NBER WORKING PAPER SERIES

INTER-INDUSTRY MOBILITY AND THE CYCLICAL UPGRADING OF LABOR

Mark Bils

Kenneth J. McLaughlin

Working Paper No. 4130

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
August 1992

For helpful comments, we thank Larry Katz and Barbara Mace, as well as participants at the NBER's conference on "Unemployment and Wage Determination" and in seminars at the following universities: Chicago, Indiana, Rochester, and Texas. We also thank Yih-Chyi Chuang for his excellent research assistance. Bils acknowledges financial support from the National Science Foundation and from the James S. Kemper Foundation through a grant to the Graduate School of Business at the University of Chicago. McLaughlin's research was funded by the John M. Olin Foundation and the Earhart Foundation through grants to the University of Chicago's Center for the Study of the Economy and the State. This paper is part of NBER's research programs in Labor Studies and Economic Fluctuations. Any opinions expressed are those of the authors and not those of the National Bureau of Economic Research.

NBER Working Paper #4130
August 1992

INTER-INDUSTRY MOBILITY AND THE CYCLICAL UPGRADING OF LABOR

ABSTRACT

We investigate whether a market-clearing model of the labor market is consistent with the cyclical upgrading of labor: workers tend to move to higher paying industries in expansions and to lower paying industries in contractions. By applying Roy's (1951) model of self-selection to industry fluctuations, we show that cyclical upgrading can be consistent with market clearing. Applying the model to inter-industry mobility patterns in panel data, we find data of substantial selection by comparative advantage. However, the panel data reveal a selection process that is consistent with cyclical upgrading. Thus the model does not simultaneously account for inter-industry mobility in panel data and cyclical upgrading.

Mark Bils
Graduate School of Business
University of Chicago
1101 East 58th Street
Chicago, IL 60637
and NBER

Kenneth J. McLaughlin
Department of Economics
University of Michigan
Ann Arbor, MI 48109
and University of Rochester

Inter-Industry Mobility and the Cyclical Upgrading of Labor

I. Introduction

Aggregate expansions are associated with upgrading in the labor market (Reder 1955; Okun 1973). In expansions, workers tend to flow from low wage industries such as retail trade to high wage industries such as durable-goods manufacturing. That is, employment in higher wage industries is more cyclically sensitive than employment in lower wage industries (Okun 1973; and Huizinga 1980). In addition, relative to the aggregate wage, wages do not rise in cyclical high-wage industries in expansions. Early research by Haddy and Tolles (1957) and Wachter (1970) concludes that inter-industry wage differences decline in expansions; and more recently Wood and Solon (1990) find that wages are equally procyclical in cyclical and noncyclical industries.

The evidence that employment is most cyclical in high wage industries and wages most procyclical in low wage industries has been cited to support disequilibrium or segmented markets theories of the labor market. First, the evidence appears to be inconsistent with a market-clearing equilibrium with high-wage cyclical industries exhibiting relatively large product demand increases in expansions: if the labor market clears, why would industries with large fluctuations in employment not have large fluctuations in wages? Second, as Okun (1973) stresses, if employers in high wage industries face queues of workers, then the industry need not increase its wage to expand employment: the upward slope of labor supply is irrelevant. Queues stabilize wages in high wage industries, but exacerbate movements in employment. McDonald and Solow (1985) draw essentially the same implications from a model where union bargaining in some industries is the source of industry wage differences and worker queues. Others draw similar conclusions from models that employ efficiency wages to create industry wage differences and queues (e.g., Akerlof and Yellen 1985).

The evidence of cyclical upgrading is not sufficient to support the conclusion of segmented labor markets. Market clearing does not require large movements in relative wages. First, if over the cycle inter-industry movers are low skill workers, then their transitions to high wage industries tends to bias down the wage growth in those industries. This is purely a compositional effect. Second, if high wage industries are more cyclically sensitive because they face quite elastic labor supply schedules, wages need not move much to support large flows of labor across industries.[1]

One of our purposes is to demonstrate that a market-clearing equilibrium model is consistent with cyclical upgrading. A second purpose is to determine whether such a model can simultaneously account for other patterns of inter-industry mobility. To balance the analysis, we also investigate the implications of simple queuing models for inter-industry mobility.

After briefly documenting the industry employment and wage patterns, we develop a market-clearing model of self-selection to industries that accounts for the cyclical upgrading regularities. Heterogeneous workers follow comparative advantage in self-selecting into industries (Roy 1951). We characterize the distribution of skills that would be consistent with low wage workers moving to high wage industries in expansions. We contrast the predictions of the market-clearing model with predictions of two disequilibrium models of the labor market: unions restricting entry to raise wages, and firms paying higher wages to attract higher quality applicants (e.g., Weiss 1980). Both disequilibrium extensions generate queues of workers to some industries.

We use data from the Panel Study of Income Dynamics (PSID) to estimate the market-clearing selection model for twenty-five industries. Parameters of the selection process are estimated to be consistent with the wages of industry stayers and inter-industry movers in the United States. By comparing the wages of industry stayers, leavers, and new hires, we qualitatively identify the selection process. The estimated

[1]A third possibility is that labor contracts smooth the wages of senior workers. Although we do not explore wage smoothing in detail, we find evidence that workers with little or no seniority do *not* display more cyclically sensitive wages.

selection process, although consistent with inter-industry mobility, is not consistent with cyclical upgrading. Our estimates imply that comparative advantage lines up with absolute advantage in nearly all industries; thus each industry employs workers who are better *in that industry* than other workers would be.

The evidence of heterogeneity and comparative advantage suggests that industries face rising labor supply schedules. However, our estimates of industry shadow prices of labor (i.e., true industry wage rates) indicate that across industries relative wage rates are unresponsive to cyclical fluctuations in employment. The model also fails to explain the wage changes of inter-industry movers: there is evidence of jumps up (down) in pay to entering (exiting) high wage industries.

II. Industry Employment, Hours, and Wage Patterns

In this section, we document several industry employment, hours, and wage patterns for the United States. Which industries exhibit the biggest employment fluctuations and which have the biggest wage fluctuations? Are the cyclical employment and wage sensitivities correlated across industries? Do high wage industries fluctuate the most in terms of employment but the least in terms of wages? For short, does cyclical upgrading characterize industries in the United States?

To answer these questions, we analyze quarterly data on employment, weekly hours, and hourly wages in twenty-five industries from 1964 through 1987 from Bureau of Labor Statistics surveys of establishments. The first two columns of Table 1 display summary characteristics—averages over the sample period—of industry employment and wages for our twenty-five industries. Column 1 lists each industry's share of aggregate employment. Column 2 reports average hourly wages of production workers in each industry relative to average hourly wages in all private nonagricultural industries. Construction, transportation, utilities, and most manufacturing industries pay relatively high wages. The low wage industries include textiles, retail trade, and most service industries.

To estimate the cyclical sensitivities of industry i's employment E_{it}, weekly hours H_{it}, and wages W_{it}, we regress each industry variable on aggregate employment E_t, our measure of the business cycle. In particular, let

$$\log(E_{it}/E_t) = a_i^e + \alpha_i^e \cdot t + \beta_i^e \cdot \log E_t + \epsilon_{it}^e \tag{1a}$$

$$\log(H_{it}/H_t) = a_i^h + \alpha_i^h \cdot t + \beta_i^h \cdot \log E_t + \epsilon_{it}^h \tag{1b}$$

$$\log(W_{it}/W_t) = a_i^w + \alpha_i^w \cdot t + \beta_i^w \cdot \log E_t + \epsilon_{it}^w, \tag{1c}$$

where the variables without industry indices are aggregates. For each industry, we estimate the time-differenced analogues of the three equations. We report our estimates of β_i^e, β_i^h, and β_i^w, the three cyclical sensitivities, in columns 3–5 of Table 1.

We report the cyclical sensitivity of industry employment in column 3. Since our measure of the business cycle is aggregate employment, an industry with a constant share of aggregate employment over the business cycle receives a value of zero. Industries vary dramatically in their cyclical sensitivities. Construction and most durable manufacturing industries exhibit cyclical movements in employment that are more than twice the size of the aggregate fluctuations. Utilities, financial industries, government, and many service industries exhibit cyclical movements in employment that are considerably less than half the size of aggregate movements.

Reflecting the cyclical upgrading of labor across industries, the cyclical sensitivities of industry employment are positively correlated with industry wages. The correlation between industry relative wages in column 2 and the cyclical sensitivities of industry employment in column 3 is .32. High wage industries expand more in aggregate expansions.

Cyclical movements in industry workweeks are summarized in column 4. Data on the workweek, hours per worker per week, are available only for production workers.[2] In

TABLE 1

Cyclical Patterns Across Industries[a]
Establishment Data, 1964–1987

Industry	Employment Share (%)	Relative Wage	Elasticity of Relative: Employment	Hours	Wages
Agriculture	4.3	0.63[b]	−0.13		
			(0.45)		
Mining	0.9	1.29	0.02	0.20	−0.28
			(0.66)	(0.21)	(0.23)
Construction	4.7	1.53	1.59	0.20	−0.49
			(0.21)	(0.20)	(0.10)
Metals	3.2	1.21	1.54	0.66	−0.04
			(0.19)	(0.11)	(0.08)
Machinery	4.8	1.12	1.14	0.36	−0.24
			(0.19)	(0.07)	(0.07)
Transportation Equipment	2.3	1.36	1.24	0.28	−0.05
			(0.41)	(0.23)	(0.17)
Other Durables	3.4	0.96	1.02	0.17	−0.32
			(0.15)	(0.09)	(0.06)
Food & Tobacco	2.2	1.00	−0.40	−0.02	−0.45
			(0.13)	(0.08)	(0.08)
Textiles, Apparel, & Leather	3.0	0.73	0.50	0.13	−0.03
			(0.21)	(0.19)	(0.09)
Paper, Printing, & Publishing	2.2	1.16	−0.10	0.21	−0.35
			(0.07)	(0.06)	(0.05)
Chemicals, Petroleum, & Rubber	2.3	1.15	0.38	0.23	−0.46
			(0.14)	(0.07)	(0.08)
Transportation	3.4	1.29	0.28	0.05	−0.16
			(0.12)	(0.08)	(0.11)
Communications	1.4	1.22	−0.56	0.16	−0.33
			(0.44)	(0.21)	(0.22)
Utilities	0.9	1.35	−0.74	−0.10	−0.35
			(0.11)	(0.09)	(0.06)
Wholesale Trade	5.5	1.05	−0.25	−0.08	−0.21
			(0.07)	(0.05)	(0.06)

TABLE 1–Continued

Industry	Employment Share (%)	Relative Wage	Elasticity of Relative: Employment	Hours	Wages
Retail Trade	15.7	0.73	−0.46 (0.12)	−0.30 (0.07)	−0.10 (0.07)
Finance, Insurance, & Real Estate	5.2	0.92	−0.64 (0.05)	−0.14 (0.06)	−0.28 (0.08)
Business Services[c]	2.9	0.93	0.10 (0.13)	−0.43 (0.10)	−0.53 (0.10)
Repair Services	0.9	0.86[b]	0.10 (0.16)		
Personal Services	1.2	0.64[b]	0.12 (0.24)		
Entertainment & Recreation	1.0	0.89	−1.00 (0.33)	−0.09 (0.23)	0.94 (0.47)
Health Services	4.9	0.88	−1.07 (0.06)	−0.30 (0.09)	−0.40 (0.06)
Education	8.1	1.17[b]	−0.53 (0.18)		
Legal & Other Professional Services	6.0	1.01[b]	−0.47 (0.12)		
Public Administration	9.9	1.17[b]	−0.90 (0.11)		

[a]Standard errors are displayed in parentheses.

[b]Establishment data are not available for wage rates and weekly hours. The relative industry wage is calculated from the PSID.

[c]For all service industries combined, relative hours per week display an elasticity of −.28 (standard error of .05) and relative wages an elasticity of −.04 (standard error of .07) with respect to movements in aggregate employment.

the aggregate, workweeks are procyclical: a one percent increase in aggregate employment is associated with an increase in hours per week of 0.22 percent (standard error of 0.06). In almost all cases, industries with procyclical shares of employment also have sharp increases in hours per week. These relative movements are large and statistically significant in a number of cases. The correlation between the cyclical sensitivities of industry employment and hours is .72. Furthermore, like employment, the workweek is more cyclical in high wage industries. The correlation between industry relative wages in column 2 and the cyclical sensitivities of industry hours in column 3 is .52.

Column 5 presents the estimated cyclical sensitivities of industry wages relative to aggregate wages in the private nonagricultural economy. (Wages are average hourly earnings for production workers; we use the GNP Deflator to compute real wages.) Aggregate real wages are slightly procyclical over the period 1964 to 1987: a one percent increase in aggregate employment is associated with a 0.08 percent increase in the real wage (standard error of 0.09). In expansions average industry wages fall relative to average aggregate wages, so industry wages tend to move countercyclically relative to aggregate wages. Because expansions are associated with faster employment growth in high wage industries, aggregate wages vary procyclically relative to a weighted average of industry wages. In response to a one percent increase in aggregate employment, aggregate wages increase by 0.23 percent relative to the average response across the industries, which weights industries by their long-run employment shares. Huizinga (1980) also documents this disparity between aggregate and industry wage movements at the one-digit industry level.

Although the relationships are fairly weak, high wage and cyclically sensitive industries have the least procyclical wages. First, the cyclical sensitivity of industry wages is negatively correlated with the level of industry wages: the correlation between cyclical

---

[2]Industry-specific elasticities are unavailable for several service industries and government employment.

wage sensitivities in column 5 and industry wages in column 2 is −.27. Second, industries with the most procyclical employments have the least procyclical wages: the correlation between cyclical employment sensitivities in column 3 and industry wages in column 2 is −.17. The weakness of these relationships is consistent with Wood and Solon's (1990) finding that the inter-industry wage structure is largely unrelated to the business cycle.

The establishment data reveal four patterns in industry employment, hours, and wages: (a) high wage industries tend to be more cyclically sensitive; (b) across industries, fluctuations in the workweek mimics employment fluctuations; (c) relative to aggregate wages, industry wages move countercyclically; (d) industry wages are not more procyclical in high-wage, cyclically sensitive industries.

III. Economic Hypotheses

Despite their richness, many of the industry employment and wage regularities are consistent with both segmented-market and market-clearing approaches to the labor market. With a segmented labor market, the source of the regularities is queues for jobs in high wage industries. Employment in high wage industries fluctuates more because firms in these industries draw from the queue without raising wages. Therefore, industries with high wages and large employment fluctuations are predicted to have small wage fluctuations. Since workers drawn from the queue receive a jump in pay, the aggregate wage would appear to be procyclical even if industry wages were not cyclical. Thus regularities (a), (c), and (d) are consistent with segmented labor markets. However, with a queue for employment in the high wage industries, it is not obvious why workweeks in these industries would rise in expansions.

With heterogeneous workers and market clearing, self-selection can produce many of the industry employment and wage regularities. The close link between employment and hours suggests an increasing supply price of labor, which can be generated by sorting heterogeneous workers by comparative advantage. If high wage industries are the most cyclical, then a cyclical expansion could draw the most talented workers from low wage industries and these workers could be the least talented workers in the high wage industries. Such inter-industry mobility generates a countercyclical selection bias in industry wages, which captures regularity (c). Industries that do not fluctuate do not have this countercyclical bias, which might account for regularity (d).

To be more precise in sorting among the competing hypotheses, in this section we sketch an equilibrium model of selection and investigate whether any inadequacies of the model can be remedied by introducing queues.

Roy's Model of Self-Selection

We use Roy's (1951) equilibrium model of self-selection in the labor market to analyze the effects of aggregate fluctuations that shift industry demands for labor. Shifts in industry labor demands generate changes in the composition of employment, production, and consumption that are supported by changes in industry wage rates and product prices. The induced reallocation of labor produces compositional effects that are potentially consistent with the industry wage and employment regularities.

We begin by summarizing the essential features of the selection model. There are $n+1$ industries indexed by $i = 0,\ldots,n$. Industry 0 is the nonmarket or home sector, which we treat the same as any industry in the market. Each industry faces a downward-sloping demand for its product. Each industry's output is an increasing concave function of its labor input L_{it}: $q_{it} = \mathrm{F}_{it}(L_{it})$. Within each industry there is a large number of *identical* firms. Taking industry product prices $\boldsymbol{p}_t = (p_{1t},\ldots,p_{nt})$ and wage rates $\boldsymbol{\omega}_t = (\omega_{1t},\ldots,\omega_{nt})$ as given, firms behave competitively in both product and labor markets. From competition, industry employment satisfies $p_{it} \cdot \mathrm{F}'_{it} = \omega_{it}$.

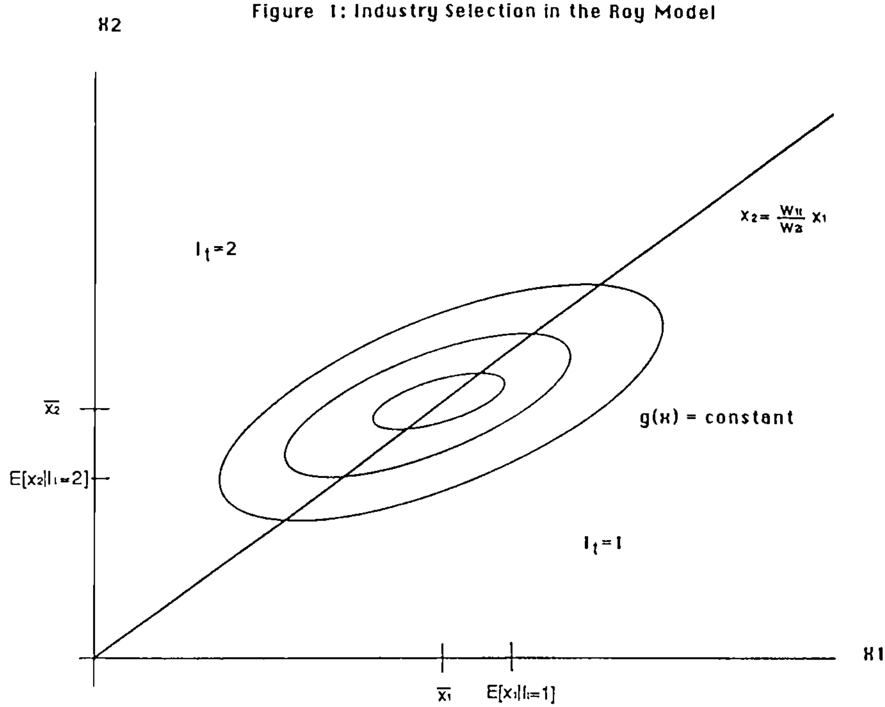
There is a large number of *heterogeneous* individuals. Skills vary across workers, and these skills are valued differently in different industries. If employed in industry i, an individual worker generates x_i units of labor input. At time t, the wages (or wage income) of a worker in industry i is $W_{it} \equiv \omega_{it} \cdot x_i$. Individuals choose where to work by comparing wages across industries, each accepting his highest offer. We indicate the choice by an industry variable I_t; I_t equals i if the individual works in industry i.

In the competitive equilibrium, product prices $\boldsymbol{p}_t^* = (p_{1t}^*,\ldots,p_{nt}^*)$ clear the product market, wage rates $\boldsymbol{\omega}_t^* = (\omega_{1t}^*,\ldots,\omega_{nt}^*)$ clear the labor market, and workers follow comparative advantage in self-selecting across industries. (Given heterogeneity, wage rates need not equalize across industries.) If comparative advantage lines up with absolute advantage, each industry employs workers who are better than average in that industry. Otherwise, each industry specializes in a quality of labor, and industries are naturally ordered from least to most selective.

This case of ordered industries is illustrated in Figure 1. With each worker described by a point on the graph, the iso-probability contours reflect the distribution of skills in the population. Workers below the reservation wage line sort into industry 1; those above choose industry 2. As drawn, the wages of workers employed in industry 1 are high because industry 1 attracts the higher quality workers (i.e., positive selection); average wages in industry 2 are low because the workers who sort into industry 2 are lower quality (i.e., negative selection).

Aggregate fluctuations—through technology shocks or product demand shocks—generate shifts in industry labor demands. In a cyclical expansion, the nonmarket sector declines, some industries grow faster than others, industry wage rates fluctuate, and workers re-sort across industries. Consistent with the simplest economic principles, industry employment and wage fluctuations depend on the magnitude of the shift in industry labor demand and the elasticity of labor supply. For instance, if industry labor supply curves have different slopes, workers re-sort across industries in response to a technology shock that increases the marginal product of labor k percent in all industries. An industry with elastic labor supply can draw from many marginal workers willing to work in the industry for only a small increase in the industry wage rate. Employment in

Figure 1: Industry Selection in the Roy Model



such an industry grows with little increase in the industry wage rate. An industry with few marginal workers grows little, but the industry wage rate must rise to attract even these few extra workers. Consequently, an aggregate expansion that is neutral in terms of industry labor demands shifts employment toward industries with elastic labor supplies.

The selection model can account for several of the industry employment and wage regularities. Begin by assuming that industries are ordered by the degree of selection, with the most selective industries attracting the best workers. (This is illustrated in Figure 1.) Two of the many industries are construction, with high wages and cyclically sensitive employment, and retail trade, with low wages and cyclically less-sensitive employment. Within the context of the selection model, wages are high in construction as a result of positive selection, which raises the average quality of labor above construction's population mean; negative selection in retail trade lowers wages there. Consider a cyclical expansion that increases all the industry wage rates ω_t, but some more than others, with employment in construction growing more than employment in retail trade. Among the many inter-industry flows, some workers flow from retail trade to construction. The new hires in construction tend to dilute the average quality of construction workers, which attenuates the wage increase in construction. These low-quality new hires in construction were high-quality retailers. As its best workers exit, retail trade's average quality of labor falls, which depresses wage growth in retailing. Re-sorting across industries attenuates industry wage growth in expansions.

In contrast, inter-industry mobility does not bias aggregate wages—an employment-weighted average of the industry wage rates—down in an expansion. The wages of stayers in each industry grow at the same rate as the industry's wage rate. Revealed preference implies that the wages of an inter-industry mover grow at least as fast as the wage rate grows in the industry he leaves. Thus aggregate wages grow at least as much as the weighted average of the growth rates of industry stayers' wages.

This application of Roy's selection model illustrates that, with ordered industries, self-selection generates patterns consistent with the industry employment and wage patterns documented in section II. If industries with high wages are more cyclically sensitive, workers move from industries with low wages to industries with high wages; the inter-industry movers receive higher wage growth in the transition than their former co-workers who remain employed in the industry with low wages; and relative to aggregate wages, industry wages are countercyclically biased.

The ability of the Roy model to account for cyclical upgrading hinges on the assumptions that industries are ordered and high wage industries are cyclically sensitive. For instance, if each industry were characterized by positive selection, which occurs if the probability contours in Figure 1 are negatively sloped, self-selection would not generate all the regularities of cyclical upgrading. As employment fluctuates across industries, the worst workers from one industry become the worst workers in another. As a result, industry wages in the least cyclical industries would be procyclically biased: these industries lose their low quality workers in expansions, and the low quality workers return in contractions. The evidence of cyclical upgrading in Table 1 does not support this.

Is there evidence regarding the selection process and the ordering of industries? Are the industries with negative selection, cyclically less sensitive? Furthermore, does the model yield strong testable predictions? By comparing the wages and wage changes of industry stayers and inter-industry movers in panel data, we can determine whether the estimated selection process is consistent with cyclical upgrading and search for violations of the model's restrictions.

Empirical Specification

In this subsection, we sketch our methods for using panel data to address these issues. We have three methods. The first compares the wages of industry stayers and inter-industry movers; the second computes the wage changes of industry stayers; and the third compares the wage changes of industry stayers and inter-industry movers.

Following the long tradition in labor economics, we analyze log wages. An industry's offer of wages (in logs) is the sum of its shadow price of labor (in logs), the industry's population mean of labor input (which might be proxied by observable skills), and a random variable.

$$\log W_{it} = \log \omega_{it}^{*} + \log x_i \tag{2}$$

$$= \log \omega_{it}^{*} + \mu_i + \epsilon_i,$$

where the random vector $\log x = (\log x_0, \ldots, \log x_n)$ has mean $\mu = (\mu_0, \ldots, \mu_n)$ and covariance matrix Σ.[3]

Our first method compares the wages of industry stayers with the wages of new hires, the entrants into the industry. By positioning inter-industry movers in the distributions of wages in their former and new industries, we can determine whether each industry is characterized by positive or negative selection. Suppose a worker moves from industry 2 to industry 1. By comparing his wages in industry 1 with average wages of workers who remain in industry 1, we establish whether the new hire is a below- or above-average worker in his new industry. If the new hire is below average, then industry 1 exhibits positive selection. (Steepening the ray in Figure 1 would produce this result). If the new hires are above average, then industry 1 exhibits negative selection.

By comparing the mover's wages before he left industry 2 with the average wages of subsequent stayers in industry 2, we can determine whether industry 2 is characterized by positive or negative selection. If the mover was below average, industry 2 exhibits positive selection; it retains its best workers as the worst workers leave. If the mover was above average in his former industry, that industry exhibits negative selection; its best workers are the first to go.

[3]Skills are invariant to time. Unfortunately, this rules out accumulation of industry-specific skills.

More formally, let W_τ^{ij} denote average *log* wages at time τ of workers employed in industry i at time t and industry j at time $t+1$. For example, W_t^{11} is the average of log wages at time t of workers who stay employed in industry 1 at times t and $t+1$; and W_t^{21} is the average of log wages at time t of workers employed in industry 2 who subsequently move to industry 1. If industry 1 grows, the following wage comparisons qualitatively identify the selection process:

$$W_{t+1}^{11} - W_{t+1}^{21} \gtrless 0 \tag{3a}$$

$$W_t^{22} - W_t^{21} \gtrless 0. \tag{3b}$$

If the first expression is positive (negative), industry 1 exhibits positive (negative) selection, because the new entrants are below- (above-) average workers. If the second expression is positive (negative), there is positive (negative) selection to industry 2; the leavers were below- (above-) average workers in the industry they left.

If industry 2 grows, so some individuals move from industry 1 to industry 2, we can identify the selection process with the following wage comparisons:

$$W_{t+1}^{22} - W_{t+1}^{12} \gtrless 0 \tag{4a}$$

$$W_t^{11} - W_t^{12} \gtrless 0. \tag{4b}$$

Therefore, if industries periodically expand and contract, these simple computations of average industry log wages yield two sets of estimates of the selection process.

Our second method computes the wage *changes* of the industry stayers to identify the growth rate of each industry's wage rate. (The size of the wage change of stayers reveals nothing about the selection process: a large wage change is consistent with positive or negative selection in either industry.) Time differencing the average log wages of the industry stayers yields the growth rate of the industry's shadow price of labor.

$$W^{11}_{t+1} - W^{11}_{t} = \log \omega^{*}_{1,t+1} - \log \omega^{*}_{1t} \equiv \gamma_{1t} \tag{5a}$$

$$W^{22}_{t+1} - W^{22}_{t} = \log \omega^{*}_{2,t+1} - \log \omega^{*}_{2t} \equiv \gamma_{2t}. \tag{5b}$$

This enables us to characterize the evolution of industry wage rates without compositional biases. However, the result does depend on the time-invariance of skills, so mobility does not exploit transitory fluctuations in labor input to industries (Keane, et al. 1988).

Our third method detects patterns of wage changes that are inconsistent with the selection model. Equilibrium self-selection imposes inequality restrictions on the wage changes of inter-industry movers. For illustration, consider movers from industry i to industry j. If the wage growth of movers were less than the wage growth of their former co-workers who remain in industry i, why would the movers choose to move? Would the turnover be involuntary? Likewise, if the wage growth of the new hires in industry j were to exceed the wage growth of the old hires (i.e., stayers), we would wonder why the new hires did not choose to be employed in industry j at time t. Were they prevented from entering industry j? Is there a queue for jobs in industry j?

We formalize these ideas with the following proposition:

PROPOSITION: If workers sort across industries on the basis of wages, then the wage growth of movers from industry i to industry j must be greater than the wage growth of stayers in the movers' former industry (i) and less than the wage growth of stayers in the movers' new industry (j). That is,

$$\Delta W^{ii} < \Delta W^{ij} < \Delta W^{jj}. \tag{6}$$

PROOF: Available on request.

Armed with this result, we can search for violations of the inequalities by computing average wage growth within and between each industry pair.

The proposition follows from a simple principle. Self-selection censors wage cuts, as well as low wage growth, and exploits high wage growth. If industries differ in cyclical sensitivities, then in expansions self-selection across industries reinforces the upward force on aggregate wages; self-selection attenuates the downward force on aggregate wages in contractions.[4] This asymmetry could be misinterpreted as a downward rigidity of wages.

The proposition contains an important qualification: workers sort across industries on the basis of wages. If jobs were characterized by attributes, as well as wages, then the restrictions on the growth rates could be violated even though the labor market efficiently allocates workers to industries. If job attributes differ across industries, then a worker who would be indifferent between two industries would not have the same wage offer from the two. The compensating wage differential drives a wedge between the wage offers faced by a marginal worker. Pulling the marginal worker into the industry with low amenities and high wages leads to a jump in his pay. If the marginal worker leaves this industry, his pay jumps down. These jumps can violate the inequality restrictions.

The inequality restriction can be tested less formally with a simple regression. In section V, we regress the wage growth of each inter-industry mover on the average wage growth in his former industry, ΔW^{ii}, and the average wage growth in his new industry, ΔW^{jj}. To satisfy the inequality restrictions, industry-specific intercepts must be zero, the coefficients on each of the two industry wage-growth variables must be positive and sum to less than one. With compensating differentials, these restrictions do not apply.

Queuing Models

Several economists have suggested that high-wage cyclical industries face queues of willing and able workers. In the Roy model, workers select industries on the basis of wage payments that reflect marginal products. Of course, factors other than comparative advantage might influence the allocation of labor to industries. A lesson from the Roy

---

[4]As a result of inter-industry mobility, aggregate wages reflect a procyclical bias in expansions and a countercyclical bias in contractions. Interpreting their evidence, Heckman and Sedlacek (1985, 1107–10) conclude that self-selection across sectors within the labor market reinforces the variability of aggregate wages. Either their estimates or their interpretation is inconsistent with this simple principle of self-selection.

model is that sorting on the basis of comparative advantage generates rising supply prices. Consequently, to capture the absence of wage increases with queues for industry employment, rationing must interfere with comparative advantage. Extending the Roy model to include queues for employment in high wage industries is one way to distort comparative advantage. Here we outline two models with rationing from industry queues: an efficiency wage model and a monopoly union model.

The efficiency wage model in Weiss (1980) is a natural extension of the Roy model. Consider the case of two industries. In industry 1, the efficiency wage industry, the random component of labor quality ϵ_1 is not observed by firms even after production. Firms in industry 2 accurately measure each worker's labor quality, so wage offers in industry 2 follow equation (2) above. Without knowledge of ϵ_1, competition among firms in industry 1 yields wage offers

$$\log W_{1t} = \log \omega_{1t} + \mu_1 + \eta, \tag{7}$$

where η is the efficiency wage premium. Observable differences in labor quality, reflected in μ_1, allow for variation in wages across workers in industry 1.

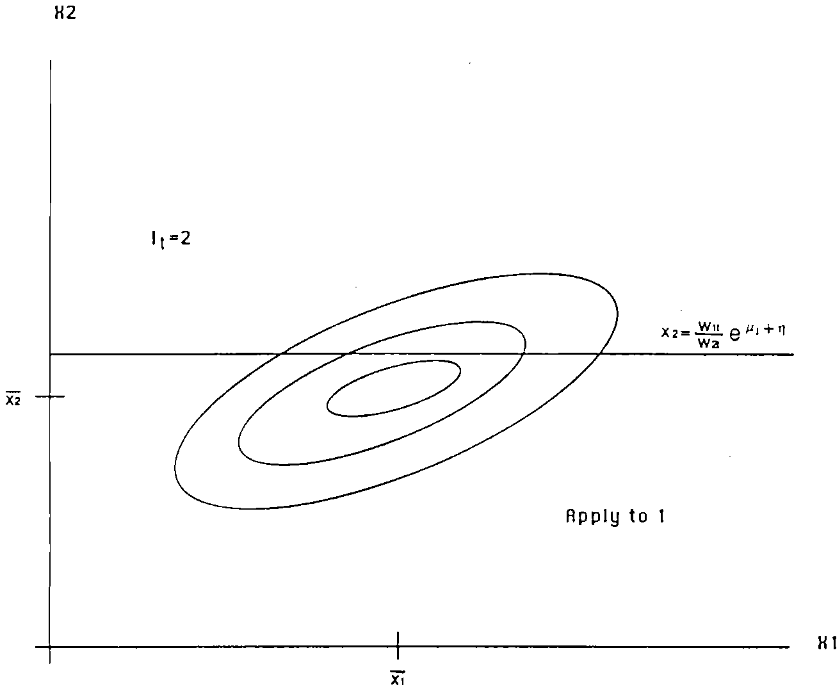
A worker applies for employment in industry 1 if his wages there would exceed his wages in industry 2. As Figure 2 illustrates, workers who apply to industry 1 tend to have low skills in industry 2. Formally, a worker applies to industry 1 if and only if

$$\epsilon_2 < \eta + (\log \omega_{1t} - \log \omega_{2t}) + (\mu_1 - \mu_2). \tag{8}$$

Thus the average quality of workers in industry 2 increases with the wage premium η. If ϵ_1 and ϵ_2 are positively correlated, quality in the efficiency wage industry also increases with η. This condition is necessary for firms to pay super-competitive wages.

Not knowing the quality of any applicant, each firm in industry 1 chooses a wage premium to minimize labor cost. Firms lower labor cost by raising the wage provided the

Figure 2: Industry Selection with Queueing



higher wage attracts a sufficiently higher-skilled pool of applicants. This produces an efficiency wage premium, with employment rationed in industry 1. Firms have no incentive to cut wages in the face of queues; and workers cannot gain employment by offering to work for less than the efficiency wage. Although the efficiency wage premium raises the wage in industry 1, the efficiency wage need not exceed the average wage in industry 2; indeed, self-selection is a force toward higher average wages outside the efficiency wage industry.

Consider the effect of an increase in industry 1's demand for labor. With no shift in the distribution of worker skills, the efficiency wage remains unchanged. Firms in industry 1 employ a greater proportion of job applicants. Thus shifts in employment imply no relative wage movements. Up to the point where rationing ceases, industry 1 appears to face a perfectly elastic supply of labor.

Compared with market clearing, efficiency wages with queuing has different predictions for the wage changes of inter-industry movers. With market clearing, the wage changes of inter-industry movers are distributed between the wage change of industry 2 stayers and the wage change of industry 1 stayers. With a small flow of inter-industry movers (so the entrants are marginal), the mean and variance of their wage changes would be small. Furthermore, for industry movers, their wages in the former industry would be an excellent predictor of their wages in the new industry. By contrast, the efficiency-wage model predicts significant wage changes for movers: entrants into the efficiency wage industry capture the wage premium; leavers lose the premium. It predicts a larger variance of wage changes because the size of those rents varies across workers. Because wages in the efficiency wage industry do not depend on the individual's skill, wages in the former industry W_{2t} would poorly predict wages in the new industry $W_{1,t+1}$ for inter-industry movers.

Can we get similar queuing behavior from union bargaining? Suppose a union in industry 1 dictates the following wage schedule:

$$\log W_{1t} = \log v_t + \mu_1 + \epsilon_1, \tag{9}$$

where the union wage premium is $\log v_t - \log \omega^*_{1t}$. Employment in the unionized industry varies inversely with the union wage premium, such that the shadow value of labor ω_{1t} equals the union's price of labor v_t. Although the number of workers willing to work in industry 1 increases with $\log v_t$, the number who can be employed decreases. The problem for union wage setters is to trade off higher wages against reducing industry employment.

Faced with the wage schedule in equation (9), firms are indifferent about whom to employ. Unionized firms could randomly choose applicants until the labor input in industry 1 equates ω_{1t} to v_t. This would produce queues of workers who resemble the union workers. Union employment can expand without adding less-skilled workers. As with efficiency wages, the industry effectively faces a perfectly elastic supply of workers.

However, random employment from the pool of applicants would be suboptimal. Workers would not allocated to industries by comparative advantage. If the union maximizes the rents of workers in industry 1, then it writes a contract that selects workers according to their comparative advantages. (See McLaughlin (1991).) This requires that wage schedules or employment rules discriminate on the basis of each worker's opportunity cost, which includes ϵ_2.

By interfering with comparative advantage, efficiency wages generate sharper contrasts with Roy's model. Even so, most of the content of the queuing extension is in relaxing the restrictions implied by self-selection.

IV. Data

Ideally, data for estimating the industry selection model would include six features. First, since we seek to estimate parameters for the U.S. labor market, the sample should be representative of the working age population of the United States. Second, since we analyze movers from industry i to industry j, which in any year is a small fraction of the population, we need a large data set. Third, since our estimators compare wages before and after industry changes, individuals must be surveyed at least twice. Fourth, to address aggregate fluctuations, the data should extend over a fairly long period. Fifth, individuals should report pay and industry of employer at the time of the interview rather than over a protracted period. Sixth, the data should include the usual set of supplementary variables including employment tenure.

Recognizing that no publicly available data set satisfies all these features, we selected the Panel Study of Income Dynamics (PSID) on the basis of its advantages and our ability to cope with its disadvantages. Beginning in 1968, the PSID is an ongoing twenty-year panel of nearly 7,000 households. Industry data have been reported since 1971. This leaves seventeen years of data to uncover the effects of aggregate fluctuations on inter-industry mobility. The PSID includes annual observations covering survey week pay with the main employer, the employer's industry, as well as earnings, weeks, usual hours per week last year. It also includes a large set of supplementary variables, however some variables are not available in all years of the panel.

For our purposes, the PSID also has deficiencies.[5] Because the PSID studies families, most of the information concerns the household's head. Although some information on spouses is surveyed, these data are not as rich as the household head's. For instance, spouse's survey week responses are collected in only two years in the 1970s. For our purposes, the PSID is also small. Although we might start with nearly 150,000 individual-year observations on the working age population, annual transitions among narrowly classified industries produce many unacceptably small cell sizes. To remedy this, we analyze twenty-five industries plus nonemployment. Overall, our sample from

[5]Although the matched sample of the Current Population Survey is large, the CPS is address based. Therefore, the matched sample loses inter-industry movers who change addresses. The National Longitudinal Surveys do not provide the full range of ages.

the PSID includes detailed information on the mobility across twenty-six industries of a representative sample of household heads and spouses in a short panel from 1979 through 1987. Where using a longer panel is essential, we limit the sample to household heads, including female heads, to extend the sample period back to 1971.

In addition to the PSID's stratified random subsample, we include a subset of the smaller nonrandom (Survey of Economic Opportunity) subsample. Rather than discarding the entire nonrandom sample, we randomly select observations such that the distribution of wages in our subset of the nonrandom sample mimics the wage distribution in the random sample. In short, we oversample high wage heads and spouses to undo the original undersampling. This allows us to keep about half of the nonrandom sample. After excluding self-employed persons, we are left with a sample of 35,418 household heads and 23,413 spouses covering the years 1979 through 1987.

Two key variables in our analysis are industry indicators and wage rates. Industry turnover compares reported industry of employment at one survey date to the reported industry at the survey the following year. Many of the workers who change industry classification from one year to the next appear to remain with the same employer. We treat persons with changing industry codes as true industry changers only if they report changing employers during the year.

Our measure of wages uses the respondent's report of his survey week pay on his main job. For salaried workers, we divide salary by annual hours worked during the survey year. Our wage variable is inflated to 1987 dollars using the Current Population Surveys' series on average hourly rate of pay for wage and salary workers.[6]

We treat the nonmarket sector (i.e., unemployment or out of the labor force) as an industry like any other. Unfortunately, we do not observe the wage rate—the value of

[6]In some years a few of the very highest wage rates were top coded. We reset these top-coded wages using labor earnings divided by annual hours of work. Also, we treat any wages below $2.50 or above $100.00 (1987 $) as outliers and set the wage to missing.

time out of the labor market—for the nonmarket sector. We take two approaches to this deficiency. One is to ignore the nonmarket sector and to estimate the model as if all workers are always employed. Recognizing that this is not satisfactory, we also impute wages for workers in the nonmarket sector. Almost all individuals participate in the labor market at some time. With a lengthy panel data set, we can use reported market wages in previous and future years to impute a value at home. We use the lowest value of the wage to proxy for the individual's value at home.[7] This might be an error-ridden measure for any particular individual. But we expect this to be less problematic for our estimators, which rely on within-industry *averages* of wages and wage changes.

Summary statistics for our sample using survey years 1979 to 1987 are displayed in Tables 2 and 3. The distribution of workers across industries is fairly consistent with the aggregate establishment numbers reported in Table 1. (Employment shares in Table 3 are expressed relative to both market and nonmarket sectors.) Our sample has a considerably smaller fraction in agriculture and a considerably higher fraction in personal services. Only thirty-three percent of our sample is out of the work force; whereas, the fraction for the aggregate economy is nearly forty percent. This probably reflects the disproportionate number of household heads in our sample relative to the U.S. population.

Table 3 provides means and standard deviations of log wage rates by industry. Relative industry wages are fairly similar to those from establishment data reported in Table 1. Entertainment and recreation, which is a somewhat low wage industry in the establishment data, is a marginally high wage industry in the PSID. Wage rates in construction are relatively high in the PSID, but not nearly as high as in the establishment data. This might reflect the oversampling of workers in larger firms within the establishment data.

[7]About forty percent of the individuals in our panel never report a wage, so we cannot impute an implicit nonmarket wage. Given that we never observe these individuals with jobs, they are likely to be irrelevant for calculating the response of industry employments to reasonable variation in industry wage rates.

TABLE 2

Summary Statistics
Panel Study of Income Dynamics, 1979–1987

Variable	Mean	Standard Deviation	Number of Observations
Real Hourly Rate of Pay (1987 $)	10.90	7.37	34,528
Real Annual Earnings Last Year (1987 $)	17,798	15,413	51,269
Real Hourly Earnings Last Year (1987 $)	11.57	7.06	43,066
Weeks Worked Last Year	36.49	18.54	53,081
Weekly Hours Worked Last Year	33.89	17.20	52,941
Annual Hours Worked Last Year	1,410	978	58,831
Government Employee	0.22	0.42	40,765
Union	0.29	0.45	31,416
Tenure with Employer, Months[a]	87.99	91.43	32,611
Separated from Employer	0.26	0.45	45,279
Experience, Years	16.08	11.41	51,120
Age	38.77	13.55	58,831
Schooling	12.39	2.71	58,372
Male	0.45	0.50	58,831
White	0.73	0.44	58,682
Disabled	0.15	0.36	53,930
Married	0.78	0.41	58,831
Number of Children in Household	1.09	1.23	58,831
SMSA	0.61	0.48	58,549
Household Head	0.60	0.49	58,831

[a]Tenure with employer is based on survey years 1981–1987.

TABLE 3

Industry Summary Statistics
Panel Study of Income Dynamics, 1979–1987

Industry	Employment Share (%)	Log Wage[a] Mean	Log Wage[a] Std. Dev.	Log-Wage Residuals[b] Mean	Log-Wage Residuals[b] Std. Dev.
Nonmarket	33.0				
Agriculture	0.8	−.476	.502	−.366	.442
Mining	0.6	.195	.433	.175	.367
Construction	3.3	.099	.459	.080	.395
Metals	1.6	.119	.378	.084	.325
Machinery	3.7	.154	.453	.096	.335
Transportation Equipment	2.5	.286	.389	.217	.321
Other Durables	2.3	−.032	.463	−.013	.348
Food & Tobacco	1.3	.019	.447	.049	.377
Textiles, Apparel, & Leather	1.8	−.456	.372	−.139	.325
Paper, Printing, & Publishing	1.6	.066	.492	.031	.358
Chemicals, Petroleum, & Rubber	1.7	.201	.442	.133	.348
Transportation	3.0	.210	.468	.145	.452
Communications	1.4	.299	.418	.255	.390
Utilities	1.5	.190	.459	.100	.395
Wholesale Trade	2.1	−.027	.483	−.077	.394
Retail Trade	8.0	−.386	.485	−.252	.405
Finance, Insurance, & Real Estate	3.9	.011	.531	.029	.417
Business Services	1.6	−.082	.599	−.082	.469
Repair Services	0.7	−.107	.425	−.136	.412
Personal Services	1.9	−.478	.491	−.216	.474
Entertainment & Recreation	0.4	.038	.616	−.038	.527
Health Services	6.2	−.130	.450	−.029	.363
Education	7.1	.123	.584	−.013	.471
Legal & Other Professional Services	2.5	−.003	.530	−.060	.469
Public Administration	5.5	.179	.491	.101	.432

[a]Computed relative to aggregate log wage.

[b]Residuals from regressing log-wage on age, sex, race, education, and marital status.

Table 3 also reports the average of the log-wage residuals (and their standard deviations) for each industry. (These are the coefficients and standard errors associated with industry dummy variables.) The residuals are derived from a common regression across the industries of log wages on individual characteristics, including age, education, sex, race, and a number of interactions. Differences in these characteristics explain some of the disparity in wage rates across industries. The standard deviation across the twenty-five industries of log wage residuals is 0.15, compared to 0.23 for log wages.

V. Empirical Results

The empirical research proceeds in three stages. First, we compare wages of industry movers to industry stayers. This reveals whether the structure of relative wages is consistent with cyclical upgrading within Roy's equilibrium model of industry selection. Second, we examine the wage changes of industry stayers. By controlling for the compositional effects of low-wage workers entering and exiting cyclical industries, this identifies the cyclical behavior of industry wage rates. Third, we compare the wage changes of industry movers to the wage changes of stayers. This tests the selection model's prediction that movers' wage changes are bounded by the wage changes of stayers in the exited and entered industries.

Results are generated for each industry by letting industries sequentially take the role of industry 1, with the complement (all other industries) becoming industry 2.

Mover-Stayer Wage Comparisons

For the equilibrium selection model to generate cyclical upgrading, we should observe positive selection of skilled workers into cyclical industries, notably construction and durable manufacturing, and negative selection into noncyclical industries and the nonmarket sector. In particular, workers entering cyclical industries during expansions should display relatively high wage rates compared to workers in the noncyclical industry from which they depart, but relatively low wages compared to workers in the cyclical industry they join; the reverse should be observed for noncyclical industries.

Table 4 displays these wage comparisons of industry movers and stayers from 1979 to 1987. Comparisons are given separately for periods that an industry's share of population, including persons out of the work force, is declining and for periods that it is expanding. We include observations from the nonmarket sector with imputed wages. The results are not sensitive to excluding the nonmarket sector.

Wage comparisons of industry stayers and inter-industry movers are inconsistent with our application of the equilibrium selection model to cyclical upgrading. For almost every industry, movers have relatively low wages compared both to the industry they leave and compared to the industry they join. First consider periods of decline. All twenty-four industries that experience some period of decline exhibit positive selection in column 1: workers who exit the declining industry were lower paid before leaving than those who remain. The difference is statistically significant for twelve industries, and positive selection is strongest for the following industries: food and tobacco; paper, printing, and publishing; education; and public administration. In column 2, for all industries except communications, the exiting workers display lower than average wages in their new industry. Results from expanding periods paint a similar picture. In column 3, wages of entering workers are lower than wages of existing workers for all industries but other durables. The difference between the wages of new workers and stayers (in column 4) is typically very large, above thirty percent for fifteen of the twenty-six industries.[8,9]

Widespread positive selection might also pose a problem for our efficiency wage

[8]Comparing results from Tables 2 and 4 uncovers a peculiar property: industries that have low average wages also tend to have high variances of wages. The inter-industry correlation between average log wages in Table 4 and the standard deviation of log wages in Table 2 is −.37. In the two-industry Roy model with log normality, the high variance industry is almost always the high wage industry. (Exceptions occur if the industries differ in size, and the larger industry has a smaller variance of wages.) If the property were to carry over to the multi-industry Roy model, the negative correlation would strengthen our evidence against equilibrium selection.

TABLE 4

Wage Comparisons of Stayers and Movers: Log Wages[a]
Panel Study of Income Dynamics, 1979–1987

Industry	Declining		Growing	
	$W_t^{11}-W_t^{12}$	$W_{t+1}^{22}-W_{t+1}^{12}$	$W_{t+1}^{11}-W_{t+1}^{21}$	$W_t^{22}-W_t^{21}$
Nonmarket	18.89	43.48	0.24	14.84
	(1.63)	(1.78)	(1.68)	(1.86)
Agriculture	6.31	46.01	18.82	56.11
	(8.98)	(7.43)	(11.61)	(7.35)
Mining	5.12	5.75	14.35	6.12
	(9.23)	(7.06)	(9.66)	(8.07)
Construction	12.06	15.69	29.01	22.52
	(4.64)	(4.06)	(4.23)	(4.17)
Metals	5.16	2.50	24.43	23.83
	(4.62)	(3.89)	(10.93)	(9.00)
Machinery	10.90	7.20	26.19	12.89
	(3.74)	(3.70)	(6.82)	(6.10)
Transportation Equipment	10.62	0.56	23.77	−0.07
	(3.93)	(4.15)	(5.68)	(5.58)
Other Durables	6.62	15.38	−3.26	5.56
	(4.42)	(4.09)	(15.22)	(15.35)
Food & Tobacco	29.44	30.75	34.61	26.07
	(6.39)	(5.62)	(13.89)	(11.42)
Textiles, Apparel, & Leather	8.59	60.34	37.77	73.61
	(5.24)	(4.58)	(6.69)	(7.06)
Paper, Printing, & Publishing	32.93	14.88	36.67	26.73
	(9.74)	(10.13)	(10.71)	(10.17)
Chemicals, Petroleum, & Rubber	15.26	6.82	35.42	25.43
	(7.01)	(6.30)	(13.42)	(11.08)
Transportation	28.46	19.88	40.97	22.52
	(5.95)	(5.20)	(8.01)	(6.28)
Communications	4.04	−10.78	32.33	−6.64
	(8.89)	(10.13)	(10.32)	(11.76)
Utilities	13.14	14.61	44.63	17.66
	(15.89)	(14.97)	(7.09)	(6.72)
Wholesale Trade	15.43	11.30	32.75	20.31
	(6.15)	(6.16)	(6.30)	(6.16)

TABLE 4–Continued

Industry	Declining		Growing	
	$W_t^{11}-W_t^{12}$	$W_{t+1}^{22}-W_{t+1}^{12}$	$W_{t+1}^{11}-W_{t+1}^{21}$	$W_t^{22}-W_t^{21}$
Retail Trade	18.57 (3.74)	52.18 (3.11)	36.71 (2.67)	62.29 (2.10)
Finance, Insurance, & Real Estate	1.47 (12.07)	0.65 (11.07)	31.19 (4.40)	26.53 (3.80)
Business Services			38.16 (5.10)	27.13 (4.01)
Repair Services	0.01 (11.21)	1.25 (7.43)	36.10 (10.36)	37.70 (8.83)
Personal Services	15.03 (11.12)	52.19 (7.78)	15.72 (5.88)	56.32 (4.59)
Entertainment & Recreation	14.76 (15.79)	6.26 (17.19)	33.58 (14.59)	13.09 (11.84)
Health Services			18.39 (3.09)	32.41 (2.79)
Education	20.83 (7.35)	15.77 (5.84)	32.11 (4.83)	27.87 (3.77)
Legal & Other Professional Services			19.18 (4.77)	12.69 (3.80)
Public Administration	24.59 (6.58)	10.01 (4.62)	44.13 (5.36)	18.25 (4.63)

[a] W_τ^{ij} is the average log wage at time τ of workers employed in industry i at time t and j at time $t+1$. Industry 1 is the designated industry; industry 2 is "all other." Standard errors are reported in parentheses.

model. To generate an efficiency wage, we require that worker quality be positively correlated across industries. But positive selection in each industry follows from negatively correlated valuations of skills. Of course, in the efficiency wage model, selection is on the unobservables. Consequently, mover-stayer comparisons of wage residuals would provide more illuminating evidence.

In Table 5, we report comparisons of movers' and stayers' log-wage residuals; that is, log wages minus the wage forecasted by the individual's age, sex, race, education, and marital status. For growing periods, the results are similar to those comparing wage rates. Entrants' wage residuals are less than those of existing workers in virtually every industry; the difference is statistically significant for twenty-one of the industries. Although the magnitude of these differences falls by about one-third, positive selection remains strong for low wage, as well as high wage, industries. Periods with declining employment now show little positive selection: the wage residuals of exiting workers are similar to those who stay. For six industries, movers have significantly lower wage residuals; for no industry do they have significantly higher wage residuals.

The evidence of widespread positive selection implies considerable and comparative advantage across industries. Following Roy, we assume skills are distributed log normal in order to estimate industry labor supply elasticities from the relative wage comparisons in Table 4. Reflecting the strong comparative advantage, these elasticities are typically

[9] The mover-stayer wage comparisons provide information on the selection process without imposing distributional assumptions on industry skills. With distributional assumptions, it is possible to estimate selection parameters, as well as more fundamental distributional parameters, from cross-sectional data. Following results in Heckman and Honore (1990), we estimate selection parameters from the skewness of observed industry wage distributions under the assumption that population skills (x_i's) are log normal. Reinforcing the mover-stayer wage comparisons, the industry wage distributions indicate positive selection across virtually all industries, implying considerable comparative advantage across industries. We also estimate the selection model from selection-bias corrected wage regressions (e.g., Heckman 1974; Maddala 1983), again assuming that population skills are distributed log normal. In contrast, the results show negative selection into most manufacturing industries, as well as transportation, communication, and utilities. A summary of these results is available on request.

TABLE 5

Wage Comparisons of Stayers and Movers: Log-Wage Residuals[a]
Panel Study of Income Dynamics, 1979–1987

Industry	Declining		Growing	
	$W_t^{11}-W_t^{12}$	$W_{t+1}^{22}-W_{t+1}^{12}$	$W_{t+1}^{11}-W_{t+1}^{21}$	$W_t^{22}-W_t^{21}$
Nonmarket	19.32	25.70	8.74	−0.98
	(1.44)	(1.50)	(1.52)	(1.58)
Agriculture	−3.10	32.79	7.66	42.87
	(7.73)	(6.67)	(10.60)	(7.81)
Mining	−6.70	5.91	0.29	−2.56
	(9.39)	(9.13)	(7.66)	(10.38)
Construction	1.90	17.17	20.48	21.82
	(4.11)	(3.60)	(3.96)	(3.77)
Metals	−0.20	7.81	−2.20	6.53
	(3.98)	(3.45)	(8.91)	(7.05)
Machinery	−1.82	7.19	14.11	10.56
	(2.96)	(3.13)	(5.87)	(5.85)
Transportation Equipment	0.84	3.34	18.40	6.04
	(3.54)	(3.64)	(5.42)	(5.37)
Other Durables	0.73	12.84	−2.26	11.75
	(3.60)	(3.31)	(9.66)	(11.38)
Food & Tobacco	14.16	19.51	34.37	26.21
	(5.83)	(5.70)	(13.04)	(8.37)
Textiles, Apparel, & Leather	6.84	32.81	26.85	36.98
	(5.23)	(3.92)	(9.04)	(6.10)
Paper, Printing, & Publishing	17.66	14.46	30.24	21.47
	(7.49)	(8.15)	(10.20)	(9.11)
Chemicals, Petroleum, & Rubber	3.16	8.23	24.97	27.37
	(5.69)	(4.71)	(9.86)	(8.89)
Transportation	18.05	22.72	27.17	20.67
	(5.64)	(5.19)	(7.86)	(6.03)
Communications	2.20	−3.41	27.02	−3.79
	(9.58)	(9.59)	(9.59)	(10.73)
Utilities	8.22	26.76	27.87	13.43
	(9.98)	(15.71)	(6.85)	(6.97)
Wholesale Trade	9.81	17.62	19.19	21.45
	(4.96)	(5.02)	(5.30)	(4.50)

TABLE 5–Continued

Industry	Declining		Growing	
	$W_t^{11}-W_t^{12}$	$W_{t+1}^{22}-W_{t+1}^{12}$	$W_{t+1}^{11}-W_{t+1}^{21}$	$W_t^{22}-W_t^{21}$
Retail Trade	6.39	34.23	22.30	38.36
	(3.43)	(2.68)	(2.46)	(2.00)
Finance, Insurance, & Real Estate	−9.14	−0.43	16.36	14.82
	(9.74)	(10.25)	(3.87)	(3.45)
Business Services			23.13	20.75
			(4.01)	(3.09)
Repair Services	−8.02	6.78	31.17	41.50
	(11.61)	(8.83)	(11.38)	(9.96)
Personal Services	−2.21	17.70	12.83	31.90
	(11.35)	(6.61)	(4.97)	(4.05)
Entertainment & Recreation	−4.41	13.31	16.95	15.00
	(20.38)	(21.43)	(14.14)	(11.51)
Health Services			12.45	18.14
			(2.60)	(2.45)
Education	4.45	19.71	15.75	30.74
	(6.11)	(4.73)	(4.25)	(3.47)
Legal & Other Professional Services			13.03	16.78
			(4.15)	(3.41)
Public Administration	11.54	9.95	30.67	19.74
	(5.59)	(4.28)	(4.54)	(4.17)

[a] W_τ^{ij} is the average log wage at time τ of workers employed in industry i at time t and j at time $t+1$. Industry 1 is the designated industry; industry 2 is "all other." Standard errors are reported in parentheses.

small, less than one for fifteen industries. The exceptions are the durable manufacturing industries, which have supply elasticities averaging over three. From section II, cyclical industries do not exhibit more cyclical wage rates. The large calculated elasticities for durable manufacturing industries might justify the failure of relative wages to increase there during expansions. However, in the selection model, relative wages must change across some industries for employment to fluctuate across industries. Our analysis of the wage changes of industry stayers indicates that industry relative wages are *generally* insensitive to aggregate fluctuations and industry shifts in employment.

Wage Changes of Stayers

From Table 4, workers moving between industries are primarily low wage workers. Therefore, as many workers move into construction and durable manufacturing during a cyclical expansion, the average skill of workers in those industries declines. This might hide important relative wage movements across industries over the business cycle.

A closer examination of the wage differences in Table 4 suggests this compositional bias is not large. Consider a one-percent aggregate expansion in employment. From Table 1, this would typically be associated with a 2.59 percent increase in construction employment. Table 4 shows that entrants to construction have wages averaging twenty-nine percent less than existing workers. If the expansion in employment occurs through entry, this entry reduces the average wage in construction by about 0.75 percent. However, Table 4 shows that new entrants to the aggregate work force reduce the average wage for the economy by 0.43 percent. Therefore, the compositional bias on the relative wage in construction is only 0.32 percent. Since the cyclical sensitivity of construction's relative wage is estimated to be −0.49 in Table 1, correcting for the compositional bias is not sufficient to turn construction's relative wage procyclical. Calculations for the other cyclical industries reveal even less compositional bias.

A more direct way to control for this compositional bias is to examine wage changes

TABLE 6

Wage Changes of Industry Stayers
Panel Study of Income Dynamics, 1971–1987, Household Heads[a]

Industry Group	Employment Share (%)	Relative Wage Elasticity: Aggregate Employment	Relative Wage Elasticity: Industry Employment
Low Wage, Low Cyclical Sensitivity —none	0.0		
Low Wage, Medium Cyclical Sensitivity —Agriculture; Textiles, Apparel, & Leather; Retail Trade; Personal Services	15.0	0.142 (0.543)	0.576 (0.939)
Low Wage, High Cyclical Sensitivity —none	0.0		
Medium Wage, Low Cyclical Sensitivity —Finance, Insurance, & Real Estate; Entertainment & Recreation; Health Services	9.8	0.003 (0.576)	0.010 (0.565)
Medium Wage, Medium Cyclical Sensitivity —Food & Tobacco; Wholesale Trade; Business Services; Repair Services; Other Professional Services	12.2	0.046 (0.601)	0.669 (1.070)
Medium Wage, High Cyclical Sensitivity —Machinery; Other Durables	11.1	0.340 (0.373)	0.031 (0.219)
High Wage, Low Cyclical Sensitivity —Communication; Utilities; Education; Public Administration	22.6	−0.189 (0.839)	0.150 (0.923)
High Wage, Medium Cyclical Sensitivity —Mining; Paper, Printing, & Publishing; Chemicals, Petroleum, & Rubber; Transportation	13.5	0.238 (0.413)	−0.150 (0.625)
High Wage, High Cyclical Sensitivity —Construction; Metals; Transportation Equipment	15.8	0.076 (0.295)	−0.028 (0.155)

[a]There are 16 time-series observations for each of the seven industry-group regressions. Standard errors are reported in parentheses.

of industry stayers. Wage changes of industry stayers identifies the growth rate of each industry's wage rate ($\gamma_{it} \equiv \log \omega^*_{i,t+1} - \log \omega^*_{it}$). For each of the twenty-five industries, we calculate the average annual growth rates of wages of the industry's stayers. The samples include only heads of households because the quality of spouses' turnover variables is poorer prior to 1979.

We aggregate the individual data on the wage changes of industry stayers to sixteen time-series observations corresponding to periods 1971–1972 to 1986–1987. Since the number of underlying observations for some industries is fairly small, we combine industries into industry groups on the basis of each industry's relative wage rate and its cyclicality. From Table 1, we classify industries into low, medium, and high combinations of relative wages and cyclical employment sensitivity. Nine industry groups are possible, but each of the low wage industries—agriculture; textiles, apparel, and leather; retail trade; and personal services—exhibits moderate cyclicality. So there are only seven industry groups. Table 6 lists the classification of industries into industry groups.

Relative wage movements across industries over the business cycle are minor. Consider the seven industry-group regressions reported in the second column of Table 6. We regress the average wage change of each industry-group's stayers on the growth rate of aggregate employment. Not one relative wage movement is significantly different from zero. The largest movements are for the machinery and other durables category, a very cyclical industry group. Relative wages for this industry group rise by 0.34 percent in response to a one percent increase in aggregate employment, which would typically represent more than a two percent increase in employment. This relative wage increase is not statistically different from zero.

We also examine whether industry relative wages move with industry shares of total employment. Results are in column 3 of Table 6. In no industry is there a significant comovement of industry wage with industry employment. The largest positive comovements are for the low wage industries and the medium wage, somewhat cyclical industries. But the wage movements are neither economically nor statistically significant.

One explanation for the absence of relative wage movements is that all industries face extremely elastic supply schedules. This explanation is neither theoretically nor empirically satisfactory. To get the industry fluctuations in employment, relative wage rates must vary across industries. Furthermore, the wage comparisons from Tables 4 and 5 reflect a substantial degree of comparative advantage across industries. This implies that industry labor supply elasticities are fairly low.

Wage Changes of Movers

We also analyze the wage changes of inter-industry movers using the panel data on household heads from 1971 to 1987.[10] Recall that, in the absence of compensating wage differentials, the equilibrium selection model implies that the wage change of inter-industry movers is bounded by the wage change of stayers in the exited industry and the wage change of stayers in the entered industry. Table 7 presents comparisons of these wage changes by industry. (Again, each industry sequentially takes the role of industry 1, with all other industries combining for industry 2.) Movers' wage changes do not reflect persons moving in and out of the work force. Results are given separately for periods that an industry's share of total employment is declining and periods for which it is expanding.

First, consider periods of declining employment share. In nearly every industry the point estimates violate the inequality restriction. Although in some cases the violations are economically sizable, most are not statistically significant. Statistically significant wage gains do accrue to workers exiting agriculture or retail trade (and perhaps textiles, apparel, and leather) as those industries decline. Second, the inequality is also violated in nearly all industries for periods of growing industry employment. Again most of the

[10]As noted above, the quality of the spouses' turnover variables is poorer prior to 1979. Results for a sample for 1979 to 1987 that includes spouses are qualitatively similar to those reported in Table 7.

TABLE 7

Wage Changes of Industry Stayers and Inter-Industry Movers
Panel Study of Income Dynamics, 1971–1987, Household Heads[a]

	Declining			Growing		
Industry	ΔW^{11}	ΔW^{12}	ΔW^{22}	ΔW^{22}	ΔW^{21}	ΔW^{11}
Agriculture	0.58 (1.95)	17.39 (4.80)	4.27 (0.19)	1.96 (0.34)	−40.17 (14.93)	5.52 (5.30)
Mining	5.08 (2.92)	4.51 (7.36)	4.68 (0.25)	2.80 (0.22)	21.56 (9.84)	4.31 (2.21)
Construction	2.30 (1.00)	−9.18 (5.50)	3.11 (0.25)	4.48 (0.23)	9.01 (4.08)	3.30 (0.78)
Metals	2.16 (0.65)	−1.02 (3.18)	4.38 (0.20)	2.44 (0.33)	3.06 (3.67)	2.41 (1.01)
Machinery	3.18 (0.61)	−5.37 (3.07)	4.52 (0.25)	3.08 (0.25)	6.38 (2.29)	3.08 (0.62)
Transportation Equipment	4.33 (0.70)	−3.77 (4.22)	4.70 (0.26)	2.95 (0.24)	1.50 (5.70)	2.91 (0.57)
Other Durables	3.02 (0.95)	−1.39 (3.57)	4.11 (0.22)	3.39 (0.27)	7.97 (3.68)	3.01 (0.99)
Food & Tobacco	2.21 (0.79)	3.53 (5.45)	3.87 (0.17)			
Textiles, Apparel & Leather	2.10 (1.13)	11.30 (4.42)	3.77 (0.18)	5.52 (0.60)	8.07 (19.53)	4.04 (4.29)
Paper, Printing, & Publishing	4.33 (1.05)	1.03 (6.09)	3.95 (0.21)	3.48 (0.30)	12.34 (15.50)	3.91 (1.12)
Chemicals, Petroleum, & Rubber	4.28 (0.71)	3.38 (5.74)	4.51 (0.20)	1.36 (0.32)	6.86 (7.06)	1.62 (1.24)
Transportation	2.46 (0.61)	−6.71 (5.94)	2.89 (0.17)	7.51 (0.49)	7.90 (8.95)	2.51 (1.93)
Communications	5.56 (1.29)	10.70 (7.34)	4.39 (0.21)	2.58 (0.28)	−11.58 (10.71)	6.17 (1.65)
Utilities	2.90 (1.05)	−7.27 (11.65)	4.56 (0.23)	2.71 (0.25)	−0.68 (10.08)	2.50 (1.14)
Wholesale Trade	6.25 (1.80)	8.12 (5.39)	5.00 (0.29)	3.09 (0.21)	−0.61 (3.68)	0.46 (1.06)

TABLE 7–Continued

Industry	Declining			Growing		
	ΔW^{11}	ΔW^{12}	ΔW^{22}	ΔW^{22}	ΔW^{21}	ΔW^{11}
Retail Trade	0.06	17.24	2.75	3.98	−11.71	3.91
	(1.65)	(5.67)	(0.46)	(0.19)	(3.23)	(0.61)
Finance, Insurance, & Real Estate	1.70	−14.81	2.54	3.97	1.48	7.64
	(2.22)	(13.56)	(0.35)	(0.19)	(3.95)	(1.27)
Business Services				3.81	−5.18	7.34
				(0.17)	(4.12)	(1.50)
Repair Services	1.13	12.34	0.99	4.29	1.97	5.78
	(2.57)	(12.77)	(0.41)	(0.19)	(4.31)	(1.72)
Personal Services	3.88	12.82	3.39	4.23	0.60	2.76
	(3.14)	(8.76)	(0.22)	(0.25)	(8.81)	(2.26)
Entertainment & Recreation	−0.33	−18.82	2.99	4.11	28.08	7.99
	(3.96)	(55.75)	(0.30)	(0.20)	(9.59)	(2.59)
Health Services	4.58	6.00	3.59	3.97	1.46	3.02
	(1.15)	(4.96)	(0.31)	(0.21)	(3.81)	(0.85)
Education	3.15	−3.86	3.55	3.91	6.00	5.04
	(1.12)	(9.45)	(0.26)	(0.22)	(4.86)	(1.04)
Legal & Other Professional Services	9.88	0.80	1.09	4.04	6.60	7.03
	(4.52)	(5.65)	(0.42)	(0.18)	(3.60)	(1.46)
Public Administration	5.92	5.70	3.57	3.70	12.94	5.71
	(0.92)	(4.25)	(0.22)	(0.27)	(4.68)	(0.81)

[a]Standard errors are reported in parentheses.

violations, though economically sizable, are not statistically significant. Statistically significant wage losses are associated with entering agriculture or retail trade as those industries expand. Significant wage gains are associated with entering entertainment and perhaps mining.

Standard errors for the average wage changes of industry movers are large in many cases due to relatively small numbers of movers. A complementary regression approach strengthens our inferences.

We regress the mover's wage change on the average wage change of stayers in the industry entered, the average wage change of stayers in the industry left, and a set of dummy variables reflecting the industry groups the worker enters and leaves. Recall that the equilibrium selection model calls for positive coefficients on the industry wage change variables, and these coefficients must sum to less than one. We combined the twenty-five market industries into the seven industry groups listed in Table 6. For each industry group we construct a dummy variable that equals one if the worker moves into that group, minus one if he moves out of that group, and zero otherwise.

Results are presented in the first column of Table 8. Wage changes for movers are positively related to the wage change in the departed industry, but negatively related to the wage change in the entered industry. If the latter effect were statistically significant, it would be inconsistent with the equilibrium model.

Wage gains and losses predicted by joining or exiting particular industry groups also appear in Table 8. All estimates are relative to the effect for medium-wage low-cyclical industries. Significant wage losses are associated with transitions to the low wage industries. There are significant wage gains associated with transitions into the most cyclically sensitive industries, as well as the fairly cyclical high-wage industries. Thus substantial wage gains are associated with entry to cyclical high-wage industries, but not to less cyclical high-wage industries.

The wage gains and losses from industry transitions are not explained by workers

TABLE 8

Wage Changes of Inter-Industry Movers[a]
Panel Study of Income Dynamics, 1971–1987, Household Heads

Regressors	(1)	(2)	Log-Wage Residual
ΔW^{ii}	0.68 (0.29)	0.70 (0.28)	
ΔW^{jj}	−0.30 (0.28)	−0.34 (0.28)	
Union		17.83 (2.22)	
Industry-Groups:			
Low Wage, Medium Cyclical Sensitivity —Agriculture; Textiles, Apparel, & Leather; Retail Trade; Personal Services	−11.23 (2.45)	−11.07 (2.41)	−23.74 (0.56)
Medium Wage, Low Cyclical Sensitivity —Finance, Insurance, & Real Estate; Entertainment & Recreation; Health Services	0.00[b]	0.00[b]	−1.00 (0.54)
Medium Wage, Medium Cyclical Sensitivity —Food & Tobacco; Wholesale Trade; Business Services; Repair Services; Other Professional Services	−1.79 (2.36)	−2.37 (2.32)	−5.51 (0.71)
Medium Wage, High Cyclical Sensitivity —Machinery; Other Durables	5.23 (2.68)	3.50 (2.64)	5.46 (0.62)
High Wage, Low Cyclical Sensitivity —Communication; Utilities; Education; Public Administration	2.22 (2.44)	1.07 (2.40)	6.29 (0.51)
High Wage, Medium Cyclical Sensitivity —Mining; Paper, Printing, & Publishing; Chemicals, Petroleum, & Rubber; Transportation	5.37 (2.66)	4.12 (2.62)	11.66 (0.69)
High Wage, High Cyclical Sensitivity —Construction; Metals; Transportation Equipment	8.41 (2.52)	6.94 (2.48)	12.92 (0.58)
R^2	.069	.100	
Root MSE	.366	.360	

[a]The dependent variable is ΔW^{ij}, the average wage change (i.e., difference of logs) of movers from industry i to industry j. The regressors ΔW^{ii} and ΔW^{jj} denote respectively the average wage change of stayers in the mover's former industry i and his new industry j. There are 1,846 observations per regression. Standard errors are reported in parentheses.

[b]The zero coefficient for this group is imposed as a normalization.

gaining and losing union jobs. We reestimate the regression including a dummy variable that equals one for workers moving from a nonunion to a union job, minus one for workers moving from a union to a nonunion job, and zero for all others.[11] Results are presented in column 2 of Table 8. The estimated union premium is very significant, equaling 18 percent. But there is a relatively small impact on the other coefficients. The premia associated with very cyclical industries are reduced somewhat.

Although the industry wage effects are significant, they are only about half the size of industry effects estimated from a log-wage regression. The latter effects, which correspond to the mean log-wage residuals in Table 3 with industry groups replacing industries, are reported in the final column of Table 8. The difference between the two sets of estimates is somewhat larger than one reported by Krueger and Summers (1988), which suggests that a considerable fraction of inter-industry wage differences can be attributed to unmeasured differences in worker quality across industries.[12]

These wage gains and losses could reflect compensating differentials for various aspects of industrial employment; alternatively, they could reflect queues for employment in high wage industries. As we discussed in section III, the two hypotheses can be disentangled by examining the predictive power of past wages. Recall that in our efficiency wage model pay in the industries with queues does not reflect individual skills. Thus, if an individual moves into or out from industries with queues, his wage at time t would poorly predict his wage in the new industry at time $t+1$. Even with jumps in pay

[11]We test whether the wage gain from joining a union job differs from the wage loss from leaving a union job. The gain from entering union work is slightly larger; but the difference is statistically insignificant.

[12]We also explore whether the wages of movers are more responsive to market fluctuations than the wages of stayers. We include three additional variables in the movers' wage change regression: the growth rate of aggregate employment, and the growth rates of industry employment shares for the entered industry and the departed industry. If more senior, less-transient workers have wages that are smoothed, then we would expect positive coefficients for the employment growth rates. We find no evidence that movers' wage rates are more responsive to market conditions. The coefficients on all three variables are statistically insignificant.

derived from compensating differentials, equilibrium selection would not predict this.

The wage at t poorly predicts the subsequent wage for movers into the two high-wage cyclical industries. Regressing a mover's log wage at $t+1$ on his log wage at t, as well as industry-group dummies, yields a coefficient of 0.75 (standard error of 0.02) for the first five industry groups. For high-wage cyclical and very cyclical industries, the coefficient is 0.53 (standard error of 0.03). The statistically significant difference between these two estimates is consistent with our queuing models.

VI. Summary and Conclusions

Our point of departure is cyclical upgrading, a set of industry employment, hours, and wage regularities. We empirically confirm that: industries with high wages tend to exhibit the strongest employment fluctuations; across industries, fluctuations in workweeks mimic employment fluctuations; relative to the aggregate wage, industry wages move countercyclically; and industries with the strongest employment fluctuations do not have more procyclical wages.

To capture cyclical upgrading, we apply Roy's (1951) model of equilibrium selection to industry fluctuations. We show that a reasonable specification of the model captures the empirical patterns of cyclical upgrading. Consequently, cyclical upgrading is consistent with market clearing.

We also investigate whether this specification is consistent with inter-industry mobility patterns in panel data. The inter-industry mobility patterns are derived from comparing (a) the wages of inter-industry movers with their co-workers before and after moving, and (b) the wage changes of industry stayers and inter-industry movers. From two simple wage comparisons for each industry, we estimate that almost every industry is characterized by positive selection. That is, each industry employs workers who are above average at work in that industry.

Positive selection accounts for inter-industry mobility patterns, but it does not account for cyclical upgrading. Consequently, the equilibrium selection model can be consistent with either cyclical upgrading or inter-industry mobility patterns, but not both.

This conclusion is reinforced by our analysis of the wage changes of industry stayers. The wage changes of industry stayers, which estimate the evolution of the unobserved industry wage rate, display very little response to aggregate employment. This is consistent with our finding that compositional effects, while present, are not large enough to account for the lack of variation in industry average wages.

The equilibrium selection model also fails to explain predictable patterns of wage changes for industry movers. For instance, the wages of workers leaving low wage industries to enter higher-wage cyclical industries increase by a magnitude that is inconsistent with the basic model of self-selection. Although the large magnitude could reflect a compensating differential for working in high-wage cyclical industries, attempts to link the wage premia to industry characteristics have failed (Krueger and Summers 1988).

Our evidence for an efficiency wage model of queues is mixed. In terms of predicting the wages of industry new hires, previous wages are less powerful for workers entering high-wage cyclical industries. Since pay in industries with queues is not as strongly related to individual skills, these industries appear to be paying super-competitive wages. However, our finding of widespread positive selection works against the efficiency wage model. To support an efficiency wage premium, an industry must have negative selection on unobservable skills.

We have presented substantial evidence against an influential and reasonable market-clearing model of the labor market. However, we have not ruled out that a richer market-clearing model might be consistent with both cyclical upgrading and inter-industry mobility patterns. Nor have we been as industrious in testing the implications of a queuing model. With two exceptions, our treatment of queuing merely relaxes some of the market-clearing model's restrictions. To subject queuing models to similarly rigorous testing would be valuable.

References

Akerlof, George, and Yellen, Janet. "A Near Rational Model of the Business Cycle, With Wage and Price Inertia." *Quarterly Journal of Economics* 100 (Supplement 1985): 823–38.

Haddy, Pamela, and Tolles, N. Arnold. "British and American Changes in Inter-industry Wage Structure Under Full Employment." *Review of Economics and Statistics* 39 (November 1957): 408–414.

Heckman, James. "The Common Structure of Statistical Models of Truncation, Sample Selection and Limited Dependent Variables and a Simple Estimator for Such Models." *Annals of Economic and Social Measurement* 15 (Fall 1976): 475–92.

Heckman, James, and Sedlacek, Guilherme. "Heterogeneity, Aggregation, and Market Wage Functions: An Empirical Model of Self-Selection in the Labor Market." *Journal of Political Economy* 93 (December 1985): 1077–1125.

Heckman, James, and Sedlacek, Guilherme. "Self-Selection and the Distribution of Hourly Wages." *Journal of Labor Economics* 8 (January 1990, part 2): S329–63.

Heckman, James, and Honore, Bo. "The Empirical Content of the Roy Model." *Econometrica* 58 (September 1990): 1121–49.

Huizinga, John. *Real Wages, Employment, and Expectations.* Ph.D. thesis, M.I.T., 1980.

Keane, Michael; Moffitt, Robert; and Runkle, David. "Real Wages over the Business Cycle: Estimating the Impact of Heterogeneity with Micro Data." *Journal of Political Economy* 96 (December 1988): 1232–66.

Krueger, Alan, and Summers, Lawrence. "Inter-Industry Wage Differentials." *Econometrica* 56 (March 1988): 259–93.

Maddala, G.S. *Limited-Dependent and Qualitative Variables in Econometrics.* Cambridge: Cambridge University Press, 1983.

McDonald, Ian, and Solow, Robert. "Wages and Employment in Segmented Labor Markets." *Quarterly Journal of Economics* 100 (November 1985): 1115–41.

McLaughlin, Kenneth. "Rent Sharing in an Equilibrium Model of Matching and Turnover." Manuscript, August 1991.

Okun, Arthur. "Upward Mobility in a High Pressure Economy." *Brookings Papers on Economic Activity* 1 (1973): 207–252.

Reder, Melvin. "The Theory of Occupational Wage Differentials." *American Economic Review* 45 (December 1955): 833–52.

Roy, A.D. "Some Thoughts on the Distribution of Earnings." *Oxford Economic Papers* (June 1951): 135–46.

Wachter, Michael. "Cyclical Variation in the Interindustry Wage Structure." *American Economic Review* 60 (March 1970): 75–84.

Weiss, Andrew. "Job Queues and Layoffs in Labor Markets with Flexible Wages." *Journal of Political Economy* 88 (June 1980): 526–38.

Wood, Robert, and Solon, Gary. "Interindustry Wage Differences over the Business Cycle." Manuscript, February 1990.