NBER WORKING PAPER SERIES

WAITING FOR WORK

George A. Akerlof

Andrew K. Rose

Janet L. Yellen

Working Paper No. 3385

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
June 1990

We would like to thank Robert Barsky, Mark Bils, Roger Craine, Benjamin Hermalin, Jonathan Leonard, David Levine, Robert Lucas, John Pencavel, Richard Rogerson, Christian Romer, David Romer, Nancy Wallace and James Wilcox for helpful comments and discussions. We thank Sharon Cohany of the Bureau of Labor Statistics for providing unpublished data. We also gratefully acknowledge financial support from the Sloan Foundation, and from the NSF under grant number SES 88-07807 administered by the Institute for Business and Economic Research at the University of California, Berkeley. This paper is part of NBER's research program in Economic Fluctuations. Any opinions expressed are those of the authors and not those of the National Bureau of Economic Research.

NBER Working Paper #3385
June 1990

WAITING FOR WORK

ABSTRACT

This paper explains upward job mobility and observed patterns of unemployment by skill as an economy recovers from a recession. Skilled unemployment is due to rational waiting by workers looking for long-term jobs when there is a "lock-in" effect. Lock-in occurs if the conditions in the labor market when a worker first accepts a job have a persistent effect on wages. Using longitudinal data, we provide empirical evidence of the cyclical pattern of wages predicted by the theory and also of lock-in.

George A. Akerlof
Andrew K. Rose
Janet L. Yellen
University of California, Berkeley
Department of Economics
611 Evans Hall
Berkeley, CA 94720

I. Introduction

This paper models cyclical upgrading and downgrading in the labor market.[1] It shows that wait unemployment can arise as an equilibrium response to time varying opportunities: workers who are laid off in a downturn rationally wait to accept jobs until business conditions improve. Workers voluntarily remain unemployed during recessions if they gain through waiting for permanently higher wages which are available in the new jobs which appear during expansions. Our empirical work provides new evidence of procyclic variation in real wages of job takers. It also tests and strongly confirms the key assumption of the model: workers hired in booms "lock-in" persistently high wages and workers hired in busts suffer low wages for significant periods.

This paper is motivated in part by the observation that labor is not the only factor of production which experiences periods of idleness. Office buildings sometimes stand unoccupied for extended periods of time and oil reserves sit idly underground. In the case of oil (and other exhaustible natural resources), a well developed theory (Hotelling 1931) explains why the owners wait to extract their resource. In the equilibrium of the Hotelling model, the owners of oil reserves are compensated for waiting by an increase in the price of oil at the rate of interest.

In contrast to oil, the use of office buildings in one period does not preclude their use in other periods. In this respect, workers more closely resemble office buildings than oil. Yet, in places like Houston, Texas and Walnut Creek, California completed office buildings have been sitting vacant for long periods. The Hotelling model can be adapted to explain the existence of vacant office buildings provided that a significant fixed cost must be borne when office space is occupied or vacated. If such costs are sufficiently large, there is a "lock-in" effect: a building owner who rents his office space today to one tenant forgoes the possibility of renting the same space in later periods to other tenants. If long term rental rates increase more rapidly than the rate of interest, it pays the owner of an unoccupied building to leave the space vacant and wait until conditions improve to rent out space[2]. This is true even if there are tenants willing to pay to occupy the space now. In contrast, if the rental rates on long term leases increase at less than the rate of interest, the building owner maximizes the present value of his income by renting all available space now, since the reward to waiting in the form of higher rents in the future, does not make up for the loss in rentals today. In analogy to the market for oil, in equilibrium, long term rental rates will rise at precisely the rate of interest with the stock of excess office space being gradually eliminated over time.

This paper develops and tests a theory of wait unemployment which is exactly analogous to Hotelling's model as it would be applied to vacant office space. Those workers seeking *long term jobs* experience cyclical *unemployment* just as those office buildings whose owners seek *long term tenants* sometimes have *vacancies*. The "labor supply" function in this model is perfectly elastic and thus the model can rationalize the finding that large variations in employment are accompanied by small procyclic variations in wages. Our model, like that of Hansen (1985) and Rogerson (1988), accounts for large aggregate fluctuations in employment without empirically implausible elasticities of substitution between leisure in different time periods. Our model offers an alternative rationale for a high elasticity of labor supply with respect to transitory wage movements. If the wage were rising more rapidly than the rate of time preference, a rational worker seeking long term work would optimally wait for work, rather than commit to the best job currently available. This behavior occurs even if workers place no value at all on leisure.[3] Analogously, the supply elasticity with respect to transitory changes in long-term rental rates is infinite in the Hotelling office-space model, even though owners place no value on vacancies per se.

The market for office buildings has two important features: in periods of glut, higher quality buildings typically have lower vacancy rates than lower quality buildings; but lower quality buildings rent out some space before vacancies are completely eliminated in higher quality buildings. A model of the market for office buildings should explain these correlations between vacancies and quality type. Our model explains the analogous correlations observed between unemployment and skill: in recessions, more highly skilled workers experience less unemployment than less skilled workers; but more highly skilled workers do not fully bump less skilled workers in competitions for the new jobs that become available as the economy emerges from recession, so that skilled workers experience *some* unemployment.

In Section II we present the model. In Section III, we analyze how the amount of wait unemployment and the path of wages vary across individuals as the economy emerges from an exogenously-caused recession. The incidence of wait unemployment (both its distribution across skill groups and its aggregate amount) as well as the paths of wages over time by skill are endogenously determined in our model in much the same way that the path of extraction of oil over time and the length of time that must elapse before the oil is fully depleted and a backstop technology comes into use is endogenously determined in the Hotelling model. The ultimate causes of cyclical variations in labor demand are not addressed in this paper and could result either from shocks to aggregate demand or from shocks to productivity.

The model implies that the real wages of new job holders move procyclically. In Section IV we present empirical results based on the National Longitudinal Survey of Youth which strongly reinforce existing evidence of this behavior. According to the key assumption of the model, individuals who commit to low wage jobs in recessions do not realize rapid market based wage adjustments when business conditions improve and the wages of new entrants rises. Section V tests for such lock-in effects and finds strong evidence of their existence. Section VI provides a summary.

II. Description of the Model

Our model of the labor market focuses on the determination of wages and employment in the "spot" market where newly created jobs are filled. The number of new jobs created at each date and the wage distribution of these new positions are exogenously determined. Workers vary in skill and employers fill new jobs with the best workers available at the offered wage. Workers maximize the present value of lifetime income. Wait unemployment occurs when an individual who could obtain work today decides to hold out for better opportunities in the future.

We use the model to characterize the equilibrium paths of wages and wait unemployment by skill type as the economy emerges from a recession. Thus we study how the labor market responds to a shock which initially destroys a fraction of existing jobs leaving their occupants unemployed; we derive the time paths describing the reabsorption of these workers into employment and the wages they obtain as this occurs.

Our model is characterized by the following assumptions.

A. Assumptions Concerning Labor Supply

1. At time 0, a shock occurs which leaves θ people unemployed.

2. These people differ in skill. Skill is indexed by x, with x uniformly distributed between 0 and 1.

3. Each unemployed person has an intertemporal utility function which depends only on the present discounted value of lifetime income, with discounting of future income at rate δ.

4. Workers' willingness to accept or reject jobs is determined by the maximization of the present discounted value of lifetime income.

5. There is no uncertainty in the model and workers have perfect foresight.

6. During a short period of time, dt, new workers arrive into the unemployment pool at the rate α dt. This is a consequence of job destruction, quits and new entry into the labor force. The skill of new entrants into the unemployment pool is also uniformly distributed between 0 and 1.

7. Workers who are unemployed receive a benefit which is a proportion, b, of their 'steady state wage' w_s, the wage that workers of that skill type earn in a long run equilibrium with full employment.

B. Assumptions Concerning Labor Demand

8. Firms hire workers into jobs. Only one worker can fill one job.

9. New jobs arrive at the rate λ dt.

10. Jobs are characterized by the wages they pay. A job of type w pays the worker in that job a wage of w.

11. The distribution of wages of the λ dt jobs which are created between time t and t+dt is uniform between 0 and $\bar{w}$. Accordingly, there is a uniform distribution (of density $\lambda\, dt/\bar{w}$) of jobs paying a wage w between 0

and $\bar{w}$.

12. A firm wishing to fill a vacancy selects the best worker willing to accept its job offer at the time the vacancy appears.

13. Once the worker has accepted a job, he cannot leave it.

14. The wage paid on a job is constant forever (at its initial level).

C. Discussion of the Assumptions.

Three points concerning labor supply merit discussion.

(1). The model lets workers choose between accepting a long-term job now, or waiting until later to accept employment. There is no job quitting. This assumption, which is so obviously extreme, enables the model to highlight the implications of lock-in for the wait unemployment of long term job seekers. Because workers are looking for long term jobs in the model, it is an important empirical fact for us that much employment is in jobs of long duration. In 1978 male employees in manufacturing held jobs whose predicted average expected tenure at completion was 18.6 years (Akerlof and Main 1981). The comparable statistic for all employees for the same year was 12.5 years.

(2). In reality, many workers have low job switching costs, high rates of time preference or severe liquidity constraints and are therefore willing to accept short duration jobs. We could easily amend the model to include such workers. In our model, these workers would experience unemployment only when their respective "spot" wage falls below the value of their leisure and unemployment benefits. The presence of such workers in our model would *add* to the unemployment of long term job seekers.[4]

(3). The workers in our model who are unemployed are well informed and reject current jobs only in order to obtain better alternatives in the future.

Unemployed workers in our model are simply *waiting*, and not *searching* for jobs since there is no stochastic element to the offers workers receive.

Four points concerning labor demand also merit discussion.

(1). The flow of new jobs occurs at an exogenous rate which is determined outside the model. The defining characteristic of a job is the wage it pays. The jobs which appear in any period pay a distribution of wages. We do not address what determines the characteristics of new jobs created.[5] The determinants could be purely technological; alternatively, job creation could be driven by fluctuations in aggregate demand.

(2). While wages are set exogenously, firms do not select job applicants randomly. Instead job applicants are ranked according to ability, and firms with job openings hire the most able workers willing to accept those jobs. Thus the wage structure of jobs is fixed outside the model, but the wage for workers of given ability is determined endogenously. Jobs which pay higher wages obtain better workers. Competition among workers for jobs results in "clearance" of the 'spot' labor market, at least for skilled workers. These workers can always obtain some job by bumping less skilled workers in the competition for newly created jobs.[6]

This assumption is contrary to the implication of most efficiency wage models, that "overskilled" workers should be rejected by firms because they receive insufficient rents to exert optimal effort.[7] As a consequence, in most efficiency wage models, skilled workers would experience job rationing. Our assumption, however, closely corresponds to the two-stage institutional wage setting commonly practiced in large organizations (see, for example, Henderson (1982)). In the first stage, personnel managers establish "wage relativities", using various evaluation schemes to decide on the appropriate relative rates of pay of different jobs. In the second stage, firms use wage surveys to discover the rates of pay offered by other employers in the area and decide on their appropriate compensation level in comparison with other firms. Finally, individual vacancies are filled by selection of the best available candidates at these predetermined compensation levels. An expense preference theory of managerial behavior, which can be derived from principal-agent theory with constraints on liability[8], could theoretically rationalize such behavior. Katz and Summers (1989), for example, have argued that such "rent-sharing" models explain a wide range of empirical regularities concerning interindustry and occupational wage differentials. This characterization of the labor market is also in agreement with, for example, Reder (1955) and Okun (1973).

(3). In the model, firms pay newly hired workers quality-adjusted wages which may differ from those paid to workers hired previously.[9] In booms, firms discriminate against workers with high mobility costs by failing to raise their wage to the current market clearing level. Such discrimination may partly explain why quits in the U.S. economy are procyclic (see Akerlof, Rose and Yellen 1988). In booms, mobile workers leave 'bad' jobs which they acquired in recessions; the less mobile workers, whose behavior we model, remain stuck in these 'bad' jobs.

(4). Our model assumes that the mean quality of newly created jobs remains constant over time. *Aggregate* wages are virtually acyclic.[10] However *quality-adjusted* wages vary procyclically as the average skill of new hires into given quality jobs falls in booms. With the more realistic assumption (see, for example, Okun (1973) or Barsky and Solon (1989)) that the average quality of new jobs rises in booms, both quality adjusted and aggregate wages would be significantly procyclic.

III. Solution of the Model

A solution to this model consists of a description of the equilibrium paths both for the wage rate of each skill type and the unemployment rate of each skill type at each date during the transition to the steady state as the stock of initially unemployed workers, along with the flow of new entrants, is matched with the flow of new jobs.[11] We will denote these $w(x,t)$ and $u(x,t)$. We will first describe the steady state of this model, in which there is no unemployment, and then the approach to the steady state.

A. *The Steady State*

In the steady state unemployment disappears and the flow of new entrants into the labor market is matched with the flow of new jobs. New entrants and new jobs flow into the labor market at the rates α dt and λ dt respectively. We will assume that $\alpha < \lambda$. Under this assumption, the flow of new jobs is more than sufficient to provide employment to all new entrants into the labor force. At each time, new entrants queue by skill and "slot" themselves in order of quality into the flow of new jobs becoming available. In a steady state, the wage received by skill type x, denoted $w_s(x)$, is determined by the equilibrium condition that the number of new jobs paying at least $w_s(x)$ should just match the number of incoming workers at least as skilled as x, leading to the following equation

$$(1) \qquad \left[\int_{w_s(x)}^{\bar{w}} \lambda/_{\bar{w}} \, dw \right] dt = \alpha(1-x)dt \ .$$

The left hand side of (1) is the number of new jobs paying a wage at least as great as $w_s(x)$. The right hand side of (1) is the number of workers at least as skilled as x who are entering the unemployment pool. Solution of (1) yields a specific formula for the steady-state wage $w_s(x)$

$$(2) \qquad w_s(x) = \overline{w}(1 - {}^{\alpha}/_{\lambda}\ (1-x)).$$

In the steady state with $\alpha < \lambda$, some newly created jobs are never filled. If, contrary to our assumption, $\alpha > \lambda$, workers of skill type less than $1 - \lambda/\alpha$ are permanently unemployed.

B. Wages and Unemployment Along the Path to the Steady State

Along an equilibrium path to the steady state, all jobs accepted by workers of the same skill type must yield the same intertemporal utility. This follows from the fact that individuals who maximize intertemporal utility will never accept a job at any date t′ if they can get higher utility by accepting a job at another date, t″. As a result, an initially unemployed worker of type x receives utility U(x) dependent only on his skill type and not on the date of job acceptance. Since firms give preference to more qualified job candidates, workers of higher skill index x will receive jobs with a higher utility.

In order to solve for the path of wages received by a given skill type x along the path to the steady state it is necessary to determine T_x, which is the first date at which workers of type x receive the steady state wage and also the last date at which they have any unemployment. The methodology is similar to that used in a natural resource problem. In a natural resources problem, the price path of a resource is computed conditional on the date of first use of the backstop technology. Then the date of first use of the backstop technology is determined by the condition that the demand for the resource up to that date exactly exhausts the supply of the resource. T_x is analogous to the date of use of the backstop technology. As in the natural resource problem, the equilibrium wage path is computed conditional on T_x. Then T_x is determined by the condition that the demand for labor of type x along the equilibrium wage path between 0 and T_x must match the supply of labor of type x over the same period.

The Wage Path Conditional on T_x. The wage paid to skill type x at the date T_x is the steady state wage, $w_s(x)$, given by formula (2). Knowing that $w(x, T_x) = w_s(x)$, it is possible to find the wages for type x workers at all preceding dates conditional on T_x, since the present discounted value of the income stream of a worker accepting a job at $t < T_x$ and at T_x must be the same.

A job accepted at T_x yields intertemporal utility $U(x)$ which is the sum of two components: the present discounted value of the income $bw_s(x)$ received from unemployment insurance between 0 and T_x plus the present discounted value of the steady state wage, which is received beyond T_x. This utility is

$$(3) \qquad U(x) = bw_s(x)\,\frac{1-e^{-\delta T_x}}{\delta} + \frac{w_s(x)}{\delta}\,e^{-\delta T_x}$$

The "reservation wage" of type x labor at time t, $w(x,t)$, is then just that wage which yields the same total utility $U(x)$ for an initially unemployed worker who instead accepts a job at date $t < T_x$. The utility from accepting a job paying $w(x,t)$ at t is

$$(4) \qquad U(x) = bw_s(x)\,\frac{1-e^{-\delta t}}{\delta} + \frac{w(x,t)e^{-\delta t}}{\delta} .$$

Equating (4) and (3) yields w(x,t).

$$w(x,t) = w_s(x)e^{-\delta(T_x-t)} + bw_s(x)(1 - e^{-\delta(T_x-t)}). \tag{5}$$

Computation of T_x. To solve for T_x we equate the number of jobs created between 0 and T_x which yield utility at least as great as U(x) with the number of initially unemployed workers and new entrants to the labor force between 0 and T_x with skills at least as great as x. In our example it is possible to show that if type x labor has no unemployment at T_x then no higher grade of labor will be unemployed. In consequence the number of new jobs taken by labor with skill at least as great as x is the sum of two parts: the first component is the stock of workers with skill at least as great as x who were initially unemployed (at T_x they are all employed); the second component is the flow between 0 and T_x of workers who entered the labor force with skill at least as great as x. (All of these workers will also be employed at T_x in jobs which are at least as good as those taken by labor of type x.) There are $(1-x)\theta$ workers who are initially unemployed, with skill at least as great as x who become re-employed by date T_x; and there are $\alpha(1-x)T_x$ workers who enter the labor pool with skill at least as high as x. Consequently $(1-x)\theta + (1-x)\alpha T_x$ jobs are taken between 0 and T_x which are at least as good as the jobs taken by workers of skill level x.

How many jobs preferable to those taken by group x are created between 0 and T_x? At time t the rate of such "superior" job creation is

$$\int_{w(x,t)}^{\overline{w}} \lambda/_{\overline{w}}\, dw \tag{6}$$

where $w(x,t)$ is the "reservation wage" of labor of type x. Any job paying a higher wage than the reservation wage of type x labor is superior to that paying $w(x,t)$. Between 0 and T_x the total number of such jobs created is

$$(7) \qquad \int_0^{T_x} \left[\int_{w(x,t)}^{\bar{w}} \lambda/_{\bar{w}} \, dw \right] dt \ .$$

To solve for T_x, we equate the number of jobs created between 0 and T_x offering utility at least as great as $U(x)$, given by (7), with the number of initially unemployed workers and new entrants to the labor force between 0 and T_x with skills at least as great as x. This results in the equation

$$(8) \qquad \int_0^{T_x} \left[\int_{w(x,t)}^{\bar{w}} \lambda/_{\bar{w}} \, dw \right] dt = \theta(1-x) + \alpha(1-x)T_x \ .$$

Substitution of the formula for the wage, given by (5), into (8) yields an implicit equation for T_x:

$$(9) \qquad T_x - \frac{1-e^{-\delta T_x}}{\delta} = \frac{\theta}{\lambda}(1-x)/(1-b)(1 - \frac{\alpha}{\lambda}(1-x)) \ .$$

The Unemployment Path by Skill. The unemployment rate of type x labor at time t, $u(x,t)$, defined as the fraction of the initially unemployed workers of this skill type who are still out of a job at time t, can now be easily obtained. At time T_x there is no unemployment of type x workers or workers with greater skill. Therefore, for any $t < T_x$, the number of unemployed workers at least as skilled as x plus the number of workers who will enter the labor force between t and T_x with skill at least as great as x must equal the number of new jobs which will be created between t and T_x with wages at least as great as w(x,t):

$$(10) \qquad \int_x^1 \theta u(\phi,t)d\phi + (1-x)\alpha(T_x-t) = \int_t^{T_x} \left[\int_{w(x,t)}^{\overline{w}} \lambda/_{\overline{w}}\, dw \right] dt \quad .$$

The first term on the left hand side of (10) is the total number of unemployed workers with skill at least as great as x; the second term is the number of new entrants to the labor market with skill at least as great as x between t and T_x. The right hand side of (10) is the total number of jobs yielding at least as much utility as U(x) which are created between t and T_x. The unemployment rate of workers of type x at time t, u(x,t), is obtained by total differentiation of (10) with respect to x. Use of (2) and (5) to substitute for w(x,t) and use of (9) to compute dT_x/dx yields the following simple formula for the unemployment rate:

$$(11) \qquad u(x,t) = \frac{1}{1 - \frac{\alpha}{\lambda}(1-x)} \frac{1-e^{-\delta(T_x-t)}}{1-e^{-\delta T_x}} \cdot \frac{\alpha(1-b)(T_x - t)}{\theta}$$

$$+ \alpha(1-b) \frac{1-e^{-\delta(T_x-t)}}{\theta\delta} \quad .$$

Differentiating (11) with respect to x and making use of the fact that T_x is higher for lower x, it is easy to verify that, at each date, unemployment rates are inversely related to skill; less skilled workers experience higher unemployment throughout the transition to the full employment steady state. The more skilled experience a more rapid decline in unemployment than the less skilled, who linger longer in the unemployment pool as the economy emerges from recession. Our theory thus rationalizes observed relations between unemployment and skill.[12] Higher skilled workers have lower unemployment rates but unemployment is not confined solely to the lowest skilled workers in recession. Although more skilled workers can always bump less skilled workers for jobs, and thus there is no "involuntary" unemployment, there are (endogenous) limits to the bumping that occurs. The rate at which skilled workers currently take jobs determines the current wage gradient with respect to skill. Too great a current skill/wage gradient makes it rational for workers to wait rather than to take the jobs which are currently available to them. Unemployment results so that the current skill/wage gradient is not too steep.

As should be intuitive, an increase in α or decrease in λ serves to lengthen the amount of time it takes for the unemployment of any group to be absorbed. The unemployment rate of each group at each date is also greater the higher the unemployment benefit, b. These benefits raise an individual's reservation wage path by providing positive income in periods in which waiting occurs. As a consequence, individuals become more patient, in the sense that their wages need to rise at a slower rate to make waiting worthwhile. In the absence of unemployment benefits, wages must rise at the rate δ in order to compensate a worker for waiting. With unemployment benefits, the required rate of increase is approximately $\delta(1-b)$. Interestingly, although not shown in equation 11, the taxation of the marginal unemployment benefits of workers of greater skill will increase the unemployment of lower skill workers because it will induce the higher skill workers to take up the jobs that would otherwise be available to lower skilled workers.

C. Simulations

Figures 1 and 2 illustrate the key properties of this model for sample parameter values. The parameters which need to be chosen are θ, the percent of the labor force initially unemployed, α, the rate of flow into the labor pool as a fraction of the labor force, λ, the rate at which new jobs are created, b, the fraction of income replaced by unemployment insurance, and δ, the rate of discount. We chose $\theta = 5$ percent; in other words, we supposed that a recession started with 5 percent excess unemployment. The model does not represent the unemployment of persons who are in the secondary labor market or who are on temporary layoff waiting to be recalled. Nor does it reflect the unemployment of those who are at the margin between being in and out of the labor force. For this reason we chose α the flow into the unemployment pool to be quite low relative to total turnover. Total turnover in manufacturing is 60 percent per year. We chose α to be 5 percent per year. Further, we chose $b = .5$, and $\delta = .1$. The major reason for choosing such a high rate of discount is to mitigate the assumption in the model that jobs last forever. Workers' leaving their jobs with a constant probability is similar to an addition to the rate of discount in our model. The final parameter chosen was λ, the rate of job creation; λ was chosen so that the length of the recovery would be 36 months, the typical length of recoveries in the United States. That is we chose, T_0, the length of time for the lowest index labor to lose all its unemployment to be three years. λ was then chosen so that with the values of α, b, θ and δ already selected, T_0 would be three years (according to formula (9) for T_0). Figures 1 and 2 show simulated paths of unemployment and wages with these benchmark parameters. It is worth noting how modest the fluctuations in real wages are over this cycle.

Figure 1. Fraction of Initial Unemployment Remaining by Skill Percentile by Month from Trough with Benchmark Parameters

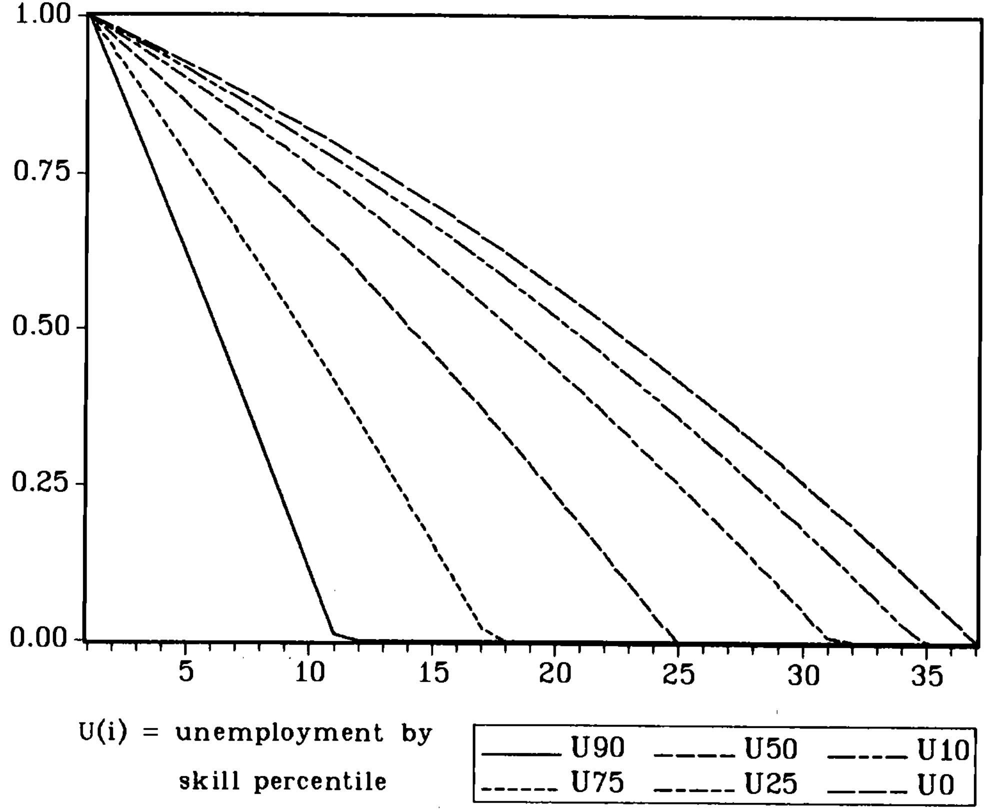
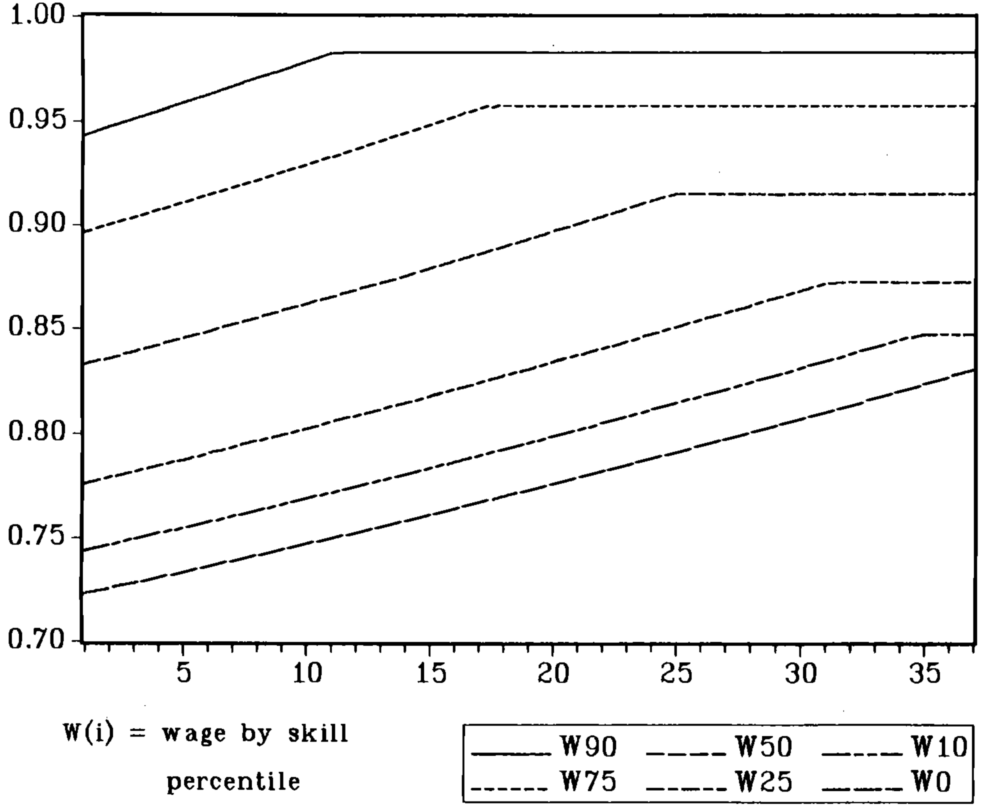


Figure 2. Wages as a Fraction of Maximum Wage by Skill Percentile by Month from Trough with Benchmark Parameters



IV. Testing for Cyclicality in the Wages of New Job Holders

The next two sections of the paper present empirical tests of two key features of our model. In this section, we demonstrate the validity of an important implication of our model, namely that wages for individuals beginning new jobs ("movers") are procyclic. We estimate that an exogenous one-point increase in aggregate unemployment lowers real wages for movers by approximately 3%. In the next section, we test an important assumption of our model, namely, that wages of individuals who remain in jobs ("stayers") differ significantly from those of movers. In particular, we test and reject the hypothesis that the wages of stayers are as cyclic as those of movers. Instead, we find that the wages of stayers persistently reflect the cyclic conditions which prevailed when the job was first taken, so that individuals who are hired during expansions "lock-in" persistently high wages.

We test our hypotheses using data drawn from the National Longitudinal Survey of Youth (NLSY). The NLSY is a nationally representative panel of 6111 youth who were between the ages of 14 and 21[13] in 1979. Detailed interviews were conducted annually with the participants from 1979 through 1986. The NLSY has suffered extremely low attrition; 92% of the original cohort answered the 1986 survey.

We use the NLSY for a number of reasons. This data set has not been previously exploited by researchers, and it is interesting to compare our results with those derived both from other NLS cohorts (e.g., the NLS cohort of young men used by both Bils (1985) and Keane, Moffitt and Runkle (1988), [hereafter "KMR"]), and from other micro-panels (e.g., the PSID used by Barsky and Solon (1989), Blank (1987) and Mincer (1987)). Many young people have low costs of job switching and change jobs frequently. Our model does *not* explain the unemployment of individuals who are willing to take short jobs at low wages. Nevertheless, irrespective of the length of stay of the incumbents, the wages obtained by young people in the spot market accurately reflects the cyclical behavior of opportunities in the general labor market. The sample period is of interest both because of its immediacy, and because it includes a natural macroeconomic experiment, the deep recession of 1982.[14]

The assumptions of the theoretical model presented in Section II imply the following structural wage equation for individuals acquiring new jobs:

$$(12) \qquad w_{i,t,j(t)} = f(u_{i,t}, HK_{i,t}, X_{i,t})$$

where: $w_{i,t,j(s)}$ is the (logarithm of the) real wage that individual i receives at time t for job j that began at time s, $s \le t$; $u_{i,t}$ is a measure of the business cycle (which may be individual-specific) at time t; $HK_{i,t}$ is a vector of human capital variables for i at time t; $X_{i,t}$ is a vector of other relevant variables facing i at time t.

We assume that f(.) is a static stochastic linear function, and estimate:

$$(13) \qquad w_{i,t,j(t)} = \alpha + \beta u_{i,t} + \sum_k \gamma_{HK,k} HK_{k,i,t} + \sum_l \gamma_{X,l} X_{l,i,t} + \epsilon_{i,t}$$

where $\epsilon_{i,t}$ is an iid individual-specific productivity shock which is unobservable to the econometrician, but orthogonal to the regressors. Under these conditions, (13) can be estimated efficiently with ordinary least squares (OLS); we discuss potential estimation problems below.

The primary parameter of interest is β. If the unemployment rate is used for $u_{i,t}$, then β is the unemployment semi-elasticity of real wages. Our model implies that β is expected to be negative in sign, with a coefficient which is approximately equal to $-\delta(1-b)T_0/\theta$. If $\delta = .1$, $b=.5$, $T_0 = 3$ and $\theta = 5$ percent, as in our benchmark simulations, then the implied unemployment semi-elasticity, β, is -.03.

The theoretical model presented above indicates that equation (13) is relevant only for job movers, that is individuals who are in new jobs at time t. In our empirical work, the universe of (13) consists of individuals who started their current job (with a new employer) after the date of the last NLS interview. We restrict our attention to individuals who are full-time workers at least 16 years old. High school and full-time college students, as well as the self-employed, are excluded from the sample.[15] The data is pooled across years, so that some individuals account for multiple observations; for instance, a person who moved before both the 1983 and 1986 interviews (and satisfied all the other requirements) would account for two observations.

We attempt to take advantage of the rich array of data available in the NLSY. The vector HK contains the following variables: a) age; b) sex dummy; c) poor health dummy; d) number of dependents; e) a dummy for individuals who are married with spouse present); f) five race dummies; g) three religion dummies; h) dummies for individuals with non-native mother and non-native father; i) experience (measured as the number of 2000-hour work-years) and its square; j) dummies for high-school and college graduation; k) years of education; and l) ten scores from a battery of vocational aptitude tests.[16,17] The X vector contains dummies for residency in: the South; a non-SMSA area; and a rural area. The regressand is the natural logarithm of the hourly wage rate (in cents) deflated by the aggregate GNP deflator (1982=1.). We use the unemployment rate for all workers as a percentage of the labor force including resident Armed Forces; this rate peaked at 9.5% in 1982-1983.

OLS estimation of (13) produces the results in the first two columns of Table 1 below. Standard errors are reported in parentheses; sample averages of the regressors are tabulated in the column on the extreme right of the table. Coefficients which are significantly different from zero at the .01 (.05) confidence level are marked with two (one) asterisks. The equations fit the data well; the adjusted R^2 of .22 compares favorably with other results (e.g., the OLS wage equation of KMR has an adjusted R^2 of .05). "RMSE" denotes the root mean squared-error of the residual.

The unemployment rate enters (13) with a coefficient of -.028, indicating that an exogenous increase in the unemployment rate of one point (from say 7% to 8%) is associated with a 2.8% decline in the real wage. The coefficient is estimated with great precision; the associated t-statistic is 5.2. By comparison, Bils (1985) finds that a one point increase in the unemployment rate is associated with a fall of between 3.5% and 4% in the real wage for job changers. Bils finds a semi-elasticity of between -.015 and -.02 for all individuals (including job stayers); KMR estimate a much smaller response (between -.005 and -.01). Mincer (1986) estimates a semi-elasticity of between -.012 and -.029. The estimate of 2.8% accords closely with the theoretical prediction of the model for reasonable parameter values.

Our estimate of (13) implies wage cyclicality which is both statistically significant and close in magnitude to the prediction of the theory. However, other aspects of (13) are also of intrinsic interest. The results in Table 1 are, for the most part, quite consistent with much of the received wisdom in labor economics. Worthy of note are: 1) the large but declining return to experience; 2) the significant positive effects of both college graduation[18] and additional years of education; 3) lower average wages for females but

Table 1: OLS Estimation of (13), Wage Equation for Movers

	Coefficient Estimate	Standard Error	Coefficient Estimate	Standard Error	Sample Average
Intercept	5.511**	(.063)	5.557**	(.095)	1.000
Time Trend	-.022**	(.003)	-.021**	(.003)	3.300
Unemployment Rate	-.028**	(.005)	-.032**	(.008)	7.752
Experience	.081**	(.008)	.096**	(.024)	3.389
Experience^2	-.004**	(.001)	-.005*	(.002)	16.350
Years of Education	.037**	(.004)	.038**	(.004)	12.460
High School Graduate	-.035*	(.017)	-.021	(.028)	.821
College Graduate	.063**	(.011)	.072**	(.018)	.288
Female	-.147**	(.015)	-.154**	(.018)	.467
Foreign Mother	.042	(.027)	.044	(.027)	.075
Foreign Father	.022	(.028)	.023	(.029)	.069
RC	.011	(.013)	.014	(.014)	.323
Jewish	.068	(.049)	.073	(.050)	.012
Other, Non-Protestant	-.006	(.017)	-.003	(.018)	.110
Black	.021	(.020)	.012	(.024)	.105
Oriental	.007	(.063)	-.003	(.065)	.007
Eastern European	-.067	(.036)	-.070	(.036)	.023
Hispanic	.034	(.025)	.031	(.026)	.066
Native American	-.025	(.019)	-.023	(.019)	.089
Married, Spouse Present	.040**	(.013)	.034*	(.016)	.268
Number of Dependents	.007	(.008)	.006	(.008)	.290
Poor Health	-.131**	(.030)	-.137**	(.031)	.032
Southern	-.012	(.012)	-.001	(.012)	.373
Non-SMSA	.019	(.011)	.022	(.012)	.338
Urban	.095**	(.014)	.102**	(.017)	.811
Aptitude Scores:					
General Science (/25)	.0015	(.0021)	.0008	(.0023)	15.5
Arithmetic (/30)	-.0003	(.0015)	-.0007	(.0016)	17.3
Word Knowledge (/35)	.0014	(.0015)	.0018	(.0015)	25.5
Paragraph Comp'n (/15)	-.0080**	(.0028)	-.0085**	(.0029)	10.7
Numerical Op's (/50)	.0046**	(.0008)	.0045**	(.0008)	33.7
Coding Speed (/84)	.0010*	(.0005)	.0010*	(.0005)	44.9
Auto/Shop Knowledge (/25)	.0043*	(.0018)	.0050*	(.0021)	14.1
Mathematics (/25)	.0027	(.0017)	.0021	(.0020)	13.0
Mechanical (/25)	-.0011	(.0018)	-.0013	(.0018)	13.8
Electronics (/20)	.0020	(.0023)	.0020	(.0023)	11.2
Sample Selection Correction			-.152	(.234)	
RMSE	.390		.390		
R^2	.23		.23		
	F(34,5564)=48.58**		F(35,5563)=47.20**		

N=5599
Mean Log Wage=6.19

(strikingly) insignificantly different wages for a variety of religious and racial groups; 4) an insignificant effect of Southern residency; 5) a positive effect of urban residency; and 6) mostly positive and sometimes significant effects of higher scores on the ten aptitude tests. The exception to the latter is the significantly negative impact of higher scores on paragraph comprehension.

OLS estimation of (13) ignores the potentially important effects of sample selection bias. Such issues have been recently stressed by KMR (see also Bils (1985)). At least two distinct types of sample selection bias are potentially important. First, (13) is only estimated for movers. However, at least some movers are individuals who quit their old jobs in order to take advantage of idiosyncratically higher wages. As quits are known to be procyclic, ignoring such self selection may lead the econometrician incorrectly to estimate a countercyclically biased semi-elasticity. More importantly, an individual must be currently employed to enter the universe of (13). The theoretical model above argues that high quality workers constitute a disproportionate number of new job movers during recessions. As a consequence, in our model, wages adjusted for 'true' quality tend to fall during recessions, although "aggregate" wages are acyclic. If labor quality is imperfectly observable, the econometrician who ignores sample selection bias will estimate an unemployment rate coefficient which is counter-cyclically biased.

We have checked the robustness of our results to both types of potential sample selection biases by using the popular two-step "Heckit" estimator; Heckman (1979) provides the classic analysis. Heckit analysis proceeds in two steps. First a probit equation is used to estimate the sample selection rule; then a function of the probit residuals which corrects the sample selection bias is added to the equation of interest (in our case, (13)). As we are concerned with two potential types of sample selection bias, we estimate two types of probit equations.[19] The more important compares movers to the remainder of the sample (e.g., including unemployed workers); the second compares movers only to employed stayers. We then include the sample selection correction in (13) and re-estimate our equations for movers. Results which include a sample-selection correction (for movers vs all others) are included in Table 1 in the third and fourth columns. Consistent with the results of Bils (1985) (but not KMR), the results do not indicate significant sample selection bias; this is true of both types of potential sample selection bias.

An interesting alternative way to avoid sample selection of the mover/stayer variety, is to examine the wages of individuals leaving school and entering full-time employment for the first time. The wages of school-leavers are highly procyclic: if (13) is estimated for the universe of school-leavers, the coefficient on the unemployment rate is -.039 with a standard error of .009. This estimate is similar to that derived from (13) above. Nevertheless, there is clearly an element of choice in the timing of the decision to finish school and enter the labor force. While we suspect that such considerations are not very important, they lead to a countercyclic bias in the unemployment coefficient (insofar as individuals avoid entering the labor force and taking low-wage jobs during recessions).

We have also checked our results for robustness with respect to a number of other perturbations of our basic methodology. We have added lags of the wage rate to the right-hand side of (13). We have used GLS, weighting observations by national sampling weights. Alternatively, we have used standard errors which are immune to arbitrary forms of heteroskedasticity. We have used different definitions of two of the key variables in (13): 1) the CPI has been substituted for the GNP deflator; 2) three alternative measures of the business cycle have been used in place of the aggregate unemployment rate: (a) the employment/population ratio; b) the aggregate unemployment rate for youth; and c) the (individual-specific) local area unemployment rate, both with and without year effects. Finally, we have restricted the sample in five different ways: 1) excluding earlier years of the sample; 2) eliminating outliers; 3) restricting the sample to non-unionized workers; 4) estimating (13) on an industry by industry basis; and 5) estimating (13) separately for each of eleven occupation groups. However, none of these exercises removes or substantially weakens our finding of substantially procyclic wages.

We note in passing that adding industry or occupation controls to (13) only slightly (and insignificantly) reduces the degree of wage cyclicality, indicating that wage cyclicality does not exist solely because individuals receive the opportunity to move to high-wage sectors or occupations during expansions (as proposed by Okun (1973)).

A differenced version of (13) which accounts for individual-specific "fixed effect" intercepts is:[20]

$$(14)\qquad w_{i,t,j(t)}-w_{i,s,j-1(s)} = \beta(u_{i,t}-u_{i,s}) + \sum_k \gamma_{HK,k}(HK_{k,i,t}-HK_{k,i,s}) + \sum_l \gamma_{X,l}(X_{l,i,t}-X_{l,i,s}) + \epsilon_{i,t}-\epsilon_{i,s}$$

OLS estimates of (14) are presented in Table 2. The effect of the aggregate unemployment rate is somewhat lower than in the levels equation (-.024 vs -.028), though not significantly so. However, the real wage rate remains significantly procyclic judged on both economic and statistical

Table 2: OLS Estimation of (14), Growth of Wage Equation for Movers

	Coefficient Estimate	Standard Error
Intercept	.083**	.018
ΔUnemployment Rate	-.024**	.007
ΔExperience	.026	.016
ΔExperience^2	-.002	.001
ΔYears of Education	.004	.021
ΔHigh School Graduate	-.053	.071
ΔCollege Graduate	.090	.077
ΔMarried, Spouse Present	.009	.023
ΔNumber of Dependents	-.014	.013
ΔPoor Health	-.086	.048
ΔSouthern	-.076	.046
ΔNon-SMSA	-.002	.024
ΔUrban	.076*	.034

N=2211 RMSE=.451 $F(12,2198)=2.54$ $R^2=.01$

grounds. As in the estimate of (13), these results are also robust. For instance, if year effects are added, they are insignificant, and (insignificantly) change the coefficient on the unemployment rate to -.031. Alternatively, if the (change in the) local area unemployment rate is used instead, the point estimate is quite similar (-.022), with a t-statistic of 7.[21]

To summarize, evidence from the NLSY panel is quite consistent with the hypothesis that the real wage for movers is significantly procyclic in both the economic and statistical senses. We now proceed to the second of our objectives, namely testing for real wage "lock-in".

V. Testing for "Lock-In"

The objective of this section is to test for a "lock-in" effect on real wages. "Lock-in" occurs if individuals who stay in jobs have wages which are significantly less cyclic than wages of comparable individuals who move into new jobs. In the extreme case used in the theoretical model, real wages of movers are procyclic, but the wage of an individual who is hired at time t for wage w_t remains fixed at w_t for as long as the individual remains in the job.

One way to test for lock-in is to estimate an analogue to (13) for stayers as well as movers. We use the following trivial generalization of (13):

$$(15) \qquad w_{i,t,j(s)} = \alpha + \beta u_{i,t} + \sum_k \gamma_{HK,k} HK_{k,i,t} + \sum_l \gamma_{X,l} X_{l,i,t} + \epsilon_{i,t}$$

If s=t, then (15) is precisely (13); however, if s≠t, the individual is a stayer. In the absence of any lock-in effect, β is identical for movers and stayers; in contrast, in our theoretical model lock-in is complete so that β is zero for stayers. To test for lock-in, we estimate (15) separately for movers and stayers and test the hypothesis that the β of stayers is significantly lower than the coefficient for movers.

Estimates of (15) for movers and stayers are tabulated in Table 3.[22] While the coefficients in the movers and stayers equations resemble each other closely in many respects, the wages of movers are much more cyclic. In particular, the coefficient on the unemployment rate for stayers is one-quarter of the comparable coefficient for movers; further, the hypothesis that the wages of stayers are acyclic cannot be rejected at conventional significance levels.[23] The conclusion that the wages of movers and stayers have differing cyclicality is not unique to this study; Bils (1985) has reached similar conclusions.[24]

An alternative test for lock-in uses the following equation:

$$w_{i,t,j(s)} = r_1\hat{w}_{i,t,j(t)} + r_2 w_{i,s,j(s)}) + \mu_{i,t} \text{ for } s \neq t \tag{16}$$

where $\hat{w}_{i,t,j(t)}$ is the wage which individual i would hypothetically receive at time t if he were to start a new job and $\mu_{i,t}$ is an iid disturbance term assumed to be orthogonal to the regressors which represents match-specific productivity effects.

To understand this equation, consider the wage of a man who began his job in the recession year 1982 and remained in the same job through 1986. The wage of this worker would exhibit lock-in if his 1986 wage was still (adversely) affected by his initially low 1982 wage. Alternatively, if the man's wage moved one for one with the wages of active participants in the spot labor market, then there would be no persistent effect of the low initial wage and thus no evidence of lock-in. Absence of lock-in can be conveniently

Table 3: OLS Estimation of (15), Wage Equation for Movers and Stayers

	Movers		Stayers	
	Coefficient Estimate	Standard Error	Coefficient Estimate	Standard Error
Intercept	5.511**	(.063)	5.362**	(.058)
Time Trend	-.022**	(.003)	-.006*	(.003)
Unemployment Rate	-.028**	(.005)	-.007	(.005)
Experience	.081**	(.008)	.078**	(.007)
Experience^2	-.004**	(.001)	-.003**	(.001)
Years of Education	.037**	(.004)	.026**	(.004)
High School Graduate	-.035*	(.017)	-.000	(.017)
College Graduate	.063**	(.011)	.049**	(.009)
Female	-.147**	(.015)	-.147**	(.013)
Foreign Mother	.042	(.027)	.029	(.026)
Foreign Father	.022	(.028)	.056*	(.026)
RC	.011	(.013)	.024*	(.011)
Jewish	.068	(.049)	-.007	(.050)
Other, Non-Protestant	-.006	(.017)	-.010	(.015)
Black	.021	(.020)	.067**	(.018)
Oriental	.007	(.063)	.146**	(.050)
Eastern European	-.067	(.036)	.034	(.031)
Hispanic	.034	(.025)	.026	(.023)
Native American	-.025	(.019)	.014	(.017)
Married, Spouse Present	.040**	(.013)	.052**	(.010)
Number of Dependents	.007	(.008)	.018**	(.006)
Poor Health	-.131**	(.030)	-.148**	(.028)
Southern	-.012	(.012)	-.034**	(.010)
Non-SMSA	.019	(.011)	.031**	(.009)
Urban	.095**	(.014)	.122**	(.011)
Aptitude Scores:				
General Science (/25)	.0015	(.0021)	-.0012	(.0018)
Arithmetic (/30)	-.0003	(.0015)	.0009	(.0013)
Word Knowledge (/35)	.0014	(.0015)	.0022	(.0013)
Paragraph Comp'n (/15)	-.0080**	(.0028)	-.0038	(.0024)
Numerical Op's (/50)	.0046**	(.0008)	.0047**	(.0006)
Coding Speed (/84)	.0010*	(.0005)	.0005	(.0004)
Auto/Shop Knowledge (/25)	.0043*	(.0018)	.0050**	(.0015)
Mathematics (/25)	.0027	(.0017)	.0035*	(.0014)
Mechanical (/25)	-.0011	(.0018)	.0001	(.0015)
Electronics (/20)	.0020	(.0023)	.0057**	(.0020)
RMSE	.390		.381	
R^2	.23		.25	
	F(34,5564)=48.58**		F(34,7764)=75.02**	
N	5599		7799	
Mean Log Wage	6.19		6.38	

parameterized as $\tau_1=1$, $\tau_2=0$; partial lock-in can be expressed as $\tau_1<1$, $\tau_2>0$; complete lock-in (as assumed in the theoretical model) implies $\tau_1=0$, $\tau_2=1$.

Equation (16) cannot be estimated without generating data for $\hat{w}_{i,t,j(t)}$. Conceptually, this is the wage that, a woman who stayed in a job through say the 1984 interview would have gotten if she had actually moved during 1984; alternatively, it can be viewed as the wage that movers with observable characteristics identical to those of the woman actually get. We generate $\hat{w}_{i,t,j(t)}$ by estimating (13) for movers, and using the fitted coefficients (along with the regressors of stayers) to generate $\hat{w}_{i,t,j(t)}$ for stayers.[25] Traditional standard errors may not be correct insofar as $\hat{w}_{i,t,j(t)}$ is a generated regressor; consequently, we estimate standard errors through a parametric bootstrap, using 1000 replications.[26]

Actual estimates of (16), with and without a constant term, are, respectively:

$$(17)\quad w_{i,t,j(s)} = \underset{(.22)}{-.69} + \underset{(.04)}{.51}\hat{w}_{i,t,j(t)} + \underset{(.03)}{.62}w_{i,s,j(s)}$$

$N=3021$ $R^2=.44$ $RMSE=.324$

$$(18)\quad w_{i,t,j(s)} = \underset{(.03)}{.41}\hat{w}_{i,t,j(t)} + \underset{(.02)}{.61}w_{i,s,j(s)}$$

$N=3021$ $R^2=.998$ $RMSE=.324$

The results indicate that the wages of stayers are substantially affected by both their initial wage and the contemporaneous wage of movers. There is strong evidence of partial lock-in; both the extreme hypotheses of complete and of no lock-in can be easily rejected at all conventional significance levels. Note that the initial wage is not adjusted for tenure or experience in any way.[27]

Equation (16) may be criticized insofar as no dynamics are included; alternatively, (16) can be viewed as a steady state target. Accordingly, we have estimated a series of dynamic models, including the following partial-adjustment models:

$$(19)\quad w_{i,t,j(s)} = \underset{(.24)}{-.31} + \underset{(.05)}{.44}\hat{w}_{i,t,j(t)} + \underset{(.03)}{.62}w_{i,t-1,j(s)}$$

N=4930 R^2=.52 RMSE=.307

$$(20)\quad w_{i,t,j(s)} = \underset{(.23)}{-.37} + \underset{(.05)}{.36}\hat{w}_{i,t,j(t)} + \underset{(.05)}{.45}w_{i,t-1,j(s)} + \underset{(.04)}{.26}w_{i,s,j(s)}$$

N=3021 R^2=.51 RMSE=.304

The significance of the initial wage in (20) indicates that the wages of stayers do not converge asymptotically to the spot market wages attained by movers. Thus, (20) provides evidence of significant "hysteresis" in wage determination of stayers. Even if the possibility of hysteresis is ignored, as in (19), the speed of adjustment of the wages of stayers to the wages of movers is not very high; the mean lag is over two and a half years. We conclude that accounting for dynamics, at least in this simple way, does not reverse our finding of partial lock-in.

For yet another test of lock-in, we mechanically first-difference (13) across time obtaining potentially different equations for "stayers", "single movers", defined at those in a new job at time t but not t-1, and "double movers", defined as those in new jobs both at t and t-1.

Stayers:

$$(21)\quad w_{i,t,j(s)}-w_{i,t-1,j(s)} = \beta_{ST}(U_{i,t}-U_{i,t-1}) + \sum_k \gamma_{ST,HK,k}(HK_{k,i,t}-HK_{k,i,t-1}) + \sum_l \gamma_{ST,X,l}(X_{l,i,t}-X_{l,i,t-1}) + \epsilon_{ST,i,t}-\epsilon_{ST,i,t-1}$$

Single Movers:

$$(22)\quad w_{i,t,j(t)}-w_{i,t-1,j-1(s)} = \beta_{SM}(U_{i,t}-U_{i,t-1}) + \sum_k \gamma_{SM,HK,k}(HK_{k,i,t}-HK_{k,i,t-1}) + \sum_l \gamma_{SM,X,l}(X_{l,i,t}-X_{l,i,t-1}) + \epsilon_{SM,i,t}-\epsilon_{SM,i,t-1},\quad s<t$$

Double Movers:

$$(23)\quad w_{i,t,j(t)}-w_{i,t-1,j-1(t-1)} = \beta_{DM}(U_{i,t}-U_{i,t-1}) + \sum_k \gamma_{DM,HK,k}(HK_{k,i,t}-HK_{k,i,t-1}) + \sum_l \gamma_{DM,X,l}(X_{l,i,t}-X_{l,i,t-1}) + \epsilon_{DM,i,t}-\epsilon_{DM,i,t-1}$$

Estimates of equations (21) - (23) are presented in Table 4. Under the null hypothesis of (13) β_{DM} should be significantly negative; partial lock-in implies that β_{ST} and β_{SM} should be closer to zero.

A rigorous test of the hypothesis that the unemployment rate coefficients are equal for stayers and movers can be computed by pooling observations. The test indicates that stayers and double movers (but not stayers and single movers) have different cyclic wage patterns. Using the aggregate unemployment rate, the t-test is 2.4 for stayers vs double movers (with a marginal significance level of 1.9%); for stayers vs single movers, the t-statistic is .8 (with a marginal significance level of 45%). Thus double movers, but not single movers, appear to have wages which are significantly more cyclic than those of stayers at traditional significance levels.

Finally, the fitted annual first-differenced version of (16) is:

Table 4: OLS Estimation of Growth of Wage Equation for Stayers, and both Double and Single Movers

	Stayers		Single Movers		Double Movers	
	Coeff Est	Stand Error	Coeff Est	Stand Error	Coeff Est	Stand Error
Intercept	.094**	(.018)	.029	(.023)	.080	(.047)
ΔUnemployment Rate	-.002	(.003)	-.009	(.007)	-.024	(.013)
ΔExperience	-.026	(.019)	.122**	(.031)	.059	(.056)
$\Delta Experience^2$	-.001	(.001)	-.007**	(.002)	-.005	(.003)
ΔYears of Education	.000	(.014)	.059**	(.018)	.026	(.064)
ΔHigh School Graduate	-.015	(.029)	.029	(.038)	-.055	(.165)
ΔCollege Graduate	.101**	(.038)	.208**	(.035)	.236	(.192)
ΔMarried, Spouse Pres	-.014	(.012)	.002	(.024)	.044	(.041)
ΔNumber of Dependents	.002	(.007)	.008	(.014)	-.013	(.024)
ΔPoor Health	-.020	(.022)	-.105**	(.037)	-.133	(.070)
ΔSouthern	.002	(.048)	.053	(.038)	-.008	(.073)
ΔNon-SMSA	-.033	(.016)	-.021	(.022)	-.023	(.040)
ΔUrban	.003	(.025)	.037	(.023)	.111*	(.047)
N	7276		4135		1023	
RMSE	.324		.503		.456	
R^2	.003		.027		.017	

$$(24) \quad w_{i,t,j(s)} - w_{i,t-1,j(s)} = .04 + .17(\hat{w}_{i,t,j(t)} - \hat{w}_{i,t-1,j-1(t-1)})$$

$$(.01) \quad (.10)$$

N=7276 R^2=.001 RMSE=.324

The results indicate that less than one-fifth of the wage growth of movers is reflected in the wage growth of comparable stayers. Incorporating a variety of dynamics does not change this conclusion.

VI. Summary

This paper has presented a theory of unemployment and wages by skill for an economy emerging from a recession. It has provided an equilibrium theory of upward mobility in a high pressure economy as observed by Okun (1973). In booms, workers of all qualities who are in the job market get better jobs than they can get in recession. Workers are sufficiently dissatisfied with the jobs available to them in recessions that some of them choose to wait rather than to work. Those who choose to wait are unemployed; the number of them is endogenously determined so that the reward to waiting due to the procyclic movement in real wages compensates for the lost income from current unemployment. We have shown that wages in the spot market, for workers currently taking jobs, improves significantly as the unemployment rate declines. Also, workers who take jobs in recessions experience lock-in: the wages received in those jobs do not rise to match the improvement in the spot market.

REFERENCES

Akerlof, George and Brian Main, "An Experience-Weighted Measure of Employment and Unemployment Durations," American Economic Review, vol. 71, December 1981, pp. 1003-11.

______________, Andrew Rose and Janet Yellen, "Job Switching and Job Satisfaction in the U.S. Labor Market," Brookings Papers on Economic Activity, 1988:2, pp. 495-592.

Barsky, Robert and Gary Solon, "Real Wages Over the Business Cycle," Working Paper No. 2888, National Bureau of Economic Research, March 1989.

Bils, Mark, "Real Wages Over the Business Cycle: Evidence from Panel Data," Journal of Political Economy, vol. 93, August 1985, pp. 666-89.

Blank, Rebecca, "Why Are Wages Cyclical in the 1970s?" Working Paper No. 2396, National Bureau of Economic Research, October 1987.

Davis, Steve and John Haltiwanger, "Gross Job Creation, Gross Job Destruction, and Intrasector Labor Reallocation," University of Chicago and University of Maryland, 1989.

Hansen, Gary, "Indivisible Labor and the Business Cycle," Journal of Monetary Economics, 16, November 1985, pp. 309-328.

Heckman, James J., "Sample Selection Bias As a Specification Error," Econometrica, vol. 47, January 1979, pp. 153-161.

Henderson, Richard I., Compensation Management: Rewarding Performance, Third Edition. (Reston, Va.: Prentice-Hall, 1982).

Hotelling, Harold, "The Economics of Exhaustible Resources," Journal of Political Economy, vol. 39, April 1931, 137-175.

Katz, Lawrence F., and Lawrence H. Summers, "Industry Rents: Evidence and Implications," Brookings Papers on Economic Activity, 1: 1989.

Keane, Michael, Robert Moffitt , and David Runkle, "Real Wages over the Business Cycle: Estimating the Impact of Heterogeneity with Micro Data," Journal of Political Economy, vol 96, December 1988, pp. 1232-1266.

Leonard, Jonathan, "In the Wrong Place at the Wrong Time: The Extent of Frictional and Structural Unemployment," in Kevin Lang and Jonathan S. Leonard, eds., Unemployment and the Structure of Labor Markets, New York: Basil Blackwell, 1987.

Lucas, Robert E. Jr., "Equilibrium Search and Unemployment," Journal of Economic Theory, vol. 7, February 1974, pp. 188-209.

Mincer, Jacob, "Wage Changes in Job Changes," Working Paper No. 1907, National Bureau of Economic Research, April 1986.

Okun, Arthur, "Upward Mobility in a High pressure Economy," Brookings Papers on Economic Activity, 1:1973.

Piore, Michael, "The Impact of the Labor Market upon the Design and Selection of Productivity Techniques within the Manufacturing Plant," Quarterly Journal of Economics, vol. 82, 1968, pp. 602-620.

Reder, Melvin W., "The Theory of Occupational Wage Differentials," American Economic Review, vol. 45, December 1955, pp. 833-52.

Rogerson, Richard, "Indivisible Labor, Lotteries and Equilibrium," Journal of Monetary Economics, vol. 21, January 1988, pp. 3-16.

Salop, Steven C., "A Model of the Natural Rate of Unemployment," American Economic Review, vol. 69, March 1979, pp. 117-125.

Sappington, David, "Limited Liability Contracts between Principal and Agent," Journal of Economic Theory, vol. 29, 1983, pp. 1-21.

Shapiro, Carl and Joseph E. Stiglitz, "Equilibrium Unemployment as a Worker Discipline Device," American Economic Review, vol. 74, June 1984, pp. 433-444.

FOOTNOTES

1. This phenomenon has been previously explored by Reder (1955), Okun (1973), Bils (1985), and Barsky and Solon (1989). This paper provides a theoretical rationale for their findings and additional evidence.

2. This abstracts from the existence of variable costs incurred from renting space and assumes that tenancies last forever.

3. Hansen (1985) and Rogerson (1988) have explained the significant variation in employment which occurs over the business cycle in a model in which unemployed workers have a contract which provides insurance when they are not working. With optimal contracts, consumption is unaffected by employment status and labor supply is more elastic than it would be in the absence of such insurance because unemployed workers experience no consumption decline. Hansen and Rogerson assume either that individuals' preferences or the technology exhibits a nonconvexity with respect to labor supply so that individuals either work full time or not at all, with the outcome determined by a lottery in each period.

4. The presence of such workers at the beginning of a recession typically leads to greater depression of quality-adjusted wages and thus increases the incentive to wait for workers with high switching costs or low rates of time preference.

5. In the model constructed, firms do not substitute <u>teams</u> of low paid, low skilled workers to perform the jobs of <u>individual</u> high skilled workers. This differs from the usual representation of production with labor of different skills in which different workers embody different efficiency units of labor and output is a function of the total labor input, in efficiency units, and capital. In such a model output is the same with one skilled laborer embodying one labor efficiency unit or two unskilled laborers each embodying one half labor efficiency unit. In contrast, in our model, the good laborer would not be a perfect substitute for the two poor laborers. Production is organized into jobs and only one laborer can fill one job. The empirical validity of this assumption is affirmed by an interview study by Michael Piore (1968), who found that job descriptions were not responsive in the short-run to relative prices.

6. Davis and Haltiwanger (1989) and Leonard (1987) have shown that the labor market is characterized by large gross flows of job creation and job destruction so that λ is large. In such an environment, it seems highly implausible that skilled workers would be unable to bump less skilled workers for jobs if they wanted them.

7. In the models of Shapiro and Stiglitz (1985) and Salop (1979), for example, workers who are overskilled would have insufficient incentive to work rather than shirk, or to remain on the job rather than quit.

8. In the usual principal agent model, a principal designs a compensation scheme to control a manager who cares not only about her compensation but also about her own effort. If a manager hires outside labor and can obtain labor which is easier to manage by paying a higher wage, the theory is formally identical with "wages

to those managed" substituted for "effort" in the standard principal/agent model. If first-best contracts are obtained, then expense preference will not occur. But first-best contracts can only be obtained under conditions which are impractical in most labor contracts. Sappington (1983) has shown that the imposition of limits to the extraction of payments from managers to firms results in contracts considerably different from first best. Such contracts are likely to result in suboptimal effort of managers, in the usual principal agent model, or an excess of expense preference, in a model where managers are hiring other inputs.

9. The existence of "two-tier" pay structures in the airline industry provides an example of how wages paid to new workers may be lower than the wages paid to workers with seniority. In academia, it is commonly alleged that new hires are paid more than equally qualified workers who are locked in. Our empirical work in Section IV shows that wage adjustments of existing workers to the current "spot wage" occurs slowly. Our model makes the extreme assumption, for simplicity, that no such adjustment occurs.

10. Aggregate wages in our model are slightly procyclic because not all newly created jobs are taken. As recovery occurs, the wage cut off of newly taken jobs rises.

11. Lucas (1974) emphasized that both wages and unemployment should be jointly determined in a full equilibrium model. Our model provides an alternative to that exposited by Lucas.

12. For example, when the unemployment rates of sex-education groups are regressed on the aggregate unemployment rate, the coefficients for both men and women decline with increasing education. Further, in the National Longitudinal Survey of Youth, the incidence of unemployment is negatively correlated with a variety of measures of labor quality.

13. Actually 22.

14. Nevertheless, the NLSY does have some potentially important drawbacks. First, the temporal span of the data is shorter than that of other tapes; we focus on the seven years of data from 1980 through 1986. Also, the NLSY does not have data on some variables of potential interest. For instance, there are no measures of overtime pay, which is the subject of considerable interest (Bils (1985), KMR).

15. We have also considered both more and less restrictive universes. In particular, we have restricted our universe to individuals who left their previous job for a reason *other than*: being laid off; fired; or becoming pregnant. We have also enlarged our sample to include school leavers (with no previous employer). Our results are typically insensitive to our exact choice of universe.

16. Our thirty-two controls exclude the labor force size variable used by Bils because it is unavailable in the NLSY. Otherwise, our controls encompass the complete list of previously used controls. Both Bils and KMR use a total of four HK controls.

17. The vocational aptitude tests measure knowledge and skill in the following areas: 1) general science; 2) arithmetic reasoning; 3) word knowledge; 4) paragraph comprehension; 5) numerical operations; 6) coding speed; 7) auto and shop information; 8) mathematics knowledge; 9) mechanical comprehension; and 10) electronics information. These tests are used by the armed services to determine eligibility and assignment qualifications for specific military jobs for new enlistees; the scores are also used as measures of trainability, and as primary criteria of enlistment eligibility for the armed forces. The NLSY members were paid $50 each to take the battery of tests.

18. High-school graduation is associated with a wage decline, but this result is of marginal statistical significance and is quite sensitive to the exact specification of (13).

19. The regressors in the probit equations are identical to those in (13).

20. Note that the differencing is taken over jobs, rather than over time.

21. The local area unemployment rate provided by the NLS is categorical, so that the semi-elasticity discussed in the text is an implied semi-elasticity.

22. Of course, the estimates for movers are identical to those of Table 1.

23. If the other regressor coefficients are equated for both movers and stayers, the hypothesis that the unemployment coefficient is equal for the pooled sample of both movers and stayers can be easily rejected; the t-statistic is over 12.

24. In contrast, Barsky and Solon (1989), using the Panel Study of Income Dynamics, find only small and statistically insignificant greater cyclicality of wages for classes of workers with many stayers in comparison with classes of workers with many movers. However as Barsky and Solon discuss, stayers and movers cannot be classified precisely in the PSID because of its lack of precision in labor force histories.

25. Results adjusted for sample selection bias are not significantly different; this is not surprising, as we have not found significant evidence of sample selection bias.

26. The generated regressor problem does not easily fit into the framework of Pagan.

27. Adding in tenure in a variety of ways (such as an independent regressor, or as an interaction with the initial wage) only strengthens evidence of lock-in.