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Wage Change and the Quit Behavior of Workers: Implications for Efficiency Wage Theory*

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I. Introduction

Over the past decade, economists have developed efficiency wage models to explain the presence of wage rigidity and thus of involuntary unemployment. In these models, workers' productivity depends positively on the wage or firms' costs depend negatively on the wage, giving firms an incentive to pay wages above the market-clearing level. One type of efficiency wage model is the turnover cost model of Stiglitz [26], Schlicht [24], and Salop [23], in which fewer workers quit at a firm paying high wages. Since hiring and training new workers is costly, firms pay high wages to reduce the number of workers who quit. In the turnover cost model, quits depend on the level of the wage.

This study argues that quits also depend on the change in the wage as well as on its level. Note that a worker's current wage is determined by his initial wage and by the amount the wage changes over his tenure at the firm. A model is developed in section II demonstrating that, under reasonable conditions, a rise in a worker's current wage not matched by a rise in his starting wage will reduce quits to a greater extent than will an equal rise in the worker's current and starting wages. This means that the change in the wage has a negative effect on the quit rate, even controlling for the current level of the wage. In fact, it is possible that quits are more affected by the change in the wage than by the current level of the wage.

The hypothesis that quits depend on the change in the wage has some interesting implications for efficiency wage theory. In section III it is argued that if quits depend on the change in the wage, efficiency wage theory may be able to explain why the economy tends to return to a fixed natural rate of unemployment in mild recessions but not in times of severe recessions such as experienced by the United States in the 1930s and by Europe in the 1980s, why wages are rigid upward as well as downward, why wage rigidity varies across industries and occupations, and why nominal wage cuts are so rare.

II. A Model of a Worker's Quit Decision

A worker's current wage depends on two components: the worker's starting wage and the amount the firm changes the worker's wage over her tenure. This section develops a partial equilibrium

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model demonstrating that, under reasonable conditions, a worker's decision on whether to quit depends more on the amount a firm changes the wage over the worker's tenure than on her initial wage.

In this study, the wage (w) is defined as the present discounted value of the worker's current and expected future salary over her expected working life, where a worker's expected future salary is likely to depend on the firm's current wage-tenure profile. Thus, a change in the wage refers to deviations in a worker's pay from its expected path. For example, suppose that a worker is hired by a firm in which salaries normally rise by 10% with each year of tenure. If the firm then cuts salaries by 5% at every level of tenure in the following year, the recently hired worker would be considered to have taken a wage cut, since the present discounted value of her lifetime pay would decrease, in spite of the fact that her salary is higher in the second year than in the first year.¹

Assume a two period model in which a worker decides whether to accept or reject an offer in the first period and then decides whether to quit or to remain with the firm in the second period.² Both a worker's decision on whether to accept a job offer and her decision on whether to quit depend on the wage she could be earning elsewhere, which in turn depends on her characteristics and on a stochastic component. The stochastic component of a worker's alternate wage arises because different firms, making differing wage offers, have openings at different times. Thus, an individual's best alternative wage offer will vary over time, depending on factors such as which firms have a position open for which the individual is suited, whether the individual is the most qualified for that position, and how much each firm is offering. Again, the alternate wage refers to the present discounted value of the salary offer at another firm.

Let the individual's alternative wage (net of the cost of changing jobs) in periods 1 and 2 be, respectively,

$$\begin{aligned}\omega_1 &= \beta'x + e_1, \\ \omega_2 &= \beta'x + g - c + e_2,\end{aligned}$$

where x represents a vector of worker characteristics, β represents a vector of coefficients, c represents the cost of changing jobs, and e_1 and e_2 represent the stochastic component of the individual's alternate wage in period 1 and period 2. In addition, g represents the normal change over time in the present discounted value of a worker's alternate wage because of his increased age, his increased experience, and general inflation.³ Note that g will normally be positive since future pay (which will generally be higher than current pay) will be discounted less with each passing year. However, g can be negative if the individual is near retirement.

The individual will accept the job in period 1 if

1. The reason why the wage is defined as the present discounted value of the worker's expected lifetime pay rather than as the worker's current wage is that firms may differ in the slope of their wage-tenure profiles, and a worker may accept a job at a firm paying a lower current wage if the firm offers a steep wage-tenure profile. If all firms offer similar wage-tenure profiles, then the wage can be defined as the current wage.

2. While this study assumes a two period model, note that workers live and work beyond the second period, and may choose to quit in a subsequent period. The assumption of a two period model is made for expositional simplicity.

3. Assume for expositional simplicity that a rise in the aggregate price level leads to an equal percentage increase in a worker's alternate wage and that workers do not suffer from money illusion. Then quits will depend on the real wage. (However, if workers have greater knowledge of their own wage than of wages at other firms and do not fully incorporate their knowledge of the aggregate price level into their expectations of their alternate wage, then quits may depend on their nominal wage.)

$$w_1 > \omega_1 = \boldsymbol{\beta}'\mathbf{x} + e_1,$$

and will remain with the firm in period 2 if

$$w_2 > \omega_2 = \boldsymbol{\beta}'\mathbf{x} + g - c + e_2,$$

where w_1 and w_2 represent the wage the firm is offering in each period.

Assume that x is distributed normally, $\mathbf{x} \sim N(\boldsymbol{\mu}_x, \boldsymbol{\Sigma}_x)$,⁴ that e is distributed normally, $e \sim N(0, \sigma_e^2)$, and that e_1 and e_2 are independent of each other (i.e., $E(e_1 e_2) = 0$) and of \mathbf{x} (i.e., $E(e_1 \mathbf{x}) = E(e_2 \mathbf{x}) = 0$). Then,

$$\begin{aligned} \omega_1 &\sim N(\boldsymbol{\beta}'\boldsymbol{\mu}_x, \sigma_\omega^2), \\ \omega_2 &\sim N(\boldsymbol{\beta}'\boldsymbol{\mu}_x + g - c, \sigma_\omega^2), \end{aligned}$$

where $\sigma_\omega^2 = \boldsymbol{\beta}'\boldsymbol{\Sigma}_x\boldsymbol{\beta} + \sigma_e^2$.

Since a worker accepts a job offer in period 1 if $w_1 > \omega_1 = \boldsymbol{\beta}'\mathbf{x} + e_1$, the probability of a worker accepting a job (Prob[a]) can be expressed as

$$\text{Prob}[a] = \text{Prob}[w_1 > \omega_1] = \int_{-\infty}^{w_1} h(\omega_1) d\omega_1, \quad (1)$$

where $h(\omega_1) = (1/(2\pi\sigma_\omega^2)^{1/2}) \exp\{(-1/2)[(\omega_1 - \boldsymbol{\beta}'\boldsymbol{\mu}_x)/\sigma_\omega]^2\}$.⁵

Only a worker who has previously accepted a job can quit. The probability of a worker quitting in period 2 (Prob[q]) is thus the conditional probability that a worker finds a job offer in period 2 that exceeds his current wage (net of the cost of changing jobs) given that he previously accepted a job offer in period 1:

$$\text{Prob}[q] = \text{Prob}[w_2 < \omega_2 | w_1 > \omega_1] = \text{Prob}[w_2 < \omega_2 \text{ and } w_1 > \omega_1] / \text{Prob}[w_1 > \omega_1]. \quad (2)$$

The numerator of this fraction can be expressed as,

$$\text{Prob}[w_1 > \omega_1 \text{ and } w_2 < \omega_2] = \int_{w_2}^{\infty} \int_{-\infty}^{w_1} f(\omega_1, \omega_2) d\omega_1 d\omega_2, \quad (3)$$

where

$$\begin{aligned} f(\omega_1, \omega_2) = & [1/(2\pi(1 - \rho^2)^{1/2}\sigma_\omega^2)] \exp\{-[1/(2(1 - \rho^2))][((\omega_2 - \boldsymbol{\beta}'\boldsymbol{\mu}_x - g + c)/\sigma_\omega)^2 \\ & - 2\rho((\omega_2 - \boldsymbol{\beta}'\boldsymbol{\mu}_x - g + c)/\sigma_\omega)((\omega_1 - \boldsymbol{\beta}'\boldsymbol{\mu}_x)/\sigma_\omega) + ((\omega_1 - \boldsymbol{\beta}'\boldsymbol{\mu}_x)/\sigma_\omega)^2]\}. \end{aligned}$$

As demonstrated in the Appendix, the correlation (ρ) between ω_1 and ω_2 is,

$$\rho = (\boldsymbol{\beta}'\boldsymbol{\Sigma}_x\boldsymbol{\beta}) / (\boldsymbol{\beta}'\boldsymbol{\Sigma}_x\boldsymbol{\beta} + \sigma_e^2).$$

Note that $\rho = 0$ if there is no variation in worker characteristics and that $\rho = 1$ if the worker's alternate wage contains no stochastic component.

4. $\boldsymbol{\Sigma}_x$ is the variance-covariance matrix of the vector \mathbf{x} .

5. Note that σ_ω determines the slope of the labor supply curve facing an individual firm. As σ_ω becomes smaller, the labor supply curve becomes more elastic; in the extreme case that $\sigma_\omega = 0$, the labor supply curve is perfectly elastic.

Let $\Delta w = w_2 - w_1$, so that $w_2 = w_1 + \Delta w$. Then from (1), (2), and (3), the probability of a worker quitting can be expressed as,

$$\begin{aligned} \text{Prob}[q] &= \left[\int_{w_2}^{\infty} \int_{-\infty}^{w_1} f(\omega_1, \omega_2) d\omega_1 d\omega_2 \right] / \left[\int_{-\infty}^{w_1} h(\omega_1) d\omega_1 \right] \\ &= \left[\int_{w_1 + \Delta w}^{\infty} \int_{-\infty}^{w_1} f(\omega_1, \omega_2) d\omega_1 d\omega_2 \right] / \left[\int_{-\infty}^{w_1} h(\omega_1) d\omega_1 \right]. \end{aligned} \quad (4)$$

This model differs from early models in the reservation wage literature.⁶ Early reservation wage models did not allow on-the-job search and thus assumed that once a worker accepted a job, she holds it forever. The assumption that workers cannot search while employed means that workers may reject a wage offer to continue searching, and the wage below which a worker will reject a job is termed the reservation wage in this literature.⁷ In contrast, on-the-job search plays an important role in the model in this study. Consistent with this model, Holzer [18] and Blau [6] present evidence that many employed workers do, in fact, engage in on-the-job search. Since the model in this study assumes that the worker's expected alternate wage is the same in both periods⁸ (except for the normal growth rate, g) a worker will never remain unemployed to look for another job, although a worker may choose to be unemployed to engage in household production. In this case ω_1 or ω_2 would represent the present discounted value of household production. This study makes different assumptions than models in the reservation wage literature since it examines quit behavior rather than search unemployment.

The important question for this study is how a change in Δw and a change in w_1 each affects the probability of a quit. First, consider the effect of Δw on quits. Taking the derivative of (4) with respect to Δw and applying Leibnitz's rule (see the Appendix for a derivation of (5)) yields,

$$d \text{Prob}[q] / d\Delta w = - \left[\int_{-\infty}^{w_1} f(\omega_1, w_2) d\omega_1 \right] / \left[\int_{-\infty}^{w_1} h(\omega_1) d\omega_1 \right]. \quad (5)$$

Similarly, in the Appendix it is shown that,

$$\begin{aligned} d \text{Prob}[q] / dw_1 &= \\ &- \left[\int_{-\infty}^{w_1} f(\omega_1, w_2) d\omega_1 \right] / \left[\int_{-\infty}^{w_1} h(\omega_1) d\omega_1 \right] \\ &+ \left\{ \int_{w_2}^{\infty} \int_{-\infty}^{w_1} [h(\omega_1) f(w_1, \omega_2) - h(w_1) f(\omega_1, \omega_2)] d\omega_1 d\omega_2 \right\} \\ &/ \left\{ \int_{-\infty}^{w_1} h(\omega_1) d\omega_1 \right\}^2. \end{aligned} \quad (6)$$

From (5) and (6) it can be seen that $d \text{Prob}[q] / d\Delta w$ is greater than $d \text{Prob}[q] / dw_1$ in absolute value (i.e., more negative) if and only if

6. See Devine and Kiefer [14] for an overview of reservation wage models.

7. Some models in the reservation wage literature, such as Burdett [7], allowed both employed and unemployed search, with two different reservation wages. If the wage offer is below the lower reservation wage, the individual remains unemployed to continue search; if the wage offer is between the two reservation wages, the individual accepts the job but continues to search; and if the wage offer is above the higher reservation wage, the individual accepts the job and stops searching.

8. It might be argued that an unemployed worker would search more intensely than an employed worker, so that ω_1 should exceed ω_2 . This effect, however, may be counteracted by the fact that potential employers may view current employment as a positive signal concerning the quality of the job applicant and offer higher wages to those already employed at another firm than to the unemployed. For example, Blau [6] found that while employed search was less frequent than unemployed search, employed searchers received more offers per week than did unemployed searchers.

$$\left\{ \int_{w_2}^{\infty} \int_{-\infty}^{w_1} [h(\omega_1)f(w_1, \omega_2) - h(w_1)f(\omega_1, \omega_2)] d\omega_1 d\omega_2 \right\} / \left\{ \int_{-\infty}^{w_1} h(\omega_1) d\omega_1 \right\}^2 > 0. \tag{7}$$

This expression will be positive if $h(\omega_1)f(w_1, \omega_2) - h(w_1)f(\omega_1, \omega_2) > 0$ over the domain in (7).⁹ This, in turn, will be positive if $\ln[h(\omega_1)f(w_1, \omega_2)] - \ln[h(w_1)f(\omega_1, \omega_2)] > 0$ over the domain. In the Appendix it is demonstrated that

$$\begin{aligned} & \ln[h(\omega_1)f(w_1, \omega_2)] - \ln[h(w_1)f(\omega_1, \omega_2)] \\ &= \left\{ [\rho / (2(1 - \rho^2)\sigma_w^2)](w_1 - \omega_1) \right\} [(2\omega_2 - 2\beta' \mu_x - 2g + 2c) \\ &+ \rho(2\beta' \mu_x - w_1 - \omega_1)]. \end{aligned} \tag{8}$$

The above expression will be positive if the probability of a worker quitting in period 2 is no more than 50% (i.e., $w_2 \geq \beta' \mu_x + g - c$) and if the expression is evaluated at the point where $w_2 = w_1 + g$ (i.e., at the margin where the firm increases its wage offer by the same amount that the worker's expected alternate wage rises). Note first that the expression in the first set of brackets must be positive since $w_1 > \omega_1$ over the domain in (7). In addition, at the point where $w_2 = w_1 + g$, the expression in the second set of brackets must also be positive. The assumption that $w_2 \geq \beta' \mu_x + g - c$, coupled with the fact that $\omega_2 > w_2$ over the domain in (7), means that the term inside the first set of parentheses must be positive. While the term inside the second set of parentheses may be negative, it must be smaller in absolute value than the term inside the first set of parentheses, since $c > 0$ and since $\omega_2 - g > w_2 - g = w_1 > \omega_1$, which means that $2\omega_2 - 2g > w_1 + \omega_1$. In addition, the coefficient on the second term is ρ , which is less than 1. Note that the expression in (8) is positive, not only at the point where $w_2 = w_1 + g$, but at any point for which $w_2 \geq w_1 + g$.¹⁰

Why might quits be more responsive to the change in the wage than to the level of the wage? An equal increase in the first period and the second period wage means that on average, workers with better opportunities outside the firm (i.e., higher values of $\beta' \mathbf{x}$) will accept jobs initially. These workers will be more likely to quit in period 2, partially counteracting the negative effect of an increase in the second period wage on quits. In contrast, if the firm increases the wage in period 2 without increasing the starting wage, it will not initially attract a workforce that is more likely to quit.

There is one case in which $d \text{Prob}[q]/dw_1 = d \text{Prob}[q]/d\Delta w$. If all workers have on average identical opportunities outside the firm, there is no variation in $\beta' \mathbf{x}$ between workers. In this case the components of Σ_x are all equal to 0, so that $\rho = 0$. Therefore, when the firm raises its initial wage, it does not hire workers with better opportunities outside the firm.

At first glance, it might appear to be an optimal strategy for a firm to pay low wages in period 1 and then raise wages in period 2. However, recall that the change in the wage refers to unexpected changes in the wage and note that a firm cannot indefinitely raise wages unexpectedly. In addition, firms are limited in how low they will set the first period wage by labor-supply constraints or by efficiency wage considerations.

9. Flanders and Price [15, 835] state that if $f(x, y) \leq g(x, y)$ on the domain \mathbf{D} , then $\iint f(x, y) dx dy \leq \iint g(x, y) dx dy$, when the integral is evaluated over the domain \mathbf{D} .

10. However, if the firm cuts the worker's wage in period 2 or increases it much less than g , then it is possible for dq/dw_1 to be greater in absolute value than $dq/d\Delta w$ at the margin.

So far this study has examined the effects of the initial wage (i.e., the period 1 wage) and the change in the wage on quits, where the effect of the change in the wage on quits was calculated holding the initial wage constant. It is also important to compare the effects of the current wage (i.e., the period 2 wage) and the change in the wage on quits, when the effect of the change in the wage on quits is calculated holding the current wage constant. Suppose we write (4) as $\text{Prob}[q] = f(w_1, \Delta w) = f(w_2 - \Delta w, \Delta w)$. Then,

$$(d \text{Prob}[q]/d \Delta w)|_{w_2} = f_2 - f_1 = (d \text{Prob}[q]/d \Delta w)|_{w_1} - (d \text{Prob}[q]/d w_1,$$

and

$$d \text{Prob}[q]/d w_2 = f_1 = d \text{Prob}[q]/d w_1. \quad (9)$$

It can thus be seen that the change in the wage has a negative effect on the quit rate, even when controlling for the current level of the wage as long as $f_2 > f_1$, a condition that was demonstrated to hold (unless $\rho = 0$, in which case $f_2 = f_1$). In addition, if $f_2 > 2f_1$, then the change in the wage has a greater effect on the quit rate than does the current level of the wage. In fact, research by the author [11] has found that a 1% rise in the current wage (relative to its predicted level) reduces quits by 0.70% to 0.93%, while a 1% rise in the change in the wage (again, relative to its predicted level) reduces quits by 2.13% to 5.03%.

This study has not dealt with two other reasons why the change in the wage can have a negative effect on quits. First, firms differ in their non-pecuniary aspects of employment and workers differ in their preferences for these non-pecuniary characteristics. Thus a firm offering a high first period wage may attract workers who, at the margin, are less attracted to the non-pecuniary characteristics of the firm. For example, Warner and Solon [29] analyzed the enlistment behavior of 30,000 individuals who entered the U.S. Army between 1974 and 1983. For a given level of the Army's wage offer and civilian opportunities at the first-term reenlistment point, they found a negative relationship between the probability of reenlistment and the individual's entry wage. They attribute this finding to the fact that, at the margin, the individuals who are induced to join the Army by the higher entry wage have a lower taste for military life. Similarly, Warner and Goldberg [28] found a negative relationship between the probability of a second-term reenlistment and the size of the first-term reenlistment bonus for U.S. Navy personnel.

Second, suppose a worker does not know his value of $\beta'x$. Then a worker may infer his value of $\beta'x$ from his first period wage. If search intensity is variable, then a worker who suffers a wage cut may find it optimal to search more intensely, while a worker who experiences an increase in his wage may choose to search less intensely.

This study has examined the effect on quits of unexpected changes in wages over time, where an unexpected change corresponds to a shift in the wage-tenure profile. Firms may also try to influence quits by the slope of its equilibrium wage-tenure profile. For example, in Nickell [21] and Salop and Salop [22], firms offer their workers a steep wage-tenure profile to attract workers who are less likely to quit. Thus, expected changes in the wage may also discourage quits. While the slope of the wage-tenure profile has important implications for the economy's equilibrium wage distribution, it has little effect on the behavior of wages over the business cycle, so this aspect of wage change is not considered in this study.

III. Implications for Efficiency Wage Theory

This section discusses possible ways that efficiency wage theory may be modified by the proposition that quits depend on the change in the wage as well as on its level. While more work needs to be done to formalize these ideas,¹¹ they are suggestive of the ways this proposition may allow us to develop a richer set of efficiency wage models.

Suppose a firm's profit function can be written as

$$\pi = PQ(L) - wL - \tau q(w, \Delta w, U)L, \quad (10)$$

where Q is output, P is the price of output, L is labor input, τ is the cost of hiring and training each new worker, and $q(w, \Delta w, U)$ is the quit rate, which depends on the wage (w), the change in the wage (Δw), and the unemployment rate (U). Then the efficiency wage is determined by the equation,¹²

$$0 = d\pi/dw = -L - \tau q_w(w, \Delta w, U)L = -1 - \tau q_w(w, \Delta w, U). \quad (11)$$

In addition, the optimal change in the wage (henceforth referred to as the efficiency wage change) is determined by the equation,

$$0 = d\pi/d\Delta w = -L - \tau q_{\Delta w}(w, \Delta w, U)L = -1 - \tau q_{\Delta w}(w, \Delta w, U). \quad (12)$$

Note that the *efficiency wage* and the *efficiency wage change* are two different concepts. The efficiency wage is an equilibrium concept. It indicates the wage that a firm that is not labor-supply constrained would pay in a long-run equilibrium. In contrast, the efficiency wage change is a dynamic concept. Given the fact that quits depend on the change in the wage, it indicates the optimal amount to change the wage from its previous level in each period. Note that in long-run equilibrium, the efficiency wage change is 0.

In the long run, the firm pays either the market-clearing wage¹³ or the efficiency wage (whichever is higher), and it is possible that equilibrium will be characterized by some firms paying the efficiency wage and other firms paying the market-clearing wage. Figure 1 illustrates the industry supply and demand graph for an industry paying a market-clearing wage in long-run equilibrium, and Figure 2 illustrates the graph for an industry paying an efficiency wage in long-run equilibrium. In the short run, firms may pay the market-clearing wage, the efficiency wage, or last period's wage plus the efficiency wage change.¹⁴ This last possibility allows efficiency wage theory to be modified to explain several phenomena that traditional efficiency wage models cannot explain.

11. Research is underway by the author to develop a computer simulation to illustrate the ideas discussed in this section.

12. Note that if a firm pays efficiency wages, then its labor-supply constraint is not binding.

13. The market-clearing wage is determined by expressing L as a function of the wage and differentiating (10) with respect to the wage.

14. At each point in time, the firm chooses from the above options (paying the market-clearing wage, the efficiency wage, or last period's wage plus the efficiency wage change) by choosing the one that maximizes the present discounted value of the firm's current and future profits, taking into account the effect of current wages on future profits and taking into account the labor-supply constraint.

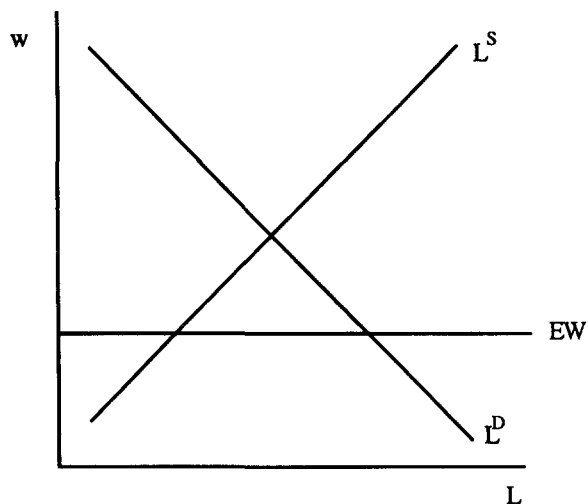


Figure 1

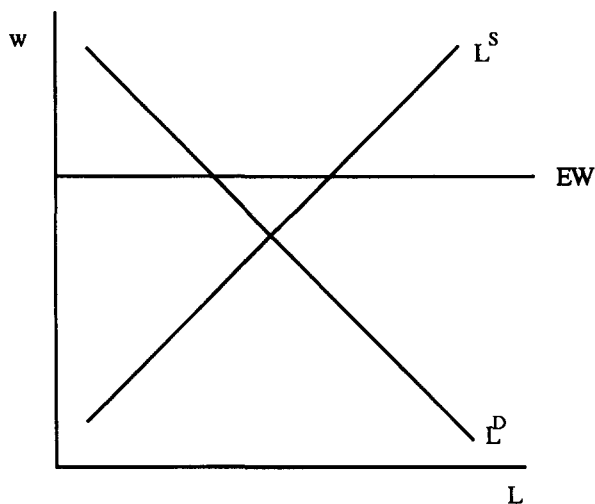


Figure 2

The Natural Rate Hypothesis

Suppose some firms pay the market-clearing wage when demand is at its normal level. Then suppose that demand falls. If (5) is differentiated with respect to Δw , it can be shown (under the same assumptions made in section II) that the second derivative of the quit rate with respect to the change in the wage is positive, meaning that quits rise at an increasing rate as a firm cuts its wage. Thus, the firm may not cut the wage to its equilibrium level immediately, but may initially cut it only partway. In subsequent periods the firm will continue to cut the wage, so that it will approach the new equilibrium level gradually.¹⁵ In the meantime, involuntary unemploy-

15. We can think of $\tau q_{\Delta w}(w, \Delta w, U)$ as representing the cost of reducing wages. Thus, the analysis is similar to the models of Lucas [20] and Gould [17] in which it is costly to change the actual capital stock to its desired level, so that

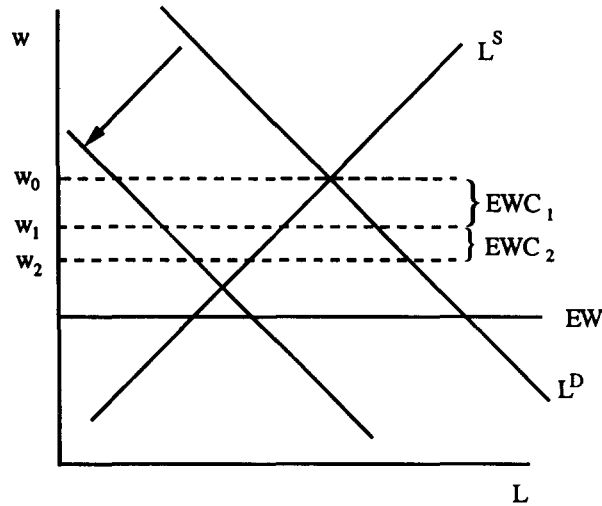


Figure 3

ment may result, but it will disappear as the wage approaches its new equilibrium level. Unlike traditional efficiency wage models, such a model is consistent with the natural rate hypothesis in which the unemployment rate eventually returns to the natural rate of unemployment after a deflationary shock.

This process is illustrated in Figure 3, where it is assumed that the market-clearing wage exceeds the efficiency wage, so that the wage is initially set at w_0 . Then suppose that the demand for labor falls, but that the intersection of the labor supply and the new labor demand curve lies above the efficiency wage curve. The efficiency wage change constraint indicates the optimal amount to change the wage from its previous level, given the dependence of quits on the change in the wage. In the first period after the fall in demand, the efficiency wage change constraint is given by the distance EWC_1 , so that the wage falls from w_0 to w_1 in the first period. In the second period, the efficiency wage change constraint is given by the distance EWC_2 ,¹⁶ and so the wage falls from w_1 to w_2 . This process continues until the wage reaches the intersection of the labor supply and new labor demand curves.

Under What Circumstances Hysteresis Occurs

According to the natural rate hypothesis, the change in the wage depends on the level of unemployment, so that if unemployment rises above a fixed natural rate, wages will fall until the labor market again reaches equilibrium. In contrast, some economists such as Blanchard and Summers [4; 5] and Coe [13] believe that hysteresis in unemployment may sometimes occur. Hysteresis means that a rise in the actual unemployment rate leads to an equal rise in the natural rate. In this case, the change in the wage depends on the *change* in the unemployment rate.¹⁷ Thus, high unemployment will not reduce wages as long as unemployment is not rising.

the adjustment of capital occurs slowly. One difference, however, between this model and models in which it is costly to change the capital stock is that it is equally costly to raise or lower the capital stock, whereas it is only costly to lower the wage.

16. Note that the distance EWC_2 is smaller than the distance EWC_1 because the unemployment rate is lower in the second period than in the first period.

17. See Blanchard and Summers [4] for a discussion of this issue.

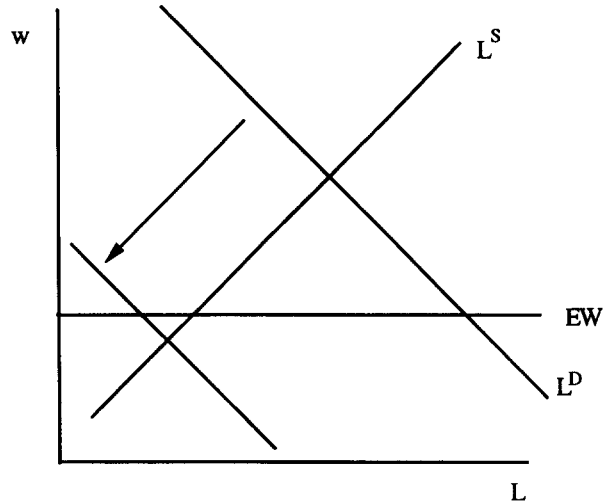


Figure 4

Blanchard and Summers [4] found that, in recent years, wage inflation has depended primarily on the level of the unemployment rate in the U.S., but has depended on the change in unemployment in Europe. They also found that wage inflation in the U.S. depended on the change in unemployment during the Great Depression. Similarly, Gordon [16] found that for real wages, the “level effect” (the effect of the level of unemployment on wages) has been much stronger than the “rate of change effect” (the effect of the change in unemployment on wages) during most periods between 1873 and 1987 in the U.S., but that the rate of change effect dominated between 1930 and 1953, a period encompassing the Great Depression. It thus appears that wage inflation is more likely to depend on the change in unemployment rather than on the level of unemployment in periods when unemployment is high, such as the Great Depression in the U.S. or in Europe today. The hypothesis that the wage can be determined by the market-clearing wage, the efficiency wage, or last period’s wage plus the efficiency wage change provides an interesting explanation for this finding.

Differentiating the efficiency wage change constraint (12) with respect to Δw and U yields,

$$d\Delta w = -(q_{\Delta w u}/q_{\Delta w \Delta w})dU. \quad (13)$$

Differentiating the efficiency wage constraint (11) with respect to w and U yields,

$$dw = -(q_{wu}/q_{ww})dU, \quad (14)$$

which can be expressed as

$$d\Delta w = -(q_{wu}/q_{ww})d\Delta U. \quad (15)$$

(13) and (15) show that wage inflation depends on the *level* of the unemployment rate when the *efficiency wage change constraint* is binding, but depends on the *change* in the unemployment rate when the *efficiency wage constraint* is binding. Suppose initially that the market-clearing wage exceeds the efficiency wage, and then suppose that demand falls, reducing the market-clearing

wage. Initially, the decrease in the actual wage is determined from the efficiency wage change constraint and thus depends on the level of the unemployment rate. This is the situation depicted in Figure 3, where the distances between w_0 and w_1 and between w_1 and w_2 depend on the level of the unemployment rate, as demonstrated in (13). However, suppose the market-clearing wage falls below the efficiency wage, as illustrated in Figure 4. Then the wage and employment level are determined from the intersection of the labor demand and efficiency wage curves, and there is no natural tendency for the labor market to clear. Since the position of the efficiency wage curve depends on the level of the unemployment rate (as demonstrated in (14)), the change in the wage depends on the change in the unemployment rate at this point (as demonstrated in (15)). As Aggregate Demand falls, relatively more industries will be in the situation depicted in Figure 4. Thus in relatively mild recessions, wage inflation tends to depend on the level of the unemployment rate, and the economy has a natural tendency to self-correct. However, in severe recessions (or depressions) wage inflation tends to depend on the change in the unemployment rate, and high unemployment may persist indefinitely.

The Presence of Tight Labor Markets

The proposition that quits depend on the change in the wage also allows us to explain the presence of tight labor markets. Suppose an economic boom raises labor demand and hence raises the equilibrium wage, and suppose the shock is perceived to be transitory. The firm might consider raising the wage to its new equilibrium level. However, when demand falls back to its normal level the firm either would pay a wage that is too high or would have to cut wages. If the firm were to cut wages, many of the workers recruited at the initial higher wage would quit. Thus, when demand rises, firms may prefer to keep wages stable, resulting in a tight labor market and an unemployment rate that is below the natural rate. In contrast, while traditional efficiency wage models can explain involuntary unemployment, they offer no reason why firms would set wages below their market-clearing level, and are thus unable to explain tight labor markets.

Why Wage Rigidity Differs across Industries and Occupations

The hypothesis that quits depend on the change in the wage may be able to explain why the degree of wage rigidity varies across industries and occupations. In traditional efficiency wage models, in which quits depend on the level of the wage, firms with high turnover costs would be expected to pay high wages. In addition, if quits also depend on the change in the wage, then firms with high turnover costs will experience the greatest cost of cutting wages in a recession. Thus, the firms with the highest turnover costs would be expected to keep their wages the most stable over the business cycle. Consistent with these predictions, Campbell [8; 9] found that in the U.S., France, and Canada, wages are the most stable in the industries with the highest costs of hiring and training new workers. Similarly, Campbell [12] found that wages are the most stable in occupations requiring the most skill and thus generally requiring the most training.

Why Nominal Wage Cuts Are So Rare

So far this study has not dealt with the issue of fairness and has not discussed the behavior of nominal wages. However, issues of fairness may be able to explain why nominal wages tend to be rigid downward. Kahneman, Knetsch, and Thaler [19] conducted a survey in which 62% of the respondents said it was unfair for firms in a community experiencing a recession to cut

wages by 7% when inflation is 0%, while only 22% felt it was unfair to raise wages by only 5% when inflation is 12%, even though real wages would fall by 7% in both cases. If workers view a nominal wage cut as unfair, there may be a sharp discontinuity in the relationship between quits and the change in wages at the point $\Delta W = 0$ (where W represents the nominal wage). If such a discontinuity exists, firms will not cut nominal wages unless demand falls dramatically. However, because of the discontinuity in the relationship, firms that do cut nominal wages will tend to cut them by a relatively large amount. Thus, this proposition can explain why firms do not normally cut nominal wages except in the case of a very deep recession and why nominal wage cuts tend to be relatively large when they do occur.

IV. Conclusion

This study has developed a model demonstrating that quits depend on the amount a firm changes its workers' wages over their tenure as well as on the level of the wage. The model shows that, under reasonable conditions, a rise in a worker's current wage not matched by a rise in her starting wage has a greater impact on her propensity to quit than does an equal increase in the worker's current and starting wage. This means that the change in the wage has a negative impact on quits, even controlling for the current level of the wage. In fact, quits may be more affected by the change in the wage than by the current level of the wage.

These results may have important implications for efficiency wage theory. In the traditional turnover cost models, quits depend on the level of the wage, giving firms an incentive to pay high wages. In addition, if quits also depend on the change in the wage, firms may also have an incentive to keep wages stable over the business cycle. It was argued that allowing quits to depend on the change in the wage could enable us to develop dynamic efficiency wage models that may be superior to the static models in the current literature. For example, it may be possible to develop efficiency wage models in which unemployment generally returns to a fixed natural rate after a deflationary shock, but in which hysteresis can occur as a special case. Such models may also allow us to explain why labor markets are sometimes tight and why wage rigidity differs across occupations and industries.

Most models in the efficiency wage literature attribute wage rigidity to the dependence of productivity on wages rather than to the dependence of quits on wages. Economists have developed at least three models to explain why productivity may depend on the wage. In Weiss [30] a firm offering high wages attracts a better pool of applicants and will thus on average hire a more productive workforce. A higher wage may also encourage workers to work harder, either out of gratitude towards the firm, as in Akerlof [1; 2], or because of the increased cost of losing their jobs, as in Shapiro and Stiglitz [25].

This study has concentrated on the effect of wages on quits. However, just as quits depend on the change in the wage as well as on its level, effort may also depend on the change in the wage. According to the fair wage-effort hypotheses of Akerlof and Yellen [3], workers paid less than their perceived fair wage will exert less than full effort. While wages of other employees at the same firm and the wages of similar employees at other firms play a role in determining a worker's perceived fair wage, Akerlof [1] and Akerlof and Yellen [3] indicate that a worker may also view her own past wage as a determinant of her fair wage. Similarly, Kahneman, Knetsch, and Thaler [19, 730] claim that "the current wage of an employee serves as reference for evaluating the fairness of future adjustments of that employee's wage." If these researchers are correct,

then the change in the wage (particularly a decrease), as well as its level, will affect the amount of effort provided by workers.¹⁸ In addition, if workers view their starting wage plus the normal rate of wage growth in the economy as indicative of the wage at which they could be rehired if they were fired, they may shirk more at a firm that increases their wage less than they expect. Consistent with these predictions, Wadhvani and Wall [27] examined data from 219 British manufacturing companies and found that the change in the wage has a positive and significant effect on productivity. If effort, as well as quits, depends on the change in the wage,¹⁹ then the arguments for a dynamic efficiency wage model are strengthened.

Appendix²⁰

Derivation of ρ

$$\begin{aligned} \rho &= \{E[(\omega_1 - E(\omega_1))(\omega_2 - E(\omega_2))]\} / \{\sigma_\omega \sigma_\omega\} \\ &= \{E[(\beta'x + e_1 - \beta'\mu_x)(\beta'x + g - c + e_2 - \beta'\mu_x - g + c)]\} \\ &\quad / \{(\beta'\Sigma_x\beta + \sigma_e^2)^{1/2}(\beta'\Sigma_x\beta + \sigma_e^2)^{1/2}\} \\ \rho &= (\beta'\Sigma_x\beta) / (\beta'\Sigma_x\beta + \sigma_e^2). \end{aligned}$$

Derivation of Equation (5)

From Leibnitz’s rule, the derivative of the numerator of (4) with respect to Δw is

$$\begin{aligned} &\int_{w_1 + \Delta w}^\infty [(\delta / \delta \Delta w) \int_{-\infty}^{w_1} f(\omega_1, \omega_2) d\omega_1] d\omega_2 + \int_{-\infty}^{w_1} f(\omega_1, \infty) d\omega_1 (d\infty / d\Delta w) \\ &\quad - \int_{-\infty}^{w_1} f(\omega_1, w_1 + \Delta w) d\omega_1 (d(w_1 + \Delta w) / d\Delta w) \\ &= 0 + 0 - \int_{-\infty}^{w_1} f(\omega_1, w_1 + \Delta w) d\omega_1. \end{aligned}$$

Derivation of Equation (6)

$$\begin{aligned} d \text{Prob}[q] / dw_1 \\ &= \{[\int_{-\infty}^{w_1} h(\omega_1) d\omega_1]\} [(d/dw_1) \int_{w_2}^\infty \int_{-\infty}^{w_1} f(\omega_1, \omega_2) d\omega_1 d\omega_2] \end{aligned}$$

18. I am currently conducting a survey of firms concerning their wage setting policies. One question asked respondents to consider two situations. In the first situation they are to assume that for the past five years their firm paid wages that were 10% lower than the wages they actually paid; in the second they are to assume that for the previous four years they paid the wages that they actually paid and then in the current year they cut wages by 10%. Respondents were asked in which situation they thought workers’ effort and morale would be worse. Of the 63 responses that have been received, 81.0% of the respondents thought effort and morale would be worse in the second situation, 12.6% thought that effort and morale would be worse in the first situation, and 6.4% thought effort and morale would be equally poor in both situations.

19. Campbell [10] suggests that past wages may have a positive impact on effort since workers’ gratitude may be earned through a history of good wages, while this study suggests that the change in the wage affects effort, so that past wages may actually have a negative impact on effort. It is possible that the effect of past wages on effort is asymmetric. On one hand, it is possible that workers’ goodwill is earned through a history of good wages, so that a firm that had been paying low wages and then increased wages may not obtain a great deal of effort from its workers. On the other hand, it is possible that resentment is created when wages are cut, even if the firm had paid good wages in the past.

20. A more detailed Appendix is available from the author on request.

$$\begin{aligned} & / \{ \int_{-\infty}^{w_1} h(\omega_1) d\omega_1 \}^2 - \{ \int_{w_2}^{\infty} \int_{-\infty}^{w_1} f(\omega_1, \omega_2) d\omega_1 d\omega_2 \} \\ & [(d/dw_1) \int_{-\infty}^{w_1} h(\omega_1) d\omega_1] / \{ \int_{-\infty}^{w_1} h(\omega_1) d\omega_1 \}^2. \end{aligned}$$

To solve this equation, it is first necessary to calculate

$$(d/dw_1) \left[\int_{-\infty}^{w_1} h(\omega_1) d\omega_1 \right]$$

and

$$(d/dw_1) \left[\int_{w_1+\Delta w}^{\infty} \int_{-\infty}^{w_1} f(\omega_1, \omega_2) d\omega_1 d\omega_2 \right].$$

These expressions can be simplified by using Leibnitz's rule. Note first that,

$$\begin{aligned} & (d/dw_1) \left[\int_{-\infty}^{w_1} h(\omega_1) d\omega_1 \right] \\ & = \int_{-\infty}^{w_1} (\delta/\delta w_1) h(\omega_1) d\omega_1 + h(w_1) (dw_1/dw_1) \\ & \quad - h(-\infty) (d(-\infty)/dw_1) \\ & = 0 + h(w_1) - 0 = h(w_1). \end{aligned}$$

To calculate the derivative of $\int \int f(\omega_1, \omega_2) d\omega_1 d\omega_2$, let

$$g(\omega_1, \omega_2, w_1) = \int_{-\infty}^{w_1} f(\omega_1, \omega_2) d\omega_1.$$

Then,

$$\begin{aligned} & (d/dw_1) \int_{w_1+\Delta w}^{\infty} \int_{-\infty}^{w_1} f(\omega_1, \omega_2) d\omega_1 d\omega_2 \\ & = (d/dw_1) \int_{w_1+\Delta w}^{\infty} g(\omega_1, \omega_2, w_1) d\omega_2 \\ & = \int_{w_1+\Delta w}^{\infty} [(\delta/\delta w_1) g(\omega_1, \omega_2, w_1)] d\omega_2 + g(\omega_1, \infty, w_1) (d(\infty)/dw_1) \\ & \quad - g(\omega_1, w_1 + \Delta w, w_1) (d(w_1 + \Delta w)/dw_1) \\ & = \int_{w_1+\Delta w}^{\infty} [(\delta/\delta w_1) \int_{-\infty}^{w_1} f(\omega_1, \omega_2) d\omega_1] d\omega_2 + 0 - g(\omega_1, w_1 + \Delta w, w_1) \\ & = \int_{w_1+\Delta w}^{\infty} f(w_1, \omega_2) d\omega_2 - g(\omega_1, w_1 + \Delta w, w_1) \\ & = \int_{w_2}^{\infty} f(w_1, \omega_2) d\omega_2 - \int_{-\infty}^{w_1} f(\omega_1, w_2) d\omega_1. \end{aligned}$$

Thus,

$$\begin{aligned} d \text{ Prob}[q]/dw_1 & = \{ \left[\int_{-\infty}^{w_1} h(\omega_1) d\omega_1 \right] \left[\int_{w_2}^{\infty} f(w_1, \omega_2) d\omega_2 - \int_{-\infty}^{w_1} f(\omega_1, w_2) d\omega_1 \right] \\ & \quad - \left[\int_{w_2}^{\infty} \int_{-\infty}^{w_1} f(\omega_1, \omega_2) d\omega_1 d\omega_2 \right] (h(w_1)) \} / \{ \int_{-\infty}^{w_1} h(\omega_1) d\omega_1 \}^2 \\ & = - \left[\int_{-\infty}^{w_1} f(\omega_1, w_2) d\omega_1 \right] / \left[\int_{-\infty}^{w_1} h(\omega_1) d\omega_1 \right] \\ & \quad + \left\{ \int_{w_2}^{\infty} \int_{-\infty}^{w_1} [h(\omega_1) f(w_1, \omega_2) - h(w_1) f(\omega_1, \omega_2)] d\omega_1 d\omega_2 \right\} \\ & \quad / \{ \int_{-\infty}^{w_1} h(\omega_1) d\omega_1 \}^2. \end{aligned}$$

Derivation of Equation (8)

$$\begin{aligned}
& \ln[h(\omega_1)f(w_1, \omega_2)] - \ln[h(w_1)f(\omega_1, \omega_2)] \\
&= \ln\{1/[(2\pi)^{3/2}(1 - \rho^2)^{1/2}\sigma_\omega^3]\} - \{1/[2(1 - \rho^2)]\}[(\omega_2 - \beta'\mu_x - g + c)/\sigma_\omega]^2 \\
&\quad + [\rho/(1 - \rho^2)][(\omega_2 - \beta'\mu_x - g + c)/\sigma_\omega][(\omega_1 - \beta'\mu_x)/\sigma_\omega] \\
&\quad - \{1/[2(1 - \rho^2)]\}[(\omega_1 - \beta'\mu_x)/\sigma_\omega]^2 - (1/2)[(\omega_1 - \beta'\mu_x)/\sigma_\omega]^2 \\
&\quad - \ln\{1/[(2\pi)^{3/2}(1 - \rho^2)^{1/2}\sigma_\omega^3]\} + \{1/[2(1 - \rho^2)]\}[(\omega_2 - \beta'\mu_x - g + c)/\sigma_\omega]^2 \\
&\quad - [\rho/(1 - \rho^2)][(\omega_2 - \beta'\mu_x - g + c)/\sigma_\omega][(\omega_1 - \beta'\mu_x)/\sigma_\omega] \\
&\quad + \{1/[2(1 - \rho^2)]\}[(\omega_1 - \beta'\mu_x)/\sigma_\omega]^2 + (1/2)[(\omega_1 - \beta'\mu_x)/\sigma_\omega]^2 \\
&= [\rho/(1 - \rho^2)][(\omega_2 - \beta'\mu_x - g + c)/\sigma_\omega][(\omega_1 - \beta'\mu_x)/\sigma_\omega] \\
&\quad - \{1/[2(1 - \rho^2)]\}[(\omega_1 - \beta'\mu_x)/\sigma_\omega]^2 - (1/2)[(\omega_1 - \beta'\mu_x)/\sigma_\omega]^2 \\
&\quad - [\rho/(1 - \rho^2)][(\omega_2 - \beta'\mu_x - g + c)/\sigma_\omega][(\omega_1 - \beta'\mu_x)/\sigma_\omega] \\
&\quad + \{1/[2(1 - \rho^2)]\}[(\omega_1 - \beta'\mu_x)/\sigma_\omega]^2 + (1/2)[(\omega_1 - \beta'\mu_x)/\sigma_\omega]^2 \\
&= \{\rho/[2(1 - \rho^2)\sigma_\omega^2]\}(\omega_1 - \omega_1)[(2\omega_2 - 2\beta'\mu_x - 2g + 2c) \\
&\quad + \rho(2\beta'\mu_x - \omega_1 - \omega_1)].
\end{aligned}$$

References

1. Akerlof, George A., "Labor Contracts as Partial Gift Exchange." *Quarterly Journal of Economics*, November 1982, 543-69.
2. ———, "Gift Exchange and Efficiency-Wage Theory: Four Views." *American Economic Review*, May 1984, 79-83.
3. ——— and Janet L. Yellen, "The Fair Wage-Effort Hypothesis and Unemployment." *Quarterly Journal of Economics*, May 1990, 255-83.
4. Blanchard, Olivier J. and Lawrence H. Summers. "Hysteresis and the European Problem," in *NBER Macroeconomics Annual 1986*, edited by Stanley Fischer. Cambridge, Mass.: MIT Press, 1986, pp. 15-78.
5. ———, "Hysteresis in Unemployment." *European Economic Review*, February/March 1987, 288-95.
6. Blau, David M., "An Empirical Analysis of Employed and Unemployed Job Search Behavior." *Industrial and Labor Relations Review*, July 1992, 738-52.
7. Burdett, Kenneth, "A Theory of Employee Job Search and Quit Rates." *American Economic Review*, March 1978, 212-20.
8. Campbell, Carl M., "Sectoral Wage Rigidity in the Canadian and French Economies." *European Economic Review*, December 1989, 1727-49.
9. ———, "Tests of Efficiency Wage Theory and Contract Theory with Disaggregated Data from the U.S." *Wirtschaftliches Archiv*, March 1991, 98-118.
10. ———, "Do Firms Pay Efficiency Wages? Evidence with Data at the Firm Level." *Journal of Labor Economics*, July 1993, 442-70.
11. ———. "The Relative Impacts of the Level and the Change in Wage on Quits: Some Empirical Evidence." Mimeo, Colgate University, 1993.
12. ———. "The Variation in Wage Rigidity by Occupation and Union Status." Mimeo, Colgate University, 1993.
13. Coe, David T. "Hysteresis Effects in Aggregate Wage Equations," in *Unemployment, Hysteresis and the Natural Rate Hypothesis*, edited by Rod Cross. New York: Basil Blackwell, Inc., 1988, pp. 284-305.
14. Devine, Theresa J. and Nicholas M. Kiefer. *Empirical Labor Economics*. New York: Oxford University Press, 1991.
15. Flanders, Harley and Justin J. Price. *Calculus with Analytic Geometry*. New York: Academic Press, 1978.
16. Gordon, Robert J., "What is New-Keynesian Economics." *Journal of Economic Literature*, September 1990, 1115-71.

17. Gould, John P., "Adjustment Costs in the Theory of Investment of the Firm." *The Review of Economic Studies*, January 1968, 47–56.
18. Holzer, Harry J., "Job Search by Employed and Unemployed Youth." *Industrial and Labor Relations Review*, July 1987, 601–11.
19. Kahneman, Daniel, Jack L. Knetsch, and Richard Thaler, "Fairness as a Constraint on Profit Seeking: Entitlements in the Market." *American Economic Review*, September 1986, 728–41.
20. Lucas, Robert E., "Adjustment Costs and the Theory of Supply." *Journal of Political Economy*, August 1967, 321–34.
21. Nickell, Stephen J., "Wage Structures and Quit Rates." *International Economic Review*, February 1976, 191–203.
22. Salop, Joanne and Steven Salop, "Self-Selection and Turnover in the Labor Market." *Quarterly Journal of Economics*, November 1976, 619–27.
23. Salop, Steven C., "A Model of the Natural Rate of Unemployment." *American Economic Review*, March 1979, 117–25.
24. Schlicht, Ekkehart, "Labor Turnover, Wage Structure and Natural Unemployment." *Zeitschrift für die Gesamte Staatswissenschaft*, June 1978, 337–46.
25. Shapiro, Carl and Joseph E. Stiglitz, "Equilibrium Unemployment as a Worker Discipline Device." *American Economic Review*, June 1984, 433–44.
26. Stiglitz, Joseph E., "Alternative Theories of Wage Determination and Unemployment in L.D.C.'s: The Labor Turnover Model." *Quarterly Journal of Economics*, May 1974, 194–227.
27. Wadhvani, Sushil B. and Martin Wall, "A Direct Test of the Efficiency Wage Model Using UK Micro-Data." *Oxford Economic Papers*, October 1991, 529–48.
28. Warner, John T. and Matthew S. Goldberg. *Determinants of Navy Reenlistments and Extension Rates*, CRC 476. Alexandria, Va.: Center for Naval Analysis, 1982.
29. Warner, John T. and Gary Solon. "First-Term Attrition and Reenlistment in the U.S. Army," in *Military Compensation and Personnel Retention: Models and Evidence*, edited by Curtis L. Gilroy et al. Alexandria, Va.: U.S. Army Research Institute, 1991.
30. Weiss, Andrew, "Job Queues and Layoffs in Labor Markets with Flexible Wages." *Journal of Political Economy*, June 1980, 526–38.

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