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Behavioral Patterns of Quits and Layoffs*

Jungyoll Yun**

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This paper demonstrates both theoretically and empirically that there are industry-specific factors as well as the cyclical ones that affect quit and layoff incidences and that the industry-specific effects are positively correlated between the two incidences across industries while the cyclical effects are negatively correlated over time. We first set up a theoretical model to analyze how its parameters affect quits and layoffs through the corresponding change in the optimal wage for the employer and the worker, and then derive from the theoretical separation behaviors the two testable hypotheses - that quits and layoffs are positively correlated to each other across industries, and that quits move procyclically while layoffs move countercyclically. We analyze the two sets of data, BLS establishment data on turnover rates and PSID, to empirically test and confirm each of the two hypotheses.

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** 이화여대 교수

1 Introduction

The separation behavior - quit and layoff - of workers has long been analyzed as an important issue in labor economics. One of the well-known facts about it is that quits are procyclical while layoffs are countercyclical or that quits and layoffs are negatively correlated to each other over time (McLaughlin(1991)). However, little has been known about the cross-sectional relationship between the two types of separations, particularly about that across industries. This paper deals with this issue both theoretically and empirically.

The main arguments of this paper are that there are industry-specific factors as well as the cyclical ones that affect quit and layoff incidences and that the industry-specific effects are positively correlated between the two incidences across industries while the cyclical effects are negatively correlated over time.

In formulating a theoretical model for these types of separation behaviors, we start with the rigid wage models by Hall & Lazear (1984) and by Hashimoto & Yu (1980), where the unilateral separations - quit and layoff - are caused by the insensitiveness of the wage to the change in the rent created. What distinguishes my model from the previous ones is that I characterize within the model the wage structure both employer and worker can agree upon, which is exogenously given (as a Nash bargaining solution) in the rigid wage models where it is critical in determining quit and layoff rates. It is through the change in the wage structure in my model that I explain how the changes in the parameters affect quits and layoffs. which enables us to account for the stylized pattern of industry-specific and cyclical effects of the separation behavior.

In setting the wage structure the employer and the worker will take into consideration the two factors: distribution and efficiency. The former is concerned with the share of the rent for each party, and the latter issue arises because the wage structure affects the probability of separation or the probability that the worker and the firm appropriate the rent in the later period. The wage structure that the employer and the worker will determine would thus be the pareto optimal one that maximizes the expected payoff for one party subject to the distributional constraint guaranteeing a ceratin amount of payoff for the other party.[1]

An interesting feature of the model is that the efficiency (or the separation behavior) is dictated by the wage in the later period only, whereas distributional constraint has to do with the total wages for all periods. This implies that the distributional constraint does not interfere with the efficiency, because once the optimal wage in the later period is determined solely from the efficiency point of view, any distributional agreement can be achieved through the appropriate adjustment of the wage in the earlier period. Thus, we can ignore the distributional constraint in setting the optimal wage in the later period and in accounting for the separation behavior of the worker.

[1] Likewise, although the workers' separation behavior were not dealt upon, Lazear & Moore(1984) characterized the optimal wage structure by focusing upon the work incentive.

The parameters that affect quits and layoffs in my model (or in the rigid wage models) are general shock, firm-specific productivity of a worker, the distributions of his productivity shock and of his outside wage offer. We can then establish the following important point: any change in the parameters except in general shock that increases (or decreases) one type of separation also increases (or decreases) the other type of separation through the corresponding change in the optimal wage. Identifying these parameters and general shock as the industry-specific and cyclical factors, respectively, we derive from the theoretical separation behavior the testable hypotheses: (i) that quits and layoffs are positively correlated to each other across industries for a given time, and (ii) that the quits and layoffs are procyclical and countercyclical over time for a given industry, respectively.

We test these hypotheses using the two sets of data in this paper. We analyze the BLS establishment data on industry turnover rates and PSID data to estimate the industry-specific and cyclical effects upon quits and layoffs, which are shown to confirm the hypotheses. In particular, PSID data allows us to control for other factors including individual worker's characteristics in estimating the industry and cyclical effects upon each type of separation.

The rest of this paper is organized as follows. The next section presents a theoretical model for quit and layoff behaviors and derives the testable hypotheses from it. In section 3 the empirical studies based upon the two data sets are conducted to confirm the hypotheses. which is followed by concluding remarks in section 4.

2 Theory

(1) Basic Model

Consider a following two-period model with no discounting. At the beginning of period 1 a firm in the j-th industry hires a worker i of the base productivity z_i which is determined by the set of his characteristics. In period 1 the worker produces the output z_i, and accumulates a certain amount K_j of the firm-specific human capital which varies with industries. The worker produces output P_{ij} in period 2:

$$P_{ij} = z_i + K_j + \varepsilon_j,$$

where ε_j, representing firm-specific shock for period 2, respectively, is distributed with mean zero and independently of each other. It is assumed that the specific shock ε_j, which is identically distributed for each firm within the j-th industry, is either a random variable x with probability β_j or zero with probability $(1 - \beta_j)$. The distribution of x is symmetric and unimodal at the mean zero. The distribution function of x. denoted by $H(.)$, is assumed to be the same for all the industries, which implies that it is the parameter β_j that captures the difference in distribution of the specific shock ε_j among the industries. An industry with large β, for example, would be the one that is subject to the highly volatile business shock. The value of ε_j, realized at the end of period 1, is privately known only to the employer although K_j, β_j, $H(.)$ are common knowledge.

At the end of period 1, a worker in an industry j privately receives an offer ω_{ij} from another firm. Let

$$\omega_{ij} = z_i + k_j,$$

where k_j is a random shock specific to an individual worker, which is identically distributed within an industry. In particular, we assume that the shock k_j is either a random variable y with probability γ_j or zero with probability $(1 - \gamma_j)$. The distribution of y is symmetric and unimodal at the mean zero. The distribution function of y, denoted by $G(.)$, is assumed to be the same for all the industries. implying that difference in the distribution of k_j among the industries is captured by the parameter γ_j. An industry with large γ, for example, would be the one in which the workers may receive relatively good outside offers (as well as relatively bad offers) more frequently. The outside offer ω_{ij} (or k_j) for a worker is not known to his employer, although γ_j, $G(.)$ are common knowledge.

The wages in period 1 and 2, W_{ij}^1, W_{ij}^2, contracted at the time of hiring, cannot be conditioned upon the unverifiable variables such as the shock ε_j or the worker's outside wage offer k_j. The insensitiveness of the wage to ε_j and k_j, what can be called the wage rigidity, gives rise to quit and layoff in this model. as in Hall & Lazear(1984). At the end of period 1 when the productivity shock ε_j and the outside offer ω_{ij} are realized, the separation could occur given the contracted wage W_{ij}^2 in period 2. The worker decides whether to quit or not by comparing ω_{ij} with the wage W_{ij}^2, and the employer also decides whether to layoff a worker or not by comparing the productivity P_{ij} with the wage W_{ij}^2. Thus. a worker's wage W_{ij}^2, his productivity P_{ij} and his outside offer ω_{ij} for period 2 are critical in determining his separation behaviors in this model.

Let $W_{ij}^1 \equiv z_i + w_j^1$ and $W_{ij}^2 \equiv z_i + w_j^2$, where w_j^t, which can be called the wage premium in the j-th industry in period t for $t = 1, 2$, is the wage payment for a worker in excess of his outside productivity z_i in period t. Here we will assume that

$$0 \leq w_j^2 \leq K_j, \tag{1}$$

which implies that the contracted wage W_{ij}^2 for period 2 is not greater than the expected productivity $(z_i + K_j)$ but not lower than the expected outside offer (z_i). This condition (1), as will be seen below, also turns out to be the sufficient condition for the optimal wage setting problem (4) and (5).

The probability of quit for a worker in industry j, Q_j, will be

$$Q_j(w_j^2; \gamma_j) = \gamma_j\{1 - G(w_j^2)\},$$

because the worker will quit if $k_j > 0$ and if

$$W_{ij}^2 = z_i + w_j^2 < z_i + k_j = \omega_j$$

or

$$w_j^2 < k_j.$$

Since the distribution of k_j is symmetric at the mean zero, we have

$$Q_j(w_j^2; \gamma_j) = \gamma_j G(-w_j^2). \quad (2)$$

The probability of being laid off for a worker in industry j, F_j, will be

$$F_j(w_j^2; \beta_j, K_j) = \beta_j H(-K_j + w_j^2), \quad (3)$$

because the employer would layoff the worker if $\varepsilon_j < 0$ and if

$$K_j + \theta + \varepsilon_j - w_j^2 < 0.$$

There are a couple of points worth noting. First, the separation rates are not affected by the worker's base productivity. It is the wage premium w_j^2 in period 2 that matters for the separation behaviors. Second, there are three parameters - the time-invariant ones K_j, β_j, γ_j - that affect quit and layoff incidences in the model. To the extent that the time-invariant parameters are industry-specific, quits and layoffs will vary with industries.

Let us turn to the wage setting in the model. In setting the wages $\{W_{ij}^1, W_{ij}^2\}$, the employer and the worker would be concerned with distribution and efficiency. Thus the wage contract $\{W_{ij}^1, W_{ij}^2\}$ or $\{w_j^1, w_j^2\}$ that both parties would agree upon will be the pareto optimal one that maximizes the expected profit for the employer

$$\pi_j = -w_j^1 + \{1-\gamma_j G(-w_j^2)\}[\{1-\beta_j H(-K_j+w_j^2)\}(K_j-w_j^2)+\beta \int_{-K+w_j^2} \varepsilon dH] \quad (4)$$

subject to the constraint that guarantees the worker a certain level U_i of expected payoff in excess of his outside values $2z_i$ for the two periods:

$$w_j^1 + \{1 - \beta_j H(-K_j + w_j^2)\}[\{1 - \gamma_j G(-w_j^2)\}w_j^2 + \gamma_j \int_{w_j^2} k_j dG] \geq U_i. \quad (5)$$

An important issue in the wage setting is whether the distributional agreement, reflected by U_i, would affect the wage premium w_j^2 and thereby the worker's separation behaviors. Since the constraint (5) will be binding, the expected profit for the employer will be

$$\begin{aligned} \pi_j &= \{1 - \gamma_j G(-w_j^2)\}[\{1 - \beta_j H(-K_j + w_j^2)\}K_j + \beta \int_{-K_j+w_j^2} \varepsilon dH] \\ &\quad + \{1 - \beta H(-K_j + w_j^2)\}\gamma_j \int_{w_j^2} k_j dG - U_i. \end{aligned}$$

Thus the optimal wage W_{ij}^2 or the optimal wage premium w_j^2 in period 2 will be the one that maximizes

$$\{1-\gamma_j G(-w_j^2)\}[\{1-\beta_j H(-K_j+w_j^2)\}K_j+\beta\int_{-K_j+w_j^2}\varepsilon dH]$$
$$+\{1-\beta H(-K_j+w_j^2)\}\gamma_j\int_{w_j^2}k_j dG$$

regardless of U_i or of the distributional objective. Once the wage W_{ij}^2 in period 2 is determined solely from the efficiency point of view, then any distributional agreement U_i can be taken care of through the appropriate adjustment of the wage W_{ij}^1 in period 1. These arguments have established a following important feature of the model.

Proposition 1 *The quits and layoffs are dictated by the wage W_{ij}^2 in period 2, which is not affected by the distributional consideration but by the efficiency only.*

This feature results from the model being a multi-period one in which only the second period wage affects the separation behavior whereas the first period wage takes care of any distributional target. In this respect this model is in contrast with the existing literature where the distributional agreement does change the quits and layoffs through its effect on the wage.

In figuring out the behavioral pattern of separation, therefore, we do not have to care about distributional bargaining between employer and the worker in the wage setting. We will hereafter focus on the optimal wage setting W_{ij}^2 or w_j^2 in period 2 from the efficiency point of view, and will thereby explain quit and layoff behaviors. Disregarding the subscripts and the superscripts for the notational simplicity, the optimal wage premium w^* in period 2 should then satisfy the following condition:

$$\begin{aligned}\Delta &\equiv \gamma g(w^*)[\{1-\beta H(-K+w^*)\}(K-w^*)+\beta\int_{-K+w}\varepsilon dH]\\ &\quad -\beta h(-K+w^*)[\{1-\gamma G(-w^*)\}w^*+\gamma\int_w kdG]\\ &= 0 \qquad (6)\end{aligned}$$

The second-order condition is

$$\begin{aligned}\frac{\partial\Delta}{\partial w} &= \gamma g'(w^*)[\{1-\beta H(-K+w^*)\}(K-w^*)+\beta\int_{-K+w}\varepsilon dH]\\ &\quad -\gamma g(w^*)\{1-\beta H(-K+w^*)\}-\gamma\beta G(w^*)\,h(-K+w^*)\end{aligned}$$

$$-\beta h'(-K+w^*)[\{1-\gamma G(-w^*)\}w^* + \gamma \int_w kdG]$$
$$< 0, \tag{7}$$

which will be satisfied by the assumption (1)[2], because then $g'(w^*) < 0$ and $h'(-K+w^*) > 0$ for $w^* \epsilon (K, 0)$ by the unimodality of $g(.)$ and $h(.)$.

We can see from the first-order condition (6) that the optimal wage premium w^* optimally balances out the benefits and the costs of increasing the wage premium. As the wage premium increases, the chance for the two parties of appropriating the rent may increase through the reduction in the quit rate of the worker or may decrease through the increase in the layoff rate.

We can establish the following comparative static results for the optimal wage premium w^*.

Proposition 2 (*i*) $0 < \frac{\partial w^*}{\partial K} < 1$

(*ii*) $\frac{\partial w^*}{\partial \beta} < 0$

(*iii*) $\frac{\partial w^*}{\partial \gamma} > 0$.

The proof of Proposition 2 is delegated to the appendix. Proposition 2 (i) says that the optimal wage premium increases with the size of the firm-specific rent, albeit not as much as the increase in the rent. In other words, both the wage for the worker and the profit for the employer increase with the firm-specific rent. As will be analyzed later, this property plays an important role for the cross-sectional separation behavior. Proposition 2 (ii) says that the optimal wage premium will decrease as the industry-specific condition gets more volatile (i.e., as β increases), because marginal layoff rate induced by the increase in the wage premium would become greater under more volatile circumstances. Proposition 2 (iii) also says that when the workers receive relatively good outside offers more frequently (i.e., when γ increases), the optimal wage premium will increase because the marginal reduction in the quit rate induced by the increase in the wage premium becomes greater as γ increases.

Since the optimal wage premium w^* in period 2 is a function of the time-invariant parameters K, β, γ, we can write by (2) and (3) quit or layoff function as $Q(\beta, \gamma, K)$ or $F(\beta, \gamma, K)$, respectively.

(2) Theoretical Separation Behaviors

In this subsection we will examine how the quit and layoff rates vary with the parameters K, β, γ in the model. First, we can prove the following.

[2] This assumption (1) would hold if K is large, because then, from the first-order condition, the value of Δ is positive or negative at $w^* = 0$ or at $w^* = K$, respectively.

Proposition 3

$$\frac{\partial Q(\beta,\gamma,K)}{\partial K} < 0$$

$$\frac{\partial F(\beta,\gamma,K)}{\partial K} < 0.$$

Proof.

By Proposition 2 (i), we have

$$\frac{\partial Q(\beta,\gamma,K)}{\partial K} < 0,$$

because $\frac{\partial w^*}{\partial K} > 0$. We also have

$$\frac{\partial F(\beta,\gamma,K)}{\partial K} < 0$$

because $\frac{\partial(-K+w^*)}{\partial K} < 0$ by Proposition 2 (i).

The Proposition 3 results from the fact that the increase in the firm-specific human capital K increases both the wage premium for the worker and the expected profit for the employer, which reduces both quit and layoff rates.

Now let us turn to the effect of the change in β and γ upon the separation rates. We will first analyze how β and γ affect layoffs and quits, respectively. Although it appears that the layoff rate (or the quit rate) increases with β (volatility of business condition) (or γ (chance for the good outside offers)), that is not always true. As β (or γ) increases, the layoff rate $\beta H(.)$ (or quit rate $\gamma G(.)$) increases by its direct effect. On the other hand, however, the increase in β (or in γ) can decrease (or increase) the wage premium w, which could reduce the layoff rate (or the quit rate) indirectly. In determining the net outcome from these conflicting effects, therefore, we will make a following technical assumption, which constitutes a sufficient condition for the direct effect to outweigh the indirect effect.

$A1: \frac{h(-x)}{H(-x)}$ is nonincreasing in x
$A2: \frac{g(-x)}{G(-x)}$ is nonincreasing in x

The above assumptions have the following implications. Note that the layoff probability $\beta H(-K+w)$ (or the quit probability $\gamma G(-w)$) decreases as the wage decreases (or increases), and that the marginal reduction in the layoff probability (or in the quit probability), $\frac{\partial \beta H(-K+w)}{\partial w}$ (or $\frac{\partial \gamma G(-w)}{\partial w}$), is decreasing as the wage decreases (or increases) because $h(.)$ (or $g(.)$) is unimodal at the mean zero. What the assumption $A1$ (or $A2$) requires is that the *the rate of reduction* in the layoff probability (or in the quit probability),

$\frac{\partial\beta H(-K+w)/\partial w}{\beta H(-K+w)}$ (or $-\frac{\partial\gamma G(-w)/\partial w}{\gamma G(-w)}$), is also non-increasing as the wage decreases (or increases).

Lemma

Under the assumption $A1$ or $A2$, we have

$$-\frac{\partial w^*}{\partial\beta}\beta < \frac{H(-K+w^*)}{h(-K+w^*)} \tag{8}$$

or

$$\frac{\partial w^*}{\partial\gamma}\gamma < \frac{G(-w^*)}{g(-w^*)}. \tag{9}$$

The proof of the lemma is delegated to the Appendix. Using the above Lemma, the following proposition establishes the effects of the change in β upon the separation rates.

Proposition 4 *Under the assumptions $A1$ and $A2$, we have*

$$\frac{\partial F(\beta,\gamma,K)}{\partial\beta} > 0$$

$$\frac{\partial Q(\beta,\gamma,K)}{\partial\gamma} > 0.$$

Proof.

Notice that

$$\begin{aligned}\frac{\partial F(\beta,\gamma,K)}{\partial\beta} &= \frac{\partial\beta H(-K+w^*)}{\partial\beta} \\ &= H(-K+w^*)+\beta h(-K+w^*)\frac{\partial w^*}{\partial\beta} \\ &> 0\end{aligned}$$

by Lemma.

Similarly,

$$\begin{aligned}\frac{\partial Q(\beta,\gamma,K)}{\partial\gamma} &= \frac{\partial\gamma G(-w^*))}{\partial\gamma} \\ &= G(-w^*)+\gamma g(-w^*)\frac{\partial w^*}{\partial\gamma} \\ &> 0\end{aligned}$$

by Lemma.

The above proposition shows that as the business condition gets more volatile or as the workers receive good outside offers more frequently, the layoff or quit rate becomes higher despite the resulting decrease or increase in the wage premium, respectively.

Now we will examine how the increase in β (or in γ) would affect quit behavior on the part of workers (or layoff behavior on the part of employer). The answer to this question can be established as follows:

Proposition 5 $$\frac{\partial Q(\beta,\gamma,K)}{\partial\beta} > 0$$

$$\frac{\partial F(\beta,\gamma,K)}{\partial\gamma} > 0.$$

Proof.

$$\begin{aligned}\frac{\partial Q(\beta,\gamma,K)}{\partial\beta} &= \frac{\partial\gamma G(-w^*)}{\partial w^*}\frac{\partial w^*}{\partial\beta}\\ &> 0\end{aligned}$$

by Proposition 2 (ii).

Also,

$$\begin{aligned}\frac{\partial F(\beta,\gamma,K)}{\partial\gamma} &= \frac{\partial\beta H(-K+w^*)}{\partial w^*}\frac{\partial w^*}{\partial\gamma}\\ &> 0\end{aligned}$$

by Proposition 2 (iii).

Propositions 4 and 5 imply that the change in the parameter which increases directly one type of separation (layoff or quit) also increases the other type of separation (quit or layoff) indirectly through the resulting change in the wage premium. For a firm facing the volatile specific shock and thereby high layoff rate, the low wage premium in period 2 would be optimal because of the high cost (in terms of layoff rate) of the increase in the wage premium, which leads to high quit rate. Also, for a firm suffering from high quit rate due to the more frequent outside offers for its workers, the high wage premium in period 2 would be optimal because of the high cost (in terms of quit rate) of the decrease in the wage premium, which leads to high layoff rates.

Next we will explore how the separation rate changes during the aggregate business fluctuation. We will first introduce the general shock θ into the expressions for the productivity and the outside wage offer of the model as follows:

$$P_{ij} = z_i + K_{ij} + \theta + \varepsilon_j,$$

and

$$\omega_{ij} = z_i + \theta + k_j.$$

The distribution functions of ε_j and k_j, which are distributed symmetrically and unimodally at mean zero, are denoted by $H_1(.)$ and $G_1(.)$, respectively. Here we disregard the parameters β, γ, which characterizes the distributions of ε_j and k_j. This would enable us to analyze more clearly the effects of the general shock θ upon the separation rates for a given industry. The value of θ, which is realized at the end of period 1, is privately known to the employer only, so that the contracted wage would not be conditioned upon it. The quit for a given wage premium w_j^2 would be

$$Q(w_j^2, \theta) = 1 - G_1(w_j^2 - \theta) = G_1(-w_j^2 + \theta) \tag{10}$$

because a worker will quit if $z_i + w_j^2 < z_i + \theta + k_j$ and k_j is distributed symmetrically. Similarily, the layoff rate would be

$$F(w_j^2, K_j, \theta) = H_1(-K_j - \theta + w_j^2) \tag{11}$$

because a worker will be laid-off if $z_i + w_j^2 > z_i + K_{ij} + \theta + \varepsilon_j$.

Taking these into account, therefore, the optimal wage premium should be the one that maximizes the following objective function:

$$\int_\theta \quad [\{1 - G(-w + \theta)\}[\{1 - H(-K - \theta + w)\}K + \int_{-K+w} (\theta + \varepsilon)dH] \\ + \{1 - H(-K - \theta + w)\} \int_w kdG]d\Gamma$$

where $\Gamma(.)$ is the distribution function of θ. Then the optimal wage premium w^* should satisfy the following condition:

$$\begin{aligned} \Delta \quad &\equiv \quad \int_\theta [g(-w^* + \theta)[\{1 - H(-K - \theta + w^*)\}(K + \theta - w^*) + \int_{-K+w} (\theta + \varepsilon)dH] \\ &\quad -h(-K - \theta + w^*)[\{1 - G(-w^* + \theta)\}w^* + \int_w kdG]]d\Gamma \\ &= \quad 0 \end{aligned} \tag{12}$$

Noting the fact that the wage premium is a function of K (not of θ), we can establish the following proposition.

Proposition 6 $\qquad \dfrac{\partial Q(K;\theta)}{\partial \theta} > 0, \qquad \dfrac{\partial F(K;\theta)}{\partial \theta} < 0.$

Proof.

Since w^* does not depend upon θ, (10) and (11) yield the results.

Proposition 6 is consistent with the stylized fact that quit rate is pro-cyclical and layoff rate is counter-cyclical. The intuition behind the above proposition comes from the fact that the wage premium w^* does not vary with θ, while the distributions of the outside offer ω and the productivity P do.

(3) Testable Hypotheses

Let F_{jt} (or Q_{jt}) be the layoff incidence (or the quit incidence) of a worker in industry j at time t, and let θ_t be the general shock at time t. Then the theory I have articulated thus far can be presented by a set of the two functions:

$$F_{jt} = f(K_j, \beta_j, \gamma_j, \theta_t)$$

$$Q_{jt} = q(K_j, \beta_j, \gamma_j, \theta_t),$$

and by the results:

$$\frac{\partial F_{jt}}{\partial K_j} < 0, \quad \frac{\partial Q_{jt}}{\partial K_j} < 0 \tag{13}$$

$$\frac{\partial F_{jt}}{\partial \beta_j} > 0, \quad \frac{\partial Q_{jt}}{\partial \beta_j} > 0 \tag{14}$$

$$\frac{\partial F_{jt}}{\partial \gamma_j} > 0, \quad \frac{\partial Q_{jt}}{\partial \gamma_j} > 0 \tag{15}$$

$$\frac{\partial F_{jt}}{\partial \theta_t} < 0, \quad \frac{\partial Q_{jt}}{\partial \theta_t} > 0. \tag{16}$$

The results (13) - (15) show that as each of the parameters K, β, γ changes, quits and layoffs move in the same direction through the corresponding change in the wage structure. To the extent that the parameters K, β, γ are industry-specific, (13)-(15) would imply that quit and layoff rates move across industries in a certain fashion, depending upon the way the parameters K, β, γ are correlated.

If K, β, γ are independently distributed of each other, then (13)-(15) will imply that quits and layoffs are positively correlated across industries. If K, β, γ are not independently distributed of each other, what would then be the most plausible correlation structure among those parameters? We can make the following arguments about it. First, workers would not have much incentive to invest in the firm-specific human capital when their firms are faced with the volatile business condition or when they expect frequent offers from outside, because then they would not expect to stay with the firm for long. This may well lead to the negative correlation between K and β or between K and γ across industries. Second, in an industry subject to the more volatile shock more layoffs and new hires would occur, yielding to more frequent outside offers for the workers. This would imply that β is positively correlated to γ across industries. To the extent that these arguments are true, the results (13)-(15) would support the positive correlation between quits and layoffs across industries.

Assume either that K_j, β_j, γ_j are independently distributed of each other across industries or that K_j is negatively correlated to β_j or to γ_j while β_j is positively correlated to γ_j. Then, noting also that the unemployment rate represents the general shock of the economy, the results (13) - (16) will yield the following testable hypotheses:

Hypothesis

(i) Industry-specific effects upon quits and layoffs are positively correlated to each other across industries.

(ii) Cyclical effects upon quits and layoffs are decreasing and increasing in the unemployment rate, respectively.

3 Empirical Analysis

In this section we will test empirically the above two hypotheses (i), (ii) using the two sets of data, BLS establishment data on turnover rates and PSID.

(1) BLS Establishment Data

The Bureau of Labor Statistics had published in its monthly periodical, Employment and Earnings, the data on the monthly turnover rates (the number of quitters or of the laid offs out of 100 employees) by industry until 1981. We will first look at this establishment data and see how the quit and layoff rates move together across industries as well as over time. In particular, we form a data set by collecting the annual quit and layoff rates by industry, which had also been published in Employment and Earnings as the average of the monthly rates for each year.[3] The data set contains the annual turnover rates for 23 two-digit industries during the period from 1963 to 1981.

To separate industry-specific effects from time-specific effects, we estimate the following equations for quit rate Q_{jt} and layoff rate F_{jt} in industry j for the year t:

$$Q_{jt} = a^q + \sum_j b_j^q I_j + \sum_t c_t^q T_t + \varepsilon_{jt}^q,$$

[3] In fact, the annual turnover rates for all the years between 1963 and 1981 are published except 1964. Thus, we calculate the average of the monthly turnover rates for the 12 months in 1964 to get the annual turnover rate for the year. This data set will be available upon request.

$$F_{jt} = a^f + \sum_j b_j^f I_j + \sum_t c_t^f T_t + \varepsilon_{jt}^f,$$

for $j = 2, 3, --, 23$, and $t = 63, 64, --, 80$, where I_j, T_t are industry and year dummies, respectively.[4] Notice that the coefficients b_j^m and c_t^m $(m = q, f)$ refer to the industry-specific and time-specific effects upon quit or layoff incidence, respectively. Table 1 indicates that both industry-specific and cyclical factors are important in determining quit and layoff rates.[5] The behavioral patterns of the industry-specific and cyclical effects are represented in Table 4, which shows that the correlation coefficient between the estimates b_j^q and b_j^f is 0.45626 (significantly greater than zero) and that between c_t^q and c_t^f is -0.71637 (significantly less than zero). In other words, quits and layoffs are strongly positively correlated across industries for a given time while they are strongly negatively correlated over time for a given industry, which confirms the hypotheses (i) and (ii).

(2) PSID Data

Here we will employ PSID data to examine the separation behavior of an individual worker. An individual worker goes through both quit and layoff decisions for him at each time t, which are made simultaneously and independently of each other in the model. A worker's separation status at time t would thus be described by the two different states - either quitting or staying (not quitting), and either being laidoff or staying (not being laidoff). Although a worker is observed to be in one of the three states - quitting, being laidoff or staying -, therefore, each individual observation at time t should be described, not by one multinomial probit with the three states, but by the two different - quit and layoff - binomial probits.[6]

I set up and estimate the following probit equations for the quit and layoff incidences:

$$Q_{it} = a^q + b^q X_{it} + c^q I + d^q O + e^q u_t + \varepsilon_{it}^q, \tag{17}$$

[4] The reference industry and year are set to be the 1st industry and the year1981, respectively.

[5] This is clear from high R^2 and F-test. The F statistic for the null hypothesis that $b_j^q = 0$ for all j (or that $b_j^f = 0$ for all j) is 48.25 (or 16.69), and that for the null hypothesis that $c_t^q = 0$ for all t (or that $c_j^f = 0$ for all j) is 155.86 (or 87.92). Each of these F statistics is large enough to reject the corresponding null hypothesis with 1% significance level.

[6] In reality, however, quit and layoff decisions for a worker are not made simultaneously. One decision precedes the other. If a worker stays with his firm through the first decision and gets separated through the second one, his separation status would be fully revealed by the observation. If a worker gets separated through the first decision, however, his status would not be fully revealed because he would not be given the second decision. In other words, a worker who chooses to quit through the first decision and thus is observed to quit, for example, could also have been laidoff through the next decision to come. Taking into account the fact that the sample proportions of quitter and of the laidoff are 0.094 and 0.069, respectively, however, the probability that both of the two separation states - quitting and being laidoff - occur for a worker at a given time would be very small in reality. As McLaughlin(1991) did, therefore, we will ignore the possibility in this paper that a worker gets separated through each of the two decisions for him at time t. In other words, when considering the quit probit, for example, we will take 'being laidoff' as well as 'staying' as 'not quitting'.

$$F_{it} = a^f + b^f X_{it} + c^f I + d^f O + e^f u_t + \varepsilon_{it}^f, \tag{18}$$

where X_{it}, I and O are vectors of individual characteristics, industry and occupation dummies, respectively,[7] and u_t is the yearly unemployment rate. The set X_{it} of individual variables includes education (years of schooling), experience (years employed since age 18), race, marital status, children. The sample statistics by turnover status are described in Table 2.

I employ a sample from the PSID spanning the years 1981-90. With these ten years of panel data, time is indexed $t = 1981, ---, 1990$. The sample consists of 25,993 observations on male household heads, aged 25-55, who are employed in period $t-1$.[8] Of the 25,993 observations, 6.9 percent are laid off and 9.4 percent quit between periods $t-1$ and t.

The PSID asks each respondent who has changed jobs in the intervening year the reason for his job mobility. I combine the responses "laid off; fired" and "company folded" to define the layoff variable. Quits include resignations and responses such as "just want to change jobs".

In estimating the above two probit equations (17) and (18), we will conduct the bivariate probit analysis to take into account the correlation between the residuals of the two probits (17) and (18).[9]

The parameter estimates of the quit and layoff probits are shown in Table 3. Individual characteristics are shown to be important in determining those incidences. Work experience and marriage reduces both quits and layoffs. while the number of children does not affect the layoff probability although it reduces the chance of quitting. Also, the workers with higher education are less likely to be laid off while they are more likely to quit. It is interesting to note that the black worker is more likely to quit than the white whereas, although not significant, he is less likely to be laid off than the white.

Since e^m and c^m $(m = q, f)$ in (17) and (18) represent cyclical and industry-specific effects upon quit or layoff incidence, respectively, we can confirm the hypothesis (i) and (ii) by testing whether or not

$$Cor\ (c_j^1, c_j^2) > 0 \tag{19}$$

for $j = 1, --, n-1$, and n is the number of industries, and

$$e^1 > 0, \quad e^2 < 0. \tag{20}$$

One of the prominent feature of the separation incidences is their cyclical movement. Table 3 indicates that quit and layoff incidences are significantly decreasing and increasing in the unemployment rate, respectively, which confirms the condition (20) (and the hypothesis (ii)). Industry specific effects on both the quit and the layoff incidences turn out to be also significant.[10] Table 4 shows

[7] There are 27 industry dummies and 9 occupation dummies.

[8] The workers who are self-employed at time $t-1$ are excluded in the sample.

[9] The correlation coefficient between ε_{it}^1 and ε_{it}^2 is estimated to be −0.24574, which is not significantly different zero as shown in Table 3, however.

[10] The likelihood ratio test rejects with 1% significance level the null hypothesis that the coefficients of the industry dummies are zero.

that the correlation coefficient between c_j^q and c_j^f for the model is 0.3717 and is significantly greater than zero, which implies that, with the other variables including individual-specific, occupation and cyclical effects being controlled, the layoff and the quit rates are strongly positively correlated to each other across industries. This result confirms the condition (19) (and the hypothesis (i)). Table 4 also shows that the occupational effects upon quits and layoffs are not significantly correlated to each other across occupations.[11]

4 Concluding Remarks

This paper examined quit and layoff behaviors both theoretically and empirically. In particular, we have established that there are industry-specific factors as well as the cyclical ones that affect quit and layoff incidences and that the industry-specific effects are positively correlated between the two incidences across industries while the cyclical effects are negatively correlated over time.

In the theory part we characterize the optimal wage structure that maximizes the chance of appropriating the positive rent in a rigid rent-sharing model (developed by Hashimoto-Yu and by Hall-Lazear), and we show that the change in each of the industry-specific parameters which increases one type of separation also increases the other type of separation through the change in the optimal wage. In an industry with the workers accumulating higher levels of firm-specific human capital or facing less frequent outside offers, or in an industry with the firms subject to less volatile business condition, for example, the optimal wage structure entails both lower quit rate and lower layoff rate. The model also showed that, during the good (or the bad) times, the more (or the less) frequent outside offers and the higher (or the lower) profitability would yield the higher (or the lower) quit rate and the lower (or the higher) layoff rate because the wage would not be fully adjusted to those changes.

We derive from the theoretical separation behaviors the testable hypotheses, which we confirm by analyzing BLS establishment data on industry turnover rates and PSID data. Based upon BLS data we show that quits and layoffs are positively correlated to each other across industries for a given time while they are negatively correlated over time for a given industry. We also show by using PSID that the quit and the layoff rates are decreasing and increasing in the unemployment rate, respectively, and that, with individual worker's characteristics and the unemployment rate controlled, the quit rate tends to be higher in an industry with higher layoff rate.

[11] One might argue that the parameters K, β, γ affecting the separation behaviors in the theoretical model could also be occupation-specific as well as industry-specific. If this is true, the theory would imply that quits and layoffs are also positively correlated to each other across occupations. The empirical result, however, does not support this argument.

Appendix: Proof of Proposition 1

(i) Since

$$\frac{\partial w^*}{\partial K} = -\frac{\partial\Delta/\partial K}{\partial\Delta/\partial w^*}$$

and

$$\frac{\partial\Delta}{\partial K} = \gamma g(w^*)\{1-\beta H(-K+w^*)\}+\beta h'(-K+w^*)[\{1-\gamma G(-w^*)\}w^*+\int_{w^*} kdG] \quad (21)$$

we have by (6)

$$1 > \frac{\partial w^*}{\partial K} > 0.$$

(ii), (iii) Since, from (5),

$$\begin{aligned} \frac{\partial\Delta}{\partial\beta} &= \frac{-\gamma g(w^*)(K-w^*)}{\beta} \\ &< 0 \end{aligned}$$

and

$$\begin{aligned} \frac{\partial\Delta}{\partial\gamma} &= \frac{\beta h(-R+w^*)w^*}{\gamma} \\ &> 0, \end{aligned}$$

we have

$$\frac{\partial w^*}{\partial\beta} < 0$$

and

$$\frac{\partial w^*}{\partial\gamma} > 0.$$

Proof of Lemma

From (5) and (6), we have

$$\begin{aligned} -\frac{\partial w}{\partial\beta}\beta &= -\frac{\gamma g(w)(K-w)}{\partial\Delta/\partial w} \\ &< \frac{g(w)\beta H(-K+w)(K-w)+\beta h(-K+w)[\{1-\gamma G(-w)\}w+\gamma\int_w kdG]}{g(w)\{1-3H(-K+w)\}+\beta h'(-K+w)[\{1-\gamma G(-w)\}w+\gamma\int_w kdG]}. \end{aligned} \quad (22)$$

Note that

$$\frac{\beta H(-K+w)(K-w)}{\{1-\beta H(-K+w)\}} < \frac{H(-K+w)}{h(-K+w)} \tag{23}$$

because $h(.)$ is symmetric and unimodal around the mean zero. Note also that by the assumption $A1$

$$\frac{h(-K+w)}{h'(-K+w)} < \frac{H(-K+w)}{h(-K+w)} \tag{24}$$

because $h'(x) = 2xh(x)$ since $h(.)$ is the normal density function. Thus we have from (20), (21) and (22)

$$-\frac{\partial w}{\partial \beta}\beta < \frac{H(-K+w)}{h(-K+w)}.$$

Similarly, we have by the assumption $A2$

$$\begin{aligned}
\frac{\partial w}{\partial \gamma}\gamma &= \frac{\beta h(-K+w)w}{\partial \Delta/\partial w} \\
&< \frac{h(-K+w)\gamma G(-w)w + \gamma g(w)[\{1-\beta H(-K+w)\}(K-w) + \beta \int_{-K+w} \varepsilon dH]}{h(-K+w)\{1-\gamma G(-w)\} + \gamma g(w)[\{1-\beta H(-K+w)\}(K-w) + \beta \int_{-K+w} \varepsilon dH]} \\
&< \frac{G(-w)}{g(-w)}.
\end{aligned}$$

References

R. Hall & E. Lazear, "The Excess Sensitivity of Layoffs and Quits to Demand," Journal of Labor Economics, 1984, 233-57

M. Hashimoto & B. Yu, "Specific Capital, Employment Contracts and Wage Rigidity," Bell Journal of Economics, 1980, 536-49

E. Lazear & R. Moore, "Incentives, Productivity, and Labor Contracts," Quarterly Journal of Economics, 1984, 275-96

K. McLaughlin, "A Theory of Quits and Layoff with Efficient Turnover," Journal of Political Economy, 1991, 1-29

Table 1
Parameter Estimates of Quit and Layoff Equations (BLS Data)

Regressor	Quit Rate	Layoff Rate
Intercept	0.20709	0.37025
	(0.09654)	(0.10226)
Industry	yes	yes
	[48.25]	[16.69]
Year	yes	yes
	[155.86]	[87.92]
R^2	0.9156	0.8495
Adj. R^2	0.9071	0.8343

* The numbers in parentheses and in brackets are standard errors and F statistics, respectively.

Table 2
Summary Statistics (Means and Standard deviations), PSID, 1981-90

Variables	Stayers and Movers	All Stayers	Movers		
			All	Quits	Layoffs
Wage(1991)	12.51	12.88	10.53	10.76	10.21
	(7.60)	(7.59)	(7.36)	(7.79)	(6.74)
Education	5.00	5.03	4.89	5.17	4.51
	(1.67)	(1.68)	(1.62)	(1.63)	(1.51)
Age	35.81	36.25	33.57	33.27	33.98
	(7.95)	(8.01)	(7.28)	(7.02)	(7.56)
Experience	13.90	14.30	11.90	11.66	12.21
	(8.06)	(8.13)	(7.34)	(7.02)	(7.73)
Tenure	93.68	103.42	43.77	41.17	47.31
	(86.03)	(86.97)	(59.90)	(57.91)	(62.35)
Union	0.24	0.26	0.14	0.09	0.19
	(0.43)	(0.44)	(0.34)	(0.29)	(0.40)
Race	0.67	0.67	0.67	0.73	0.60
	(0.47)	(0.47)	(0.47)	(0.45)	(0.49)
Married	0.81	0.82	0.73	0.74	0.72
	(0.40)	(0.38)	(0.44)	(0.44)	(0.45)
Children	1.47	1.50	1.30	1.22	1.41
	(1.33)	(1.33)	(1.29)	(1.24)	(1.34)
Sample proportion	1.00	0.84	0.16	0.094	0.069
# of obs	25,993	21,748	4,245	2,447	1,798

Table 3

Probit Estimates of Quits and Layoffs (PSID)

Regressor	Quits	Layoffs
Constant	-0.33725	-1.20054
	(0.15781)	(0.20299)
$Education_{t-1}$	0.01468	0.04133
	(0.00891)	(0.00957)
$Experience_{t-1}$	-0.02352	-0.01492
	(0.00560)	(0.00621)
$Experience_{t-1}^2$	0.00572	0.01033
	(0.01602)	(0.01752)
$Race_{t-1}$	0.15414	-0.04528
	(0.02627)	(0.02865)
$Married_{t-1}$	-0.07065	-0.19190
	(0.03179)	(0.03476)
$Children_{t-1}$	-0.04768	-0.00308
	(0.01022)	(0.01082)
Unemployment $Rate_{t-1}$	-0.06528	0.02970
	(0.00837)	(0.00923)
$Industry_{t-1}$	yes	yes
	[169.72]	[225.58]
$Occupation_{t-1}$	yes	yes
	[53.92]	[52.18]
ρ	-0.24574	
	(0.27852)	

* The numbers in parenthesis and brackets are standard errors and likelihood ratio statistics, respectively.

* ρ is the correlation coefficient between the residual errors of the two probits.

Table 4

Correlation Coefficients of Dummy Variable Estimates between Quits and Layoffs

Dummy Variable	Correlation Coef. (BLS)	Correlation Coef. (PSID)
Industry	0.45626	0.37173
	(0.0328)	(0.0279)
Time	-0.71637	-
	(0.008)	
Occupation	-	0.03493
		(0.8906)

* The numbers in parentheses are p-values.