reduce the supply of labor to industry). A time trend is also added to allow for secular factors such as wealth accumulation, educational attainment, etc.

Equations (5.2) and (5.3) follow Lucas and Rapping in assuming that the permanent components of returns and the cost of living are updated adaptively, with the same "rate of learning" applying in both cases. Constants and trends are excluded from (5.2) and (5.3); if included they would be absorbed into the constant and trend of the estimated equation, with no effect on the important estimated parameters.

Using (5.2) and (5.3), the labor supply equation (5.1) can be transformed so that only observable variables appear (see Lucas and Rapping). The use of a non-linear estimation procedure permits the recovery of the original parameters of (5.1) to (5.3).

The results of estimating the system (5.1)–(5.3) are reported in **Table 8**. The estimation method was (non-linear) two-stage least-squares, used to correct for simultaneity bias. (Instruments are listed in the data appendix.) The sample was January 1923–December 1939; estimates obtained for the sample ending before the New Deal, which set $\alpha_U = \alpha_W = \alpha_N = 0$, are also reported. The Durbin-Watson statistics are for the Koyck-transformed equations.

The most important result in **Table 8** is that the estimate of β_1 , which measures the elasticity of worker-hours supplied to earnings, is positive and highly significant in every case. There is also a remarkable uniformity across industries and sample periods of the magnitude of this estimated parameter. This is consistent with the idea that (5.1) is a true supply curve in which earnings are acting as a proxy for the total utility from working.³⁸

The estimates of β_2 are also all positive, although magnitudes and statistical significance vary. The finding that β_2 is positive, i.e., that higher long-run returns to work increase labor supply, is the opposite of the prediction of the intertemporal substitution model. An explanation of this finding is available, if we are willing to re-interpret (5.1): Recall that these estimates have been obtained from industry-level, not aggregate, data. At the level of the industry, labor supply depends not only on the decisions of workers already

“in” the sector (e.g., already living in the mill town) but also on the number of workers that can be drawn from the rest of the economy. If there are mobility costs to switching sectors, higher long-run returns in an industry will *increase* the industry’s labor supply, by making it more worthwhile for workers to incur the fixed costs of entering the sector. Thus it might be argued that long-run earnings belong in (5.1) because of their relevance to worker mobility decisions, not for any reason of intertemporal substitution.

This alternative interpretation of (5.1) is an attractive one, and not simply because it rationalizes $\beta_2 > 0$: A drawback of the intertemporal substitution hypothesis as a model of 1930’s labor supply is that it assumes perfect capital markets. This assumption appears at variance with the tremendous disarray of the financial sector in the Depression, and the resulting large difference between lending and borrowing rates for consumers.³⁹ In contrast, the mobility-cost interpretation of (5.1) does not require perfect capital markets; indeed, under this interpretation (5.1) is consistent with the Section II model of this paper, with its no-borrowing, no-lending assumption.

For the sake of space, I will not carry on with a line-by-line discussion of Table 8. However, the estimated effects of the New Deal on effective labor supply deserve a brief mention: Table 8 finds the same result as the estimated earnings function in Table 6; namely, that the legislation-supported unionization drive was the most important New Deal change in labor markets. In contrast to the NRA codes and government work programs, which had little systematic impact, unionization appears to have had a strong effect in a number of industries.

Overall, the Darby-type specification seems to work well in these data. If the interpretation of this specification that I have given is accepted, this bodes well for the development of a more explicitly dynamic version of this paper’s model of labor supply.

VI. Conclusion

This paper has employed monthly, industry-level data in a study of Depression labor markets. The framework of analysis was a model in which, as in Lucas (1970), both firms and workers are concerned with the distinction between the number employed and the number of hours each worker works. In the context of the Depression, this distinction appears to be an important one; and, in conjunction with additional empirical elements,

this model does a rather good job of explaining the behavior of the key time series. This raises the possibility that the decomposition of aggregate labor supply into participation rates and hours per worker may be important for understanding other macroeconomic episodes as well.

A limitation of this analysis is its partial equilibrium nature: Output is treated as exogenous. A really satisfactory analysis of the 1930s would have to consider labor markets, product markets, and financial markets in a simultaneous general equilibrium. This should be pursued in future research.

Notes

1. Baily (1983) gives an interesting discussion of labor markets in the 1930s but does not estimate a structural econometric model.
2. Darby (1976) estimates an equilibrium model that does better than the model of Lucas and Rapping in explaining the 1930s. This model is discussed and re-interpreted in Section V below.
3. The Keynesian story does not have a very satisfactory answer to why firms prefer laying off workers to cutting the wage, although some theoretical attempts (relying, e.g., on adverse selection problems) have been made in that direction. The sticky-wage story is also not very useful for explaining 1933-39, when real wages rose despite high unemployment and *rising* prices.
4. Rosen and Quandt's cited paper postulated sticky real (rather than nominal) wages. In recent unpublished work these authors estimated a sophisticated disequilibrium model in which sticky nominal wages are assumed; they again found very slow speeds of wage adjustment.
5. Union membership peaked at 5.05 million in 1920, then fell to 3.62 million in 1923, from where it trended slowly downward. The percentage of nonagricultural employees who belonged to unions fell from 19.4 in 1920 to 10.2 in 1930; moreover, the powerful unions that did exist were almost completely outside manufacturing (Bernstein (1960), p. 84, citing Leo Wolman).
6. Technical innovations in the 1920s made many traditional skills and specialties obsolete and increased the percentage of low-skilled labor. See Bernstein (1960). Documentation of the decline in skill levels for individual industries in this study may be found in McPherson (1940), Davis (1940), Brody (1960), and Dunn and Hardy (1931), among others.
7. Declines in European immigration in the 1920s were more than compensated for by the influx of workers into manufacturing areas from the rural U.S. (According to Bernstein, p. 48, during 1922-29 over two million people per year left the farm for the city; the U.S. farm population fell in 1920-30 while the nonfarm population grew by a quarter.)

8. Aggregate industrial production indices are heavily contaminated by input-based measures of output. For this reason I obtained estimates only at the industry level, not for all manufacturing.
9. This is the opposite of the usual reference cycle convention.
10. If the number of months in the descending or ascending part of the cycle was not evenly divisible by three, the first extra month was assigned to the second of the three stages, the second extra month to the third stage.
11. Note that at this point the extra step of averaging across the standardized cycles would create a "reference cycle".
12. The countercyclicality found by Bernanke and Powell is actually somewhat out of phase; that is, the peak in the real wage occurs some months after the trough in production.
13. The data on wage rates, available for the first six industries and through August 1931 only, are from Creamer (1950).
14. However, the sensitivity of the real wage to the cycle in the post-war period is not strong, and the sign of the relationship is controversial. Few recent studies have considered pre-war real wage behavior. See Bernanke and Powell for a survey of this literature.
15. For very different discussions of the sources of business cycles during the whole period, see Friedman and Schwartz (1963) and Gordon (1974). Also see Brunner (1981), Temin (1976), Roose (1969), and Bernanke (1983) for analyses of the 'thirties. While the views expressed by these authors are diverse, all emphasize the aggregate demand channel.
16. Another, very different, model which does not restrict the (contemporaneous) cyclical behavior of the real wage is given in Sargent (1978).
17. It should be made clear that Lucas is not to be implicated for the details of what follows, which differ substantially from his paper. Plessner and Yitzhaki (1983) contains a model similar to that below.
18. Since workers have identical utility functions and productivity, there is no opportunity for firms to induce self-selection among workers, as in Weiss (1980).
19. The expression for total labor cost (2.6) assumes that primary sector firms pay workers just enough to make the marginal worker indifferent between the primary and secondary

sector. An alternative assumption, suggested by the "efficiency wage hypothesis" (see, e.g., Yellen (1984)), is that firms avoid the costs of continuous monitoring of employees by paying more than the minimum required earnings (thus giving employed workers a surplus), then firing workers caught shirking in random "spot checks". This alternative assumption, which could easily be incorporated into the present framework, has the advantage of being able to explain such phenomena as the long queues at employment offices and the extreme reluctance of the employed to leave their jobs.

20. Lengthening the work-week may have diminishing returns because of increased worker fatigue; increased employment does not increase fatigue but will typically dilute the capital-labor ratio. See Feldstein for further discussion.

21. It is not difficult to construct examples that satisfy (2.12)–(2.14): E.g., $F(N, H) = N^\alpha H^\beta$, $\beta > \alpha$ satisfies these conditions for any E . Note also that (2.13) is actually redundant, given (2.12) and (2.14).

22. Equivalently, by (2.11), we require that F_H/N_j not greatly exceed F_{NH} . This is likely to hold, since N_j and H_j by their nature must be strong complements, i.e., F_{NH} will be large positive.

23. This single-period rationalization of the layoff vs. work-sharing decision ignores an important dynamic element, i.e., the differential costs of adjusting workforces and shift lengths. This will be incorporated in the empirical model below.

24. See Rosen (1968) and references therein for evidence supporting this assumption.

25. Note that convexity of the earnings function is not necessary for the second-order condition (2.13) to hold. The earnings function estimated below is log-linear, i.e., earnings is concave in hours; empirically, this seemed to work best.

26. Economy-wide rather than industry series are used primarily because of lack of data. Arguably, however, union successes in individual industries had "spillover" effects on industries not directly involved. (But see note 31 below.)

27. For simplicity I have assumed that the adjustment of hours depends only on the difference between actual and desired hours, not on the difference between actual and

desired employment (and similarly, for the adjustment of employment). Arguments made in Nadiri and Rosen (1973) would favor the relaxation of this restriction.

28. The money supply might seem to be a possible exception to this statement. I did experiment with this variable. However, its correlation with industry variables in monthly data is sufficiently low that it is of not much value as an instrument.

29. The "total output effect" coefficients in the last row of Table 4 (and Table 5) actually double-count the effect of an output increase on employment (or hours), since they represent the effect of a simultaneous increase in adjusted output and the (multiplicative) seasonal adjustment factor. Short-run increasing returns exists when the sum of the coefficients on either seasonal or non-seasonal output alone, divided by one minus the coefficient on the lagged endogenous variable, is less than one.

30. Actually, the estimated coefficient α_H measures the elasticity of earnings less the intercept, not earnings itself, to hours. The elasticity of earnings to hours is strictly less than α_H and is less than one for each industry except automobiles.

31. Davis (1940) notes: "Another significant point [regarding the decline in shoe industry wages], as bearing on the year 1937, was the checking of the unionization drive in shoes at the very time when unionism was getting established in several other manufacturing industries for the first time." [p. 98] The unusual decline in shoe industry wages after 1937 probably also accounts for the very different estimates of α_E in the 1923-33 and the 1923-39 samples.

32. This is a bit of evidence against Darby's view that Federal employment displaced private employment during this period.

33. Henning Bohn suggested that agricultural earnings, an additional measure of workers' alternative opportunities, might belong in the industry earnings functions; so I tried this. Monthly agricultural wage rates (nominal, without board) are reported for each quarter in the sample in Sayre (1940); I interpolated this series and divided by the cost of living to obtain a monthly series on real agricultural earnings. Re-estimated earnings functions including this variable looked quite similar to those reported in Table 6. The estimated coefficient of agricultural earnings was typically found to be positive, as predicted by the

theory, but of only moderate magnitude and statistical significance. An exception was the lumber industry, for which agricultural wages appear to have had an important influence on earnings.

34. Employment is measured as an index (1923=100). Hours is actual hours per week and the real wage is in 1923 cents per hour.

35. No similar systematic attempt to promote work-sharing during this period (in excess of what is predicted by the model) was noticeable for any of the other six industries.

36. It may be noted also that estimation of a Lucas-Rapping type model using these data (equations (5.1)–(5.3) below with the real wage in place of real earnings) yielded a number of wrong signs and a generally poorer fit than the Darby real earnings version.

37. The FTE earnings variable used by Darby is essentially identical to actual average earnings for most industries, including manufacturing. That is, the variable reflects actual rather than “normal” work-weeks. See the *Survey of Current Business*, June 1945, pp. 17-18.

38. The positive and significant estimates of β_1 , it should be noted, did not simply reflect the fact that weekly hours is a constituent of both the dependent variable and weekly earnings. Re-estimates using employment as the dependent variable instead of worker-hours also yielded positive and highly significant values for $\hat{\beta}_1$.

39. See Bernanke (1983). The failure of the perfect capital markets assumption may explain the difficulty the intertemporal substitution model has in explaining the path of consumption in the 1930s (Altonji (1982)).

Data Appendix

The sources of the data used in this study are as follows:

1) Earnings, hours, and employment data are from Beney (1936) and Sayre (1940). These data are the result of an extensive monthly survey conducted by the National Industrial Conference Board from 1920 until 1947.

All of the industries in the sample paid at least part of their workforce by piece rates (see the *Monthly Labor Review*, vol. 41, no. 3, September 1935, pp. 697-700). No correction was made for this. This should not create any problem of interpretation, as long as the speed at which the piecework tasks were executed did not vary much in the short run.

2) Industrial production data are from the Federal Reserve Board. See "New Federal Reserve Index of Industrial Production", *Federal Reserve Bulletin*, August 1940, pp. 753-69 and 825-74.

3) Wholesale price indexes are from the Bureau of Labor Statistics. See the following publications of the U.S. Department of Labor: *Handbook of Labor Statistics* (1931 ed., Bulletin 541; 1936 ed., Bulletin 616; 1941 ed., Bulletin 694), and *Wholesale Prices 1919 to 1927* (Washington: U.S.G.P.O., 1929, Bulletin 473). For the automobile industry I merged two BLS series of motor vehicles prices. Neither series covered 1935; the price series on all metal products was used to interpolate the automobiles price series for that year.

4) The consumer price series is from Sayre (1948).

5) The NRA dummy is set equal to one for all months from September 1933, when the first NRA industry codes went into effect, until May 1935, when the Act was declared unconstitutional. The monthly data on man-days idle due to strikes (used in the construction of the UNIONPOWER variable) is from the Bureau of Labor Statistics, Bulletins 651 and 694. The data series for total Federal emergency workers, which include the WPA, the CCC, and other programs, is from the NICB's *Economic Almanac* for 1941-42.

The basic data were seasonally unadjusted. These data were used in estimation without adjustment (see text for discussion). Seasonal adjustment by the TSP routine was used in the construction of the standardized cycles (Table 2).

The span of the sample is January 1923 to December 1939. Although some of the data exist before 1923, there are two major problems with extending the sample further back:

1) Some of the industrial production data are missing and cannot be constructed. 2) There is a six month gap in the NICB survey in 1922. The December 1939 stop date was chosen so as to avoid consideration of the many special features of the wartime economy.

The variables treated as endogenous and the additional instruments used in estimation in the principal equations are as follows: 1) *Demand for workers equation*. PAY_t and $QADJ_{t+1}$ are taken to be endogenous. ($QADJ_{t+1}$ is treated as endogenous because of the measurement error problem created when a future value of a variable is used in place of a forecast. See the text.) Additional instruments are $QADJ_{t-1}$, HRS_{t-1} , $UNIONPOWER_t$, and the current value and two lags of the cost-of-living variable COL . 2) *Demand for hours of work equation*. The endogenous variable is the cost variable, $HCOST_t$. Additional instruments are EMP_{t-1} , $UNIONPOWER_t$, and the current value and two lags of COL . 3) *Earnings equation*. Endogenous variables are EMP_t and HRS_t . Instruments were the current and two lagged values of production Q and current and two lagged values of COL . Because it was observed earlier that current employment was highly correlated with one-month-ahead production in some industries, I also used as an instrument a forecast of one-month-ahead production based on a univariate autoregression. 4) *Dynamic labor supply, or "Darby", equation*. Endogenous variable is $EARN_t$. Instruments are the same as in the earnings equation above.

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Table 1
Industries Included in the Data Set

Industry (mnemonic)	Wage - earners ¹		Value - added ²	
	Thousands	% Total Mfg.	\$Millions	% Total Mfg.
1. Iron and steel (<i>IRON</i>)	419.6	5.02	1622.8	5.40
2. Automobiles (<i>AUTOS</i>)	226.1	2.70	1315.0	4.37
3. Meat packing (<i>MEAT</i>)	122.5	1.46	460.5	1.53
4. Paper and pulp (<i>PAPER</i>)	128.0	1.53	482.8	1.61
5. Boots and shoes (<i>SHOES</i>)	205.6	2.46	450.9	1.50
6. Wool textiles (<i>WOOL</i>)	179.6	2.15	414.8	1.38
7. Leather tanning and finishing (<i>LEATH</i>)	49.9	0.60	143.7	0.48
8. Lumber and millwork ³ (<i>LUMBER</i>)	509.2	6.09	1088.5	3.62
TOTAL	1840.5	22.01	5979.0	19.89

Notes

1. Number of wage earners, and percentage of wage-earners in all manufacturing employed in the industry, 1929; from Fabricant (1942), Appendix B.
2. Millions of dollars of value added, and percentage of all manufacturing value added originating in the industry, 1929; from Fabricant (1940), Appendix C.
3. Furniture is excluded.

Table 2
Standardized Business Cycles

1. Iron and Steel

		Output	Employ- ment	Hours of work	Wages	Real wages	Product wages
1923-26	I	100.0	100.0	100.0	100.0	100.0	100.0
	II	97.2	103.0	96.9	103.9	103.6	106.1
	III	90.5	98.3	96.9	111.6	110.1	116.4
	IV	77.2	93.5	83.5	108.8	107.6	118.8
	V	51.2	71.4	79.9	109.0	108.3	123.5
	VI	89.0	89.4	88.7	108.5	106.7	126.1
	VII	93.4	93.7	89.7	108.0	104.0	131.2
	VIII	100.2	98.3	91.4	108.2	103.6	132.5
	IX	106.8	101.7	91.0	108.5	105.5	132.6
1926-29	I	100.0	100.0	100.0	100.0	100.0	100.0
	II	93.5	94.3	101.0	102.6	102.3	103.6
	III	91.5	92.0	98.4	101.5	101.7	105.2
	IV	82.2	88.3	96.7	101.1	103.0	106.4
	V	80.6	87.2	97.3	100.9	102.6	107.8
	VI	93.0	88.1	99.1	101.7	103.6	108.0
	VII	103.0	94.4	99.8	102.0	104.8	107.3
	VIII	112.4	97.5	102.2	102.9	106.2	105.8
	IX	115.6	100.4	101.8	102.9	104.9	105.1
1929-37	I	100.0	100.0	100.0	100.0	100.0	100.0
	II	75.3	91.4	92.6	101.2	104.0	106.1
	III	43.7	65.9	78.9	97.9	112.4	114.3
	IV	22.4	62.4	49.7	80.5	105.1	99.6
	V	15.9	49.3	48.2	73.6	103.0	94.9
	VI	47.4	76.4	62.1	87.6	114.5	103.8
	VII	50.1	83.8	57.4	99.8	123.2	113.0
	VIII	83.8	105.2	72.9	106.7	126.9	116.8
	IX	99.4	118.9	69.5	132.1	151.8	130.6
1937-39	I	100.0	100.0	100.0	100.0	100.0	100.0
	II	95.3	101.1	99.1	100.1	100.0	99.3
	III	48.3	90.3	69.4	94.8	95.3	94.6
	IV	36.1	72.9	65.7	95.3	97.6	94.8
	V	34.0	71.0	66.4	98.5	101.2	96.8
	VI	73.9	78.3	86.7	97.3	101.5	100.4

Table 2 (continued)

4. Paper and Pulp

		Output	Employ- ment	Hours of work	Wages	Real wages	Product wages
1923-26	I	100.0	100.0	100.0	100.0	100.0	100.0
	II	96.1	97.4	97.5	100.7	100.5	101.6
	III	95.4	93.8	95.9	101.2	99.9	104.9
	IV	98.9	96.1	93.9	102.6	101.4	107.3
	V	90.1	86.9	92.2	103.1	102.5	109.3
	VI	105.6	94.1	95.7	103.5	101.8	105.4
	VII	106.9	100.5	96.7	103.3	99.5	100.2
	VIII	116.2	107.4	98.0	102.9	98.6	104.4
	IX	115.7	107.0	98.3	102.6	99.8	115.2
1926-29	I	100.0	100.0	100.0	100.0	100.0	100.0
	II	103.1	96.0	100.6	101.2	100.9	100.4
	III	101.2	92.8	99.0	102.3	102.6	102.2
	IV	100.5	92.8	97.9	100.4	102.2	101.0
	V	103.4	91.7	100.9	100.5	102.2	101.3
	VI	106.2	90.7	98.7	101.7	103.6	103.8
	VII	108.0	94.3	97.8	101.1	103.8	105.1
	VIII	114.7	95.7	99.9	103.4	106.7	108.6
	IX	114.8	98.0	100.7	102.0	104.0	107.4
1929-37	I	100.0	100.0	100.0	100.0	100.0	100.0
	II	95.5	96.2	96.9	100.7	103.5	102.8
	III	86.1	83.3	84.9	99.6	114.4	106.9
	IV	72.6	77.3	77.3	86.2	112.7	100.5
	V	69.9	75.6	74.4	78.5	109.8	95.2
	VI	86.7	89.0	76.1	88.1	115.3	96.3
	VII	92.1	97.6	74.6	98.9	122.1	107.7
	VIII	113.6	101.9	82.2	103.3	122.9	109.5
	IX	131.8	108.1	83.5	114.1	131.2	106.0
1937-39	I	100.0	100.0	100.0	100.0	100.0	100.0
	II	93.6	99.9	97.2	105.0	104.9	105.7
	III	72.7	92.8	87.1	105.6	106.2	109.8
	IV	74.1	88.5	86.3	106.2	108.7	113.8
	V	73.2	87.2	84.7	106.7	109.7	117.8
	VI	92.3	91.7	92.5	104.5	109.0	120.2

Table 2 (continued)

7. Leather Tanning and Finishing

		Output	Employ- ment	Hours of work	Wages	Real wages	Product wages
1923-26	I	100.0	100.0	100.0	100.0	100.0	100.0
	II	91.6	97.9	97.4	101.5	101.2	105.9
	III	86.0	96.8	97.1	103.8	102.4	113.0
	IV	76.7	92.2	96.8	105.0	103.8	113.6
	V	70.1	85.2	88.5	104.5	103.8	118.1
	VI	79.2	86.8	96.5	104.1	102.4	107.7
	VII	77.2	88.0	96.9	105.1	101.2	110.1
	VIII	81.0	91.8	95.7	106.3	101.9	114.4
	IX	86.3	90.5	95.6	106.2	103.3	116.8
1926-29	I	100.0	100.0	100.0	100.0	100.0	100.0
	II	99.0	98.8	99.7	101.2	100.9	100.0
	III	95.9	97.7	97.4	103.8	104.1	98.3
	IV	99.4	98.5	98.7	104.0	105.9	89.4
	V	95.6	98.4	101.1	103.1	104.8	86.6
	VI	98.0	99.2	98.4	104.5	106.4	80.2
	VII	92.2	98.0	97.2	104.5	107.4	82.6
	VIII	89.2	94.7	100.6	101.2	104.5	87.2
	IX	94.3	92.5	102.4	100.5	102.4	88.9
1929-37	I	100.0	100.0	100.0	100.0	100.0	100.0
	II	96.3	98.0	97.7	100.6	103.4	106.0
	III	82.6	84.4	94.1	97.2	111.6	124.1
	IV	71.7	78.7	86.2	86.9	113.6	152.0
	V	71.4	77.3	87.0	77.4	108.4	153.7
	VI	89.6	96.0	83.8	95.3	124.5	137.1
	VII	96.2	100.7	78.8	105.9	130.7	152.5
	VIII	100.5	99.6	83.0	109.2	129.9	137.3
	IX	113.8	110.2	83.7	118.7	136.5	129.8
1937-39	I	100.0	100.0	100.0	100.0	100.0	100.0
	II	85.3	96.6	95.2	102.6	102.4	105.3
	III	68.6	84.3	86.6	103.2	103.8	116.1
	IV	67.9	76.9	83.2	104.2	106.6	126.6
	V	67.8	76.2	87.0	101.9	104.8	125.6
	VI	82.1	83.1	96.3	102.7	107.1	121.0

Table 3
Definitions of Variables Used in Estimation

Variable name	Definition
<i>COL</i>	Cost-of-living index
<i>EARN</i>	Nominal weekly earnings (per wage-earner)
\widehat{EARN}	Nominal weekly earnings, less intercept; see (3.2)
<i>EMERGWORK</i>	"Emergency workers" hired under New Deal
<i>EMP</i>	Employment of wage-earners
<i>EMPLF</i>	$EMP - LABORFORCE$
<i>HCOST</i>	Marginal cost of <i>HRS</i> ; see (3.12)
<i>HRS</i>	Weekly hours of work (per wage-earner)
<i>INTERCEPT</i>	Intercept in earnings equation; see (3.2)
<i>LABORFORCE</i>	Aggregate labor force (Lebergott), interpolated
<i>NRA</i>	National Recovery Act dummy
<i>P</i>	Industry output price
<i>PAY</i>	Nominal weekly earnings deflated by product price
<i>Q</i>	Real production (not deseasonalized)
<i>QSEAS</i>	Purely seasonal component of real production
$Q - QSEAS$	Deseasonalized real production
<i>t</i>	Time
<i>UNIONPOWER</i>	Cumulative man-days idled by strikes; =0, May 1935

All variables except *COL*, *EMERGWORK*, *LABORFORCE*, *NRA*, *t*, and *UNIONPOWER* are defined separately for each of the eight industries.

Other than *NRA*, *INTERCEPT*, *t*, and *UNIONPOWER*, variables are in logarithms.

Table 4
Industry Demands for Workers

Dependent variable: EMP_t

Independent variables	Industries							
	<i>IRON</i>	<i>AUTOS</i>	<i>MEAT</i>	<i>PAPER</i>	<i>SHOES</i>	<i>WOOL</i>	<i>LEATH</i>	<i>LUMBER</i>
EMP_{t-1}	.740 (19.6)	.610 (11.3)	.916 (16.7)	.881 (42.5)	.720 (13.2)	.578 (11.8)	.771 (19.2)	.684 (16.1)
PAY_t	-.135 (-3.70)	-.134 (-1.04)	-.094 (-1.98)	-.046 (-1.59)	-.202 (-1.87)	-.229 (-2.82)	.008 (0.16)	-.204 (-2.91)
$Q_{t+1} - QSEAS_{t+1}$	.123 (1.69)	.450 (5.39)	.918 (1.87)	.179 (1.27)	-.033 (-0.32)	.002 (0.02)	-.046 (-0.26)	.216 (1.39)
$QSEAS_{t+1}$	.102 (1.94)	.343 (4.94)	.124 (1.90)	.039 (0.98)	.220 (8.12)	.286 (2.61)	.147 (2.36)	.279 (3.50)
$Q_t - QSEAS_t$	.058 (1.94)	-.125 (-2.06)	-.532 (-1.37)	-.050 (-0.37)	.240 (1.86)	-.008 (-0.11)	.236 (1.37)	.071 (0.42)
$QSEAS_t$	.081 (1.47)	-.160 (-2.35)	-.016 (-0.23)	.082 (2.01)	-.030 (-1.03)	.393 (5.10)	.160 (2.55)	.172 (1.73)
NRA_t	.010 (1.04)	.035 (1.48)	.026 (1.40)	.019 (2.72)	.018 (1.85)	-.002 (-0.16)	.015 (2.38)	-.024 (-1.04)
Durbin-Watson	1.46	1.79	1.81	2.11	1.90	1.91	1.65	1.55
Sum of output coefficients	.364 (6.71)	.508 (6.69)	.494 (3.68)	.250 (4.76)	.397 (4.74)	.673 (8.06)	.497 (6.69)	.737 (7.34)

Sample: January 1923—December 1939

Estimation was by 2SLS.

See Table 3 for variable definitions; instruments are given in the appendix.

Estimates of the constant and the trend term are not reported.

t-statistics are in parentheses.

Table 5
Industry Demands for Hours of Work

Dependent variable: HRS_t

Independent variables	Industries							
	<i>IRON</i>	<i>AUTOS</i>	<i>MEAT</i>	<i>PAPER</i>	<i>SHOES</i>	<i>WOOL</i>	<i>LEATH</i>	<i>LUMBER</i>
HRS_{t-1}	.560 (14.0)	.761 (11.0)	.521 (10.6)	.612 (14.5)	.397 (5.58)	.512 (10.1)	.562 (10.0)	.381 (5.83)
$HCOST_t$	-.312 (-7.76)	-.162 (-2.85)	-.116 (-6.88)	-.056 (-2.51)	-.509 (-6.42)	-.334 (-7.82)	-.217 (-5.22)	-.159 (-3.70)
$Q_t - QSEAS_t$	.323 (12.4)	.131 (4.01)	.196 (7.11)	.220 (8.70)	.474 (7.50)	.242 (9.17)	.130 (5.05)	.254 (7.44)
$QSEAS_t$	.231 (3.99)	.062 (1.96)	.111 (5.01)	.162 (3.49)	.160 (3.29)	.348 (5.31)	.263 (3.63)	.357 (5.70)
NRA_t	-.041 (-3.40)	-.010 (-0.53)	-.016 (-2.34)	-.026 (-4.86)	.047 (3.06)	-.042 (-3.95)	-.007 (-0.80)	-.062 (-4.61)
Durbin-Watson	1.99	1.57	1.73	1.80	1.47	1.44	1.49	1.54
Sum of output coefficients	.553 (8.17)	.193 (3.42)	.307 (7.54)	.382 (7.06)	.634 (6.42)	.590 (7.65)	.394 (4.94)	.611 (6.89)

Sample: January 1923—December 1939

Estimation was by 2SLS.

See Table 3 for variable definitions; instruments are given in the appendix.

Estimates of the constant and trend term are not reported.

t-statistics are in parentheses.

Table 6
Earnings Functions

Estimated parameter	Industries							
	<i>IRON</i>	<i>AUTOS</i>	<i>MEAT</i>	<i>PAPER</i>	<i>SHOES</i>	<i>WOOL</i>	<i>LEATH</i>	<i>LUMBER</i>
1. Sample: January 1923 - June 1933								
α_E	.352 (4.13)	.048 (0.98)	.202 (2.71)	.496 (2.95)	1.111 (5.76)	.285 (4.95)	.267 (3.07)	.364 (3.33)
α_H	.951 (11.8)	1.172 (22.1)	.648 (8.79)	.869 (7.43)	.784 (7.53)	.737 (9.22)	1.010 (17.8)	.817 (4.16)
λ_P	.127 (3.19)	.173 (2.99)	.188 (3.88)	.078 (2.57)	.204 (3.30)	.175 (3.97)	.145 (3.40)	.320 (4.52)
Durbin-Watson	1.99	1.82	1.96	2.16	2.09	1.97	2.25	2.20
2. Sample: January 1923 - December 1939								
α_E	.320 (4.08)	.004 (0.14)	.118 (1.85)	.419 (2.84)	.317 (2.46)	.326 (5.76)	.252 (3.90)	.369 (4.28)
α_H	1.030 (18.9)	1.203 (27.0)	.713 (8.52)	.913 (11.8)	.983 (12.2)	.697 (9.13)	.966 (18.1)	.698 (4.76)
α_N	.029 (1.47)	.020 (1.25)	.009 (0.53)	.008 (0.64)	.053 (2.38)	.057 (3.11)	.040 (3.73)	.036 (0.98)
α_U	.229 (2.42)	.183 (1.61)	.210 (4.00)	.137 (2.23)	-.250 (-1.60)	.117 (1.63)	.097 (2.32)	.030 (0.24)
α_W	-.069 (-0.88)	-.131 (-1.94)	.163 (2.64)	.007 (0.17)	.008 (0.08)	-.035 (-0.47)	.045 (1.03)	.020 (0.17)
λ_P	.129 (3.84)	.073 (2.22)	.204 (4.81)	.095 (3.27)	.068 (1.97)	.163 (4.45)	.157 (4.50)	.217 (4.60)
Durbin-Watson	1.83	1.84	2.03	2.20	1.95	1.97	2.10	2.32

Estimation was by NL2SLS.

See text for parameter definitions; instruments are given in the appendix.

Estimates of the constant and trend term are not reported.

The estimates of α_U and α_W are multiplied by 10^5 and 10^4 respectively, for legibility.

t-statistics are in parentheses.

Table 7
Statistics of Model Simulation, January 1930–June 1933

1. Employment

Industry		Mean	Std. Dev.	Min.	Max.	%RMSE
<i>IRON</i>	<i>Actual</i>	71.0	14.4	51.7	98.3	
	<i>Simulated</i>	70.4	13.6	52.7	94.6	.098
<i>AUTOS</i>	<i>Actual</i>	66.0	14.3	37.3	94.4	
	<i>Simulated</i>	66.0	20.2	33.3	107.3	.143
<i>MEAT</i>	<i>Actual</i>	79.2	6.4	69.2	93.8	
	<i>Simulated</i>	79.2	6.0	69.0	94.9	.026
<i>PAPER</i>	<i>Actual</i>	89.9	8.2	80.0	109.0	
	<i>Simulated</i>	90.7	9.1	77.3	106.4	.033
<i>SHOES</i>	<i>Actual</i>	83.9	4.4	76.5	96.1	
	<i>Simulated</i>	84.8	4.1	79.8	94.3	.027
<i>WOOL</i>	<i>Actual</i>	59.7	8.2	37.2	77.8	
	<i>Simulated</i>	59.4	7.5	41.5	75.5	.060
<i>LEATH</i>	<i>Actual</i>	71.2	7.2	57.5	85.2	
	<i>Simulated</i>	72.3	5.9	63.8	81.5	.054
<i>LUMBER</i>	<i>Actual</i>	46.3	12.7	29.8	73.8	
	<i>Simulated</i>	46.5	12.7	30.5	69.3	.066

Table 7. continued

2. Hours of work

Industry		Mean	Std. Dev.	Min.	Max.	%RMSE
IRON	<i>Actual</i>	38.7	9.6	24.2	54.5	
	<i>Simulated</i>	38.1	8.3	26.8	52.3	.087
AUTOS	<i>Actual</i>	35.9	6.1	20.5	44.6	
	<i>Simulated</i>	37.3	2.4	33.5	41.9	.221
MEAT	<i>Actual</i>	48.8	1.5	44.5	52.1	
	<i>Simulated</i>	48.7	1.1	46.8	51.1	.021
PAPER	<i>Actual</i>	44.1	4.1	36.9	52.1	
	<i>Simulated</i>	44.4	3.8	38.9	51.7	.028
SHOES	<i>Actual</i>	41.8	3.1	36.8	49.0	
	<i>Simulated</i>	39.2	3.2	34.8	49.9	.089
WOOL	<i>Actual</i>	40.9	3.0	34.0	47.1	
	<i>Simulated</i>	40.7	3.0	32.8	48.8	.039
LEATH	<i>Actual</i>	43.5	3.3	34.8	48.4	
	<i>Simulated</i>	43.1	2.3	39.1	47.7	.049
LUMBER	<i>Actual</i>	39.3	4.6	29.4	46.4	
	<i>Simulated</i>	38.9	3.6	34.3	46.0	.045

Table 7. continued

3. Real wage

Industry		Mean	Std. Dev.	Min.	Max.	%RMSE
<i>IRON</i>	<i>Actual</i>	0.69	0.035	0.63	0.76	
	<i>Simulated</i>	0.69	0.012	0.66	0.71	.044
<i>AUTOS</i>	<i>Actual</i>	0.76	0.032	0.68	0.81	
	<i>Simulated</i>	0.76	0.028	0.70	0.81	.021
<i>MEAT</i>	<i>Actual</i>	0.56	0.021	0.53	0.60	
	<i>Simulated</i>	0.56	0.015	0.53	0.58	.038
<i>PAPER</i>	<i>Actual</i>	0.59	0.023	0.54	0.62	
	<i>Simulated</i>	0.58	0.017	0.54	0.60	.026
<i>SHOES</i>	<i>Actual</i>	0.51	0.022	0.46	0.56	
	<i>Simulated</i>	0.53	0.019	0.49	0.59	.072
<i>WOOL</i>	<i>Actual</i>	0.51	0.029	0.46	0.56	
	<i>Simulated</i>	0.51	0.018	0.47	0.54	.052
<i>LEATH</i>	<i>Actual</i>	0.57	0.020	0.52	0.61	
	<i>Simulated</i>	0.57	0.017	0.53	0.60	.012
<i>LUMBER</i>	<i>Actual</i>	0.57	0.033	0.52	0.62	
	<i>Simulated</i>	0.57	0.007	0.55	0.58	.051

Table 8
Dynamic Labor Supply Equation

Estimated parameter	Industries							
	<i>IRON</i>	<i>AUTOS</i>	<i>MEAT</i>	<i>PAPER</i>	<i>SHOES</i>	<i>WOOL</i>	<i>LEATH</i>	<i>LUMBER</i>
Sample: January 1923–June 1933								
β_1	1.78 (8.25)	1.63 (11.1)	1.77 (6.98)	1.45 (8.51)	1.04 (12.1)	2.10 (10.1)	1.21 (11.1)	1.80 (3.24)
β_2	0.03 (0.08)	2.29 (3.43)	2.99 (0.97)	0.30 (0.41)	0.29 (0.83)	0.42 (0.67)	2.92 (2.31)	0.26 (0.58)
β_3	-0.95 (-0.74)	-0.66 (-0.46)	-2.55 (-3.32)	-1.51 (-3.55)	-0.74 (-1.24)	-2.69 (-2.15)	-1.24 (-2.47)	-3.12 (-1.53)
λ_P	.137 (2.57)	.148 (3.49)	.093 (1.59)	.071 (2.30)	.184 (3.17)	.199 (3.26)	.095 (2.72)	.351 (4.24)
Durbin-Watson	2.02	1.85	1.81	2.06	2.04	2.23	1.86	2.08
2. Sample: January 1923–December 1939								
β_1	1.43 (16.3)	1.99 (10.5)	1.86 (7.54)	1.38 (12.5)	1.38 (15.2)	2.24 (14.8)	1.31 (12.9)	1.59 (8.28)
β_2	0.52 (2.05)	2.61 (3.34)	4.11 (1.62)	0.79 (1.71)	0.10 (0.23)	0.67 (1.25)	3.01 (3.35)	0.52 (1.46)
β_3	-1.93 (-2.74)	-0.32 (-0.21)	-3.11 (-4.39)	-1.64 (-5.97)	0.07 (0.12)	-2.01 (-2.35)	-1.53 (-4.17)	-4.21 (-3.99)
α_N	-.021 (-0.49)	.085 (0.98)	-.003 (-0.06)	.011 (0.65)	.020 (0.62)	.032 (0.66)	-.009 (-0.42)	-.046 (-0.87)
α_U	-.035 (-1.56)	-.102 (-2.57)	-.088 (-2.04)	-.030 (-1.92)	-.051 (-3.24)	-.009 (-0.43)	-.027 (-1.98)	.023 (1.00)
α_W	.142 (0.86)	.098 (0.31)	-.149 (-0.87)	.019 (0.28)	-.145 (-1.10)	.157 (0.89)	.065 (0.76)	-.211 (-1.03)
λ_P	.128 (3.90)	.170 (3.89)	.094 (2.49)	.081 (3.68)	.136 (2.76)	.165 (4.03)	.107 (3.99)	.174 (4.52)
Durbin-Watson	1.85	1.79	1.82	2.13	2.21	2.07	1.93	2.20

Estimation was by NL2SLS.

See text for parameter definitions; instruments are given in the appendix.

Estimates of the constant and trend term are not reported.

The estimates of α_U and α_W are multiplied by 10^4 for legibility.

t-statistics are in parentheses.

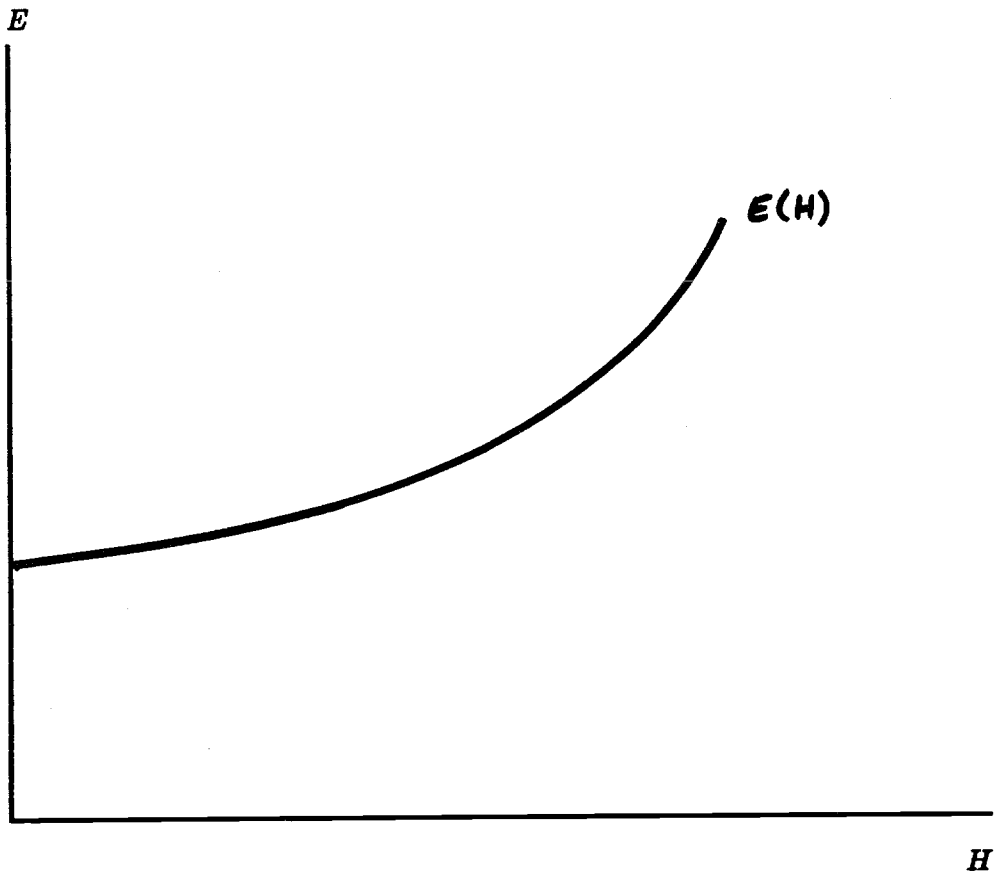


Figure 1. The Earnings Function

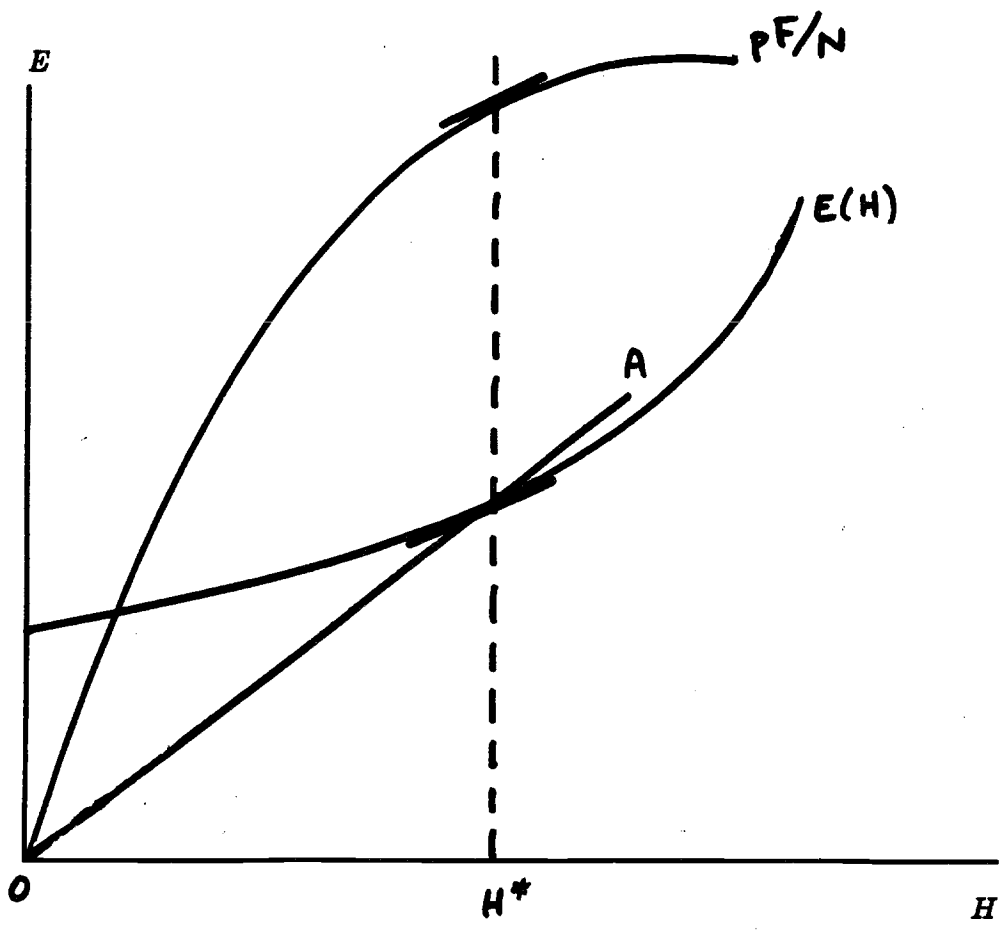


Figure 2. The Determination of H^*