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A TWO-SECTOR IMPLICIT CONTRACTING MODEL WITH PROCYCLICAL QUITS AND INVOLUNTARY LAYOFFS

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I. Introduction

Empirical studies of mobility in the labor market have shown that quits are procyclical and layoffs are countercyclical. In addition, most economists believe that at least some layoffs are involuntary. That is, laid-off workers are worse off than they would be if they could have continued working at the wage paid to retained workers. The purpose of this paper is to develop an implicit contracting model to help explain these phenomena.

Equilibrium models of unemployment have failed to explain why some unemployment might be involuntary. For example, Lucas and Prescott (1974) imply that workers will become unemployed if their expected present discounted value of future utility is greater than or equal to their discounted value of future utility when they are unemployed. Another objection to using search models to explain unemployment is the assumption that unemployed search is more productive than employed search. This assumption has frequently been questioned.

Implicit contracts provided one of the first attempts to explain involuntary unemployment as an equilibrium phenomenon. In Azariadis' (1975) seminal work, involuntary unemployment results because firms cannot make severance paymentsto laid-off workers. In particular, Azariadis assumes that 1) workers are risk averse while firms are risk neutral, 2) working is a 0 or

1 decision, that is, hours worked per worker is not a choice variable, and 3) firms cannot make severance payments to unemployed workers. The optimal contract calls for workers to become unemployed during certain states of nature and, because of the no-severance-payment assumption, to consume the value of their leisure. Because workers are risk averse, they desire a constant consumption stream, and hence it is not optimal to lower the consumption of employed workers in bad states in order to induce them to leave.

Another characteristic of Azariadis' model is that whenever there is involuntary unemployment there is also overemployment, that is, overemployment occurs because there is more employment (and less unemployment) than would occur in a pure Walrasian market. Workers remain employed even though their marginal productivity of labor is less than their reservation wage. Both involuntary unemployment and overemployment result from the assumption that firms cannot make severance payments to laid-off workers. As a result, the implication is that firms will partially insure workers against the risk of being laid off by having more employment than would occur in a pure Walrasian market. Once severance payments are allowed, unemployment becomes purely voluntary and production is efficient.

The goal of this paper is to integrate a simple model of on-the-job search with an implicit contracting model. One objective is to be able to explain involuntary unemployment without placing any a priori restrictions on severance payments. Like Azariadis' model, the model predicts that there will be overemployment whenever there is involuntary unemployment. This is in contrast to Grossman and Hart (1983), who developed a model to explain underemployment. A recent paper by Oswald (1986) provides one of the first attempts to explain both involuntary unemployment and underemployment, but to do so he exogenously assumes that severance payments are zero.

In order to explain involuntary unemployment, it is promising to follow the lines of Kahn (1985). He showed that complete insurance is not possible (or that wages will not be independent of the state of nature) when a firm cannot monitor a worker's alternative wage offer. Arvan (1986) extended Kahn's analysis and suggested that this might explain why involuntary layoffs occur. In Arvan's model, firms cannot insure against layoffs because of the need to promote on-the-job search. However, Arvan implicitly constrains the severance payment to laid-off workers to equal the severance payment offered to those who voluntarily quit their jobs. It is this assumption that enables him to explain involuntary unemployment.

This paper is similar to those by both Kahn and Arvan. It also extends the implicit contracting framework by developing a model that can explain why quits are procyclical. The structure of the paper is as follows. Sections II-IV consider a one-sector version of the model, where only the primary sector is explicitly modeled. Section II considers the case where a firm can observe both a worker's search intensity and whether the worker receives a job offer. I show that the optimal contract for this case implies complete insurance.

Section III drops the assumption that a firm can observe a worker's search intensity, but assumes that the firm can observe which workers receive job offers and can hence make severance payments conditional on the worker's accepting an offer. This section shows that the firm's inability to observe a worker's search efforts is not sufficient to produce involuntary unemployment. However, the optimal contract does result in incomplete risk-sharing because firms trade off their desires to provide incentives for on-the-job search and to insure workers against future wage changes. The optimal contract is also characterized by production efficiency for laid-off workers. However, workers who receive job offers are shown to leave more often than they would in a Walrasian world.

Section IV shows that when firms cannot observe both a worker's search efforts and whether the worker receives a job offer, the incentive-compatible contract implies that laid-off workers will be worse off than their employed counterparts. Involuntary unemployment provides the proper incentive in bad states of nature for job-finders to reveal that they received an offer. Section V extends the previous analysis by explicitly modeling both sectors. I show that a two-sector implicit contracting model can help explain why quits are procyclical. The model also predicts that while fewer workers receive job offers in such a model, there are states of nature that promote more mobility than in a Walrasian labor market. For example, in some states of nature, both sectors will be hiring workers from the other sector. This occurs because firms must provide incentives for on-the-job search.

II. The Model with Symmetric Information

Consider an economy that lasts for two periods indexed by $t = 1, 2$. Labor is hired in the first period, and production takes place according to a deterministic production function $f(N)$. Production in the second period is subject to a random shock, 6, where the range of θ is the closed interval $[0, \theta"]$, with a density function and a cumulative distribution function of $g(\theta)$ and $G(\theta)$, respectively. During the first period, workers can search for alternate work in another sector in case of a bad shock to the industry's output in the second period.

In the first period, workers choose their search effort. The probability of finding a job is assumed to be an increasing function of effort expended on search, but the workers' utility is assumed to be a decreasing function of effort expended on search. These relationships are expressed by a function $c(\lambda)$, which indicates the disutility associated with expending enough search to find a job with probability A.

The cost of pursuing on-the-job search is assumed not to affect a worker's marginal utility of income. In that sense, searching can be thought of as requiring a "psychic" cost $c(\lambda)$. Preferences are given by $U(C + BL) - c(\lambda)$, where L is leisure, B is the value of leisure or the reservation wage of a worker, and C is consumption. The following restrictions are placed on utility: $L \epsilon [0, 1]$, $0 \leq \lambda \leq 1$, $U''(.) < 0$, and $c''(\lambda) > 0$. Restricting L to be either one (not working) or zero (working) assumes that hours worked is not a choice variable. Searching also is assumed not to affect the productivity of a worker. The assumption that search effort enters separably in the worker's utility function is not crucial; it is meant to aid comparison with other implicit contracting models.

An alternative explanation of the model is that workers must undergo training on the job if they wish to switch to another sector. The cost of training would be $c(\lambda)$, where λ is the probability that the training is successful. The same restrictions as before would be placed on $c(\lambda)$.

A worker's productivity (and hence wage) at the alternate sector is exogenously given to be w'. Searching does not affect this productivity/wage offer. That is, plants are either productive and produce w', or are not productive. It is also assumed that the firm cannot hire workers in the second period. This assumption will be dropped later so that additional labor can be hired in period two at the market wage rate, w'.

A quit is defined to be a job change, while a layoff is defined to be a transition from employment to unemployment. These definitions are motivated by the empirical regularity that most people who report being laid off become unemployed (at least temporarily), while workers who report quitting their previous job typically do not have an **intervening** spell of unemployment.

Contracts consist of wages, severance payments, layoff probabilities, and a search intensity. That is, a contract consists of $\{w_1, w_2(\theta), l(\theta), q(\theta), s_l(\theta), s_q(\theta), \lambda\}$, where w_1 is the first-period wage; $w_2(\theta)$ is the second-period wage chosen in period one contingent upon the realization of θ in period two; and $l(\theta)$ is the fraction of workers without outside offers who are laid off, while $q(\theta)$ is the fraction of workers who receive outside offers who quit; and $s_l(\theta)$ and $s_q(\theta)$ are the severance payments (or taxes) given to (or applied to) workers who did not receive job offers and workers who did receive job offers, respectively. For the full-information case considered below, one can think of the firm as also choosing the search intensity of workers, λ.

Defining $V(.)$ to be the discounted value of utility for a representative worker and assuming that workers cannot save or dissave so that their consumption in every period is equal to their wage in that period, the expected utility of a representative worker equals

$$
\begin{aligned}
& EV(w_1,\ w_2(\theta),\ s_q(\theta),\ s_l(\theta)),\ l(\theta),\ q(\theta),\ \lambda) \\
= \ & U(w_1) - c(\lambda) + \int\{\lambda(1-q(\theta))U(w_2(\theta)) + \lambda q(\theta)U(w'+s_q(\theta))\}g(\theta)d\theta \\
+ \ & \int\{(1-\lambda)(1-l(\theta))U(w_2(\theta)) + (1-\lambda)l(\theta)U(B+s_l(\theta))\}g(\theta)d\theta.
\end{aligned}
$$

The intuition is as follows: $\lambda(1-q(\theta))$ is the probability that a worker receives a job offer from outside, but remains employed at his original firm earning $w_2(\theta)$; $\lambda q(\theta)$ is the probability that a worker receives a job offer and accepts it, in which case he earns w' plus a severance payment $s_q(\theta)$; $(1-\lambda)(1-l(\theta))$ is the probability that a worker does not find a job and is not laid off, in which case he earns $w_2(\theta)$; $(1-\lambda)l(\theta)$ is the probability that the worker does not receive a job offer and is laid off, in which case he earns the value of his leisure, B, and a severance payment, $s_l(\theta)$. The firm is assumed to maximize profits where profits are given by

$$\begin{aligned} & E\Pi(w_1,\ w_2(\theta),\ s_q(\theta),\ s_l(\theta),\ q(\theta),\ l(\theta),\ \lambda,\ N) \\ = \ & f(N) - w_1N + \int\{\theta f([\lambda(1-q(\theta)) + (1-\lambda)(1-l(\theta))]N) \\ - \ & [(1-q(\theta))\lambda + (1-\lambda)(1-l(\theta))]w_2(\theta)N - \lambda q(\theta)s_q(\theta)N \\ - \ & (1-\lambda)l(\theta)s_l(\theta)N\}g(\theta)d\theta. \end{aligned}$$

The optimal employment contract maximizes expected utility subject to nonnegative profits.

$$\max_{\substack{\{w_1,\ w_2(\theta),\ s_q(\theta), \\ s_l(\theta),\ q(\theta),\ l(\theta),\ \lambda\}}} EV(w_1,\ w_2(\theta),\ s_q(\theta),\ s_l(\theta),\ q(\theta),\ l(\theta),\ \lambda)$$

s.t.

$$E\Pi(w_1,\ w_2(\theta),\ s_q(\theta),\ s_l(\theta),\ q(\theta),\ l(\theta),\ \lambda,\ N) \geq 0$$

The first-order conditions can be characterized by the following equations:

(1) $\quad U'(w_1) = U'(w_2(\theta)) = U'(w'+s_q(\theta)) = U'(B+s_l(8)) \quad = \gamma_1,$

(2) $\theta f'([1-\lambda q(\theta)]N) = w'$ when $\theta > \theta_H$,

(3) $\theta f'([(1-l(\theta))(1-\lambda)]N) = B$ when $\theta < \theta_L$

$q(\theta)=1$, $l(\theta) = 0$ when $\theta_L < \theta < \theta_H$

where $\theta_L f'([1-\lambda]N) = B$, $\theta_H f'([1-\lambda]N) = w'$,

(4) $c'(\lambda) = \gamma_1[G(\theta_L)(w'-B) + {}_{\theta_L}\int^{\theta H}(w' - Of'((1-X)N)g(B)dB]$,

where γ is the Lagrangian multiplier associated with the expected profit constraint and $\gamma_1 = N\cdot y$.

The solution to this problem is straightforward. Since there are no informational asymmetries, the optimal contract involves both perfect risk-sharing and production efficiency. From (1), workers are guaranteed the same income (or income equivalent) during all states of the world, independent of both the state of nature and whether a worker receives a job offer. Workers who are successful in their job search subsidize those who are unsuccessful. From (2) and (3) we have production efficiency. Workers are laid off only after all workers who received outside offers have quit. Since $w' > B$, it is cheaper for the firm to let all the workers with outside offers quit and earn w' than to lay off a worker who has an income equivalent of B. When $\theta > \theta_H$, no workers are laid off and workers with outside offers quit until the marginal productivity of the remaining workers equals the wage earned by the workers who quit, w'. After workers with outside offers leave, firms do not start laying off workers until the marginal productivity of labor equals the reservation wage for a worker without an outside offer, $\theta_L < \theta < \theta_H$. When $\theta < \theta_L$, firms lay off workers until the marginal productivity of labor is equal to the reservation wage of the marginal worker. Firms then subsidize workers who are laid off by giving them a severance payment so that they are indifferent between staying with the firm or leaving.

Firms also force workers to supply the optimum amount of search intensity given by (3). One can think of wages being set equal to zero when workers supply less than the required amount of search effort. The marginal cost of searching is equal to the marginal benefit of searching. The marginal benefit of searching is the difference between what the worker would earn in an alternate job, w', and what he produces in his current job, $\theta f'(.)$. In good states of nature $(\theta > \theta_H)$ this difference is zero from production efficiency, while in bad states of nature $(\theta < \theta_L)$ the difference is $w' - B$. When $\theta_L < \theta < \theta_H$ (that is, $q(\theta) = 1, l(\theta) = 0$), this difference is $w' - \theta f'(.)$ otherwise. The marginal benefit of searching is therefore the difference between what the worker would earn if he quit and what he would produce if he stayed. Since the marginal cost of searching has units of utilities, this quantity is multiplied by a worker's marginal utility of income.

This contract specifies that all workers receive the same utility whether or not they succeed in finding outside alternatives. Hence, if firms did not know how hard a worker had searched, this contract would offer no incentive for workers to search. The next section considers the optimal contract when a firm cannot monitor a worker's search intensity.

III. Imperfect Monitoring

In this section, it is assumed that a worker's search intensity is known only by the worker. However, it is assumed that the following contingency can be included in the optimal contract: severance payments can be made conditional on the worker's accepting a job offer. With asymmetric information, firms choose the optimal contract on the assumption that workers will then choose λ to maximize their utility given this contract. That is, given a contract $\{w_1, w_2(\theta), s_q(\theta), s_l(\theta), q(\theta), l(\theta)\}$, workers will choose their desired search intensity, λ^*, such that

$$\lambda^* = \underset{\lambda \in [0,1].}{\operatorname{argmax}} \; EV(w_1, w_2(\theta), s_q(\theta), s_l(\theta), q(\theta), l(\theta), \lambda)$$

To solve for the optimal contract, we replace the above condition with the first-order condition for an agent's search effort. It shows how agents choose λ in response to the employment contract. This incentive-compatibility constraint is appended to the optimal contract problem in the previous section giving

$$\max_{\substack{\{w_1(\theta), w_2(\theta), s_q(\theta),\\ s_l(\theta), q(\theta), l(\theta), \lambda\}}} EV(w_1, w_2(\theta), s_q(\theta), s_l(\theta), q(\theta), l(\theta), \lambda)$$

s.t.

$$E\Pi(w_1, w_2(\theta), s_q(\theta), s_l(\theta), q(\theta), l(\theta), \lambda, N) \geq 0$$

$$\int\{(1-q(\theta))U(w_2(\theta)) + q(\theta)U(w'+s_q(\theta))\}g(\theta)d\theta$$
$$- \int\{(1-l(\theta))U(w_2(\theta) + l(\theta)U(B+s_l(\theta))\}g(\theta)d\theta - c'(\lambda) = 0.$$

The first-order conditions can be characterized by the following equations:

(1) $U'(w_1) = \gamma_1$

$$(2) \quad U'(w_2(\theta)) = \frac{\gamma_1[\lambda(\theta)(1-q(\theta))+(1-\lambda)(1-l(\theta))]}{[(\lambda+\gamma_2)(1-q(\theta))+(1-\lambda-\gamma_2)(1-l(\theta))]}$$

$$(3) \quad U'(w'+s_q(\theta)) = \frac{\lambda\gamma_1}{(\lambda+\gamma_2)}$$

$$(4) \quad U'(B+s_l(\theta)) = \frac{\gamma_1(1-\lambda)}{(1-\lambda-\gamma_2)}$$

$$(5) \quad q(\theta) = \begin{cases} 1 & \text{if} \quad W(\theta) - \theta f'((1-\lambda)[1-l(\theta)]N) > 0 \\ q^*(\theta) & \text{where} \quad W(\theta) - \theta f'([\lambda(1-q^*(\theta)+(1-\lambda)(1-l)]N) = 0 \\ 0 & \text{if} \quad W(\theta) - \theta f'([1-(1-\lambda)l]N) < 0 \end{cases}$$

where

$$W(\theta) = w' + \{U(w'+s_q) - U(w_2) - U'(w'+s_q)[(w'+s_q) - w_2]\}/U'(w'+s_q)$$

$$(6) \quad l(\theta) = \begin{cases} 1 & \text{if} \quad B - \theta f'(\lambda(1-q(\theta)) > 0 \\ l^*(\theta) & \text{where} \quad B - \theta f'([\lambda(1-q(\theta)+(1-\lambda)[1-l^*(\theta)]N) = 0 \\ 0 & \text{if} \quad B - \theta f'((1-\lambda q(\theta))N) < 0 \end{cases}$$

$$(7) \quad \gamma_2 c''(\lambda) = \gamma_1 \int q(\theta)\{w_2(\theta) - (\theta f'(.)+s_q(\theta))\}g(\theta)d\theta.$$

From equations (5), (6), and (7) we obtain:

$q(\theta) = 1,\ l(\theta) > 0$ when $\theta < \theta_L$

$q(\theta) = 1,\ l(\theta) = 0$ when $\theta_L < \theta < \theta_H$

$q(\theta) < 1,\ l(\theta) = 0$ when $\theta > \theta_H$

$$(2a) \quad U'(w_2(\theta)) = \frac{\gamma_1(1-\lambda)}{(1-\lambda-\gamma_2)} \text{ when } \theta < \theta_L$$

$$(2b) \quad U'(w_2(\theta)) = \frac{\gamma_1(1-\lambda q(\theta))}{[1-(\lambda+\gamma_2)q(\theta)]} \text{ when } \theta > \theta_L$$

where $\theta_L f'([1-\lambda]N) = B$, $\theta_H f'([1-\lambda]N) = W(\theta)$.

Like the case with symmetric information, (5a) and (5b) show that layoffs occur only after all workers with outside offers accept employment. From (2a) and (4), when $\theta' < \theta_L$, layoffs occur and there is complete insurance for laid-off workers, that is, $B + s_l = w_2$. When $\theta' > \theta_H$, not all workers with outside offers accept new jobs. From (2b) and (3), workers who receive job offers and leave the firm are subsidized and earn more than those who do not find other employment, that is, $w' + s_q > w_2$. However, this differential gets smaller with better states of nature.

Since workers are risk averse, the definition of $W(\theta)$ in equation (5) and (2b) implies that when $\theta_L < \theta' < \theta_H$, the marginal productivity of labor will decrease with better states of nature. Similarly, using the fact that $U(C)$ is concave, the definition of $W(\theta)$ and (5) shows that workers with outside offers are allowed to leave the firm more often than they did with symmetric information, that is, $W(\theta) > w'$. The intuition behind this result is that on-the-margin firms find it optimal to provide additional incentives for on-the-job search by allowing workers to earn more after they find another job, and also by allowing them to leave more often than they would if they had full information. From (5), the amount that production differs from a Walrasian market depends on the curvature of the utility function. The more risk-averse the worker, the greater the need to insure his income. Since insurance results in less search effort, firms provide incentives for on-the-job search by allowing workers to leave more often than in a world with symmetric information.

It should be noted that the above solution assumes that firms have the power to either subsidize or tax workers who leave. When $\theta' > \theta_H$, the firm announces that the first $q(\theta)N$ workers who volunteer to leave can do so with a severance payment of $s_q(\theta)$. The rest of the job-finders voluntarily stay at the firm if $w' < w_2$. However, if $w' > w_2$, the firm must tax the successful workers to prevent them from leaving.

Since workers respond optimally to changes in the contract offered to them, equation (7) states that their search intensity will be chosen so that the change in the marginal cost to workers from increasing their search effort is equal to the marginal benefit (expressed in units of utility) to the firm resulting from workers' increasing their search effort. The marginal benefit from increasing a worker's search intensity is the difference between what the worker is paid, w_2, and the sum of what he produces, $\theta f'(.)$, and the severance payment given to departing workers, $s_q(\theta)$. The proof that γ_2 is strictly positive follows because when $\gamma_2 < 0$, workers would have no incentive to search. A sufficient condition for an interior solution to occur is that $c'(0) = 0$, $c'(1) = \infty$ and $w' > B$, that is, it is costless to exert a little search effort, but the marginal cost of searching so that a worker can ensure a job offer is infinitely costly.

Note that when $\theta f'(\lambda(1-q^*(\theta)N) > w'$, there is an incentive for workers who receive job offers to recontract with the firm. This is not possible, however, given the assumption that firms can observe which workers received job offers after the offers were accepted. In addition, there is an implicit assumption that firms cannot hire these workers back after the offer has been accepted. If the firm could costlessly observe a worker's offer, there would always be production efficiency because firms could bribe workers who found jobs to continue employment by offering them a higher wage rate, w'.
If the marginal productivity of labor is greater than w', then the firm has an incentive to induce workers who received an offer to stay, since they can produce more at their present job than they can at an alternative job.

Underemployment results when $\theta_L < \theta < \theta_H$ because firms, by assumption, cannot hire workers in the second period at the market wage rate, w'. If additional labor can be hired, then an interesting result occurs. Workers will leave the firm while other workers are being hired by the firm. Since the marginal productivity of labor is greater than w', the firm has an incentive to hire additional workers at a wage of w'. Although ex post this seems wasteful (because of possible moving costs that are not built into the model), ex ante such behavior is necessary in order to motivate workers to engage in on-the-job search.

To formalize, assume that the firm can hire $n(\theta)$ workers in the second period at a market wage rate of w'. The optimal contract is then to choose $\{w_1(\theta), w_2(\theta), s_q(\theta), s_l(\theta), q(\theta), l(\theta), A, n(\theta)\}$ in order to maximize expected utility subject to the constraint of nonnegative profits, the incentive-compatibility constraint, and the restriction that additional employment in period two be nonnegative:

$$\max_{\substack{\{w_1(\theta),\, w_2(\theta),\, s_q(\theta), \\ s_l(\theta),\, q(\theta),\, l(\theta),\, \lambda,\, n(\theta)\}}} EV(w_1, w_2(\theta), s_q(\theta), s_l(\theta), q(\theta), l(\theta), \lambda)$$

s.t.

$$E\Pi(w_1, w_2(\theta), s_q(\theta), s_l(\theta), q(\theta), l(\theta), \lambda, N) > 0$$

$$\int\{1-q(\theta))U(w_2(\theta) + q(\theta)U(w'+s_q(\theta))\}g(\theta)d\theta$$

$$- \int\{(1-l(\theta))U(w_2(\theta) + l(\theta)U(B+s_l(\theta))\}g(\theta)d\theta - c'(\lambda) = 0$$

$$n(\theta) \geq 0.$$

The first-order conditions can be characterized by the following equations:

$$(1) \qquad U'(w_1) = \gamma_1$$

$$(2) \qquad U'(w_2(\theta)) = \frac{\gamma_1[\lambda(1-q(\theta))+(1-\lambda)(1-l(\theta))]}{[(\lambda+\gamma_2)(1-q(\theta))+(1-\lambda-\gamma_2)(1-l(\theta))]}$$

$$(3) \qquad U'(w'+s_q(\theta)) = \frac{\lambda\gamma_1}{(\lambda+\gamma_2)}$$

$$(4) \qquad U'(B+s_l(\theta)) = \frac{\gamma_1(1-\lambda)}{(1-\lambda-\gamma_2)}$$

$$(5) \qquad q(\theta) = \begin{cases} 1 & \text{if} \quad W(\theta) - \theta f'((1\text{-}A)\ [1-l(\theta)]N+n(\theta)) > 0 \\ q^*(\theta) & \text{where} \quad W(\theta) - \theta f'([\lambda(1-q^*(\theta)+(1-\lambda)(1-l)]N+n(\theta)) = 0 \\ 0 & \text{if} \quad W(\theta) - \theta f'([1-(1-\lambda)l]N+n(\theta)) < 0 \end{cases}$$

where

$$W(\theta) = w' + \{U(w'+s_q) - U(w_2) - U'(w'+s_q)[(w'+s_q) - w_2]\}/U'(w'+s_q)$$

$$(6) \qquad l(\theta) = \begin{cases} 1 & \text{if} \quad B - \theta f'(\lambda(1-q(\theta)+n(\theta)) > 0 \\ l^*(\theta) & \text{where} \quad B - \theta f'([\lambda(1-q(\theta)+(1-\lambda)(1-l^*(\theta))]N+n(\theta)) = 0 \\ 0 & \text{if} \quad B - \theta f'((1-\lambda q(\theta))N+n(\theta)) < 0 \end{cases}$$

$$(7) \qquad n(\theta) = \begin{cases} \infty & \text{if} \quad w' - \theta f'(\infty) > 0 \\ n^*(\theta) & \text{where} \quad w' - \theta f'(\lambda(1-q(\theta)+(1-\lambda)(1-l(\theta))]N+n^*(\theta)) = 0 \\ 0 & \text{if} \quad w' - \theta f'(\lambda(1-q(\theta)+(1-\lambda)(1-l(\theta))]N) < 0 \end{cases}$$

$$(8) \qquad \gamma_2 c''(\lambda) = \gamma_1 \int q(\theta)\{w_2(\theta) - (\theta f'(.)+s_q(\theta))\}g(\theta)d\theta$$

Using e.1), e.2), e.3), and b) yields:

$q(\theta) = 1$, $l(\theta) < 0$, $n(\theta) = 0$ when $\theta < \theta_L$

$q(\theta) = 1,\ l(\theta) = 0,\ n(\theta) = 0$ when $\theta_L < \theta < \theta_H$

$q(\theta) = 1,\ l(\theta) = 0,\ n(\theta) > 0$ when $\theta > \theta_H$

(2a) $$U'(w_2(\theta)) = \frac{\gamma_1(1-\lambda)}{(1-\lambda-\gamma_2)}$$

where $\theta_L f'([1-\lambda]N) = B$, $\theta_H f'([1-\lambda]N) = w'$.

The results when the firm can hire additional workers at a wage of w' are as follows. Workers who stay with the firm earn a wage w_2, which is independent of the state of the world. Workers who receive job offers accept their offers and receive a severance payment from the firm, s_q, which is also state-independent. When firms lay off workers, that is, when $\theta < \theta_L$, there are complete severance payments and production efficiency. All workers with outside offers will quit and no additional workers will be hired in these states of nature. When $\theta_L < \theta < \theta_H$, all workers with outside offers quit, no workers are laid off, and no additional workers are hired. When $\theta > \theta_H$, all workers with outside offers quit and no workers are laid off, but the firm hires additional workers at a wage of w' until production efficiency prevails.

The contract implies a two-tier system for adjusting a firm's work force. Firms first offer a severance payment to workers who wish to leave the firm. Every worker who has found another job will then accept this offer. In more complex models, one can think of the severance payment offered to departing workers as also consisting of possible early retirementbenefits, etc. After workers accept this offer, the firm then adjusts the labor force by laying off workers or hiring workers until it reaches the desired level of employment. This sort of two-tier system seems to have its counterpart in the world. Although the current analysis indicates that those who find jobs will always leave the firm, the reason is that no adjustment costs are incurred when hiring new workers. If there were adjustment costs (or firm-specific human capital), not all of the workers who found jobs would leave the firm.

It should be noted that since every worker who receives an outside job offer is allowed to accept the offer, the assumption that firms have the power to tax workers who leave is no longer necessary. Equation (3) assumes that the severance payment to workers who receive job offers might be negative.

Since γ_2, $c''(\lambda)$, and γ_1 are all positive and $\theta f^1(.) \geq B$, the optimal contract implies that $s_l(\theta) > s_q(\theta)$. The intuition behind this result is straightforward. Consider the optimal contract when workers are risk neutral. In this case, production efficiency results and workers are paid the value of their marginal productivity in every state of the world. Workers would earn $\theta f'(.)$ in all states of nature (B when $\theta < \theta_L$, and w' when $\theta > \theta_H$). The first-period wage would be chosen so that firms earn zero expected profits. With risk-averse workers, firms trade off the incentives of providing on-the-job search with insurance against wage changes. First-period wages would be reduced in order to smooth second-period earnings; that is, $s_l(\theta) > s_q(\theta)$. Otherwise, it would be preferable to keep the contract that resulted when workers were risk neutral, since it also provided the proper incentives for on-the-job search.

When the assumption that firms can observe which workers receive job offers is dropped, the above contract must be modified to make it incentive-compatible. The reason is that the severance payment offered to workers who find alternate employment is less than the one offered to workers who are laid off. The following incentive-compatibility constraint reflects the constraint necessary to prevent workers with outside offers from accepting these offers during bad states of nature:

$$(1-q(\theta))U(w_2) + q(\theta)U(w'+s_q(\theta)) >$$

$$l(\theta)U(w'+s_l(\theta)) + (1-l(\theta))U(w_2(\theta)).$$

The condition implies that firms first ask workers to reveal whether they received a job offer. To induce workers to tell the truth, the expected utility of a worker who admits to receiving a job offer must be greater than the expected utility of a worker who does not admit to receiving a job offer. In particular, when $l(\theta) = 0$, the above constraint is always satisfied. However, when $l(\theta)$ is near one (that is, when a large fraction of the labor force is being laid off), the above constraint is not satisfied. To make the above contract incentive-compatible, severance payments to quits and layoffs must be equal when $l(\theta) = 0$. This restriction implies that there will be involuntary unemployment during bad states of nature. The next section solves for the optimal contract when the firm cannot observe both a worker's search intensity or whether a worker receives a job offer.

IV. Involuntary Layoffs

Although the assumption that firms can hire additional labor in the second period is not necessary for the following results, it will be maintained in this section. Since firms cannot monitor which workers receive job offers, the optimal contract in the previous section may not be incentive-compatible. For the following contract it will be assumed that either $w_2 < w'$, or that the firm can restrict the mobility of job-finders by taxing them when they leave. The optimal contract with an additional incentive-compatibility constraint is to choose $\{w_1(\theta),\ w_2(\theta),\ s_q(\theta),\ s_l(\theta),\ q(\theta),\ l(\theta),\ \lambda,\ n(\theta)\}$

to maximize expected utility subject to the constraint of nonnegative profits, the incentive-compatibility constraints, and the restriction that employment be nonnegative:

$$\max_{\{w_1(\theta),\, w_2(\theta),\, s_q(\theta),\, s_l(\theta),\, q(\theta),\, l(\theta),\, \lambda,\, n(\theta)\}} EV(w_1,\, w_2(\theta),\, s_q(\theta),\, s_l(\theta),\, q(\theta),\, l(\theta),\, \lambda)$$

s.t.

$$E\Pi(w_1,\, w_2(\theta),\, s_q(\theta),\, s_l(\theta),\, q(\theta),\, l(\theta),\, \lambda,\, N) > 0$$

$$\int\{1-q(\theta))U(w_2(\theta) + q(\theta)U(w'+s_q(\theta))\}g(\theta)d\theta$$

$$- \int\{(1-l(\theta))U(w_2(\theta) + l(\theta)U(B+s_l(\theta))\}g(\theta)d\theta - c'(\lambda) = 0$$

$$(1-q(\theta))U(w_2(\theta)) + q(\theta)U(w'+s_q(\theta)) \geq$$

$$l(\theta)U(w'+s_l(\theta)) + (1-l(\theta))U(w_2(\theta))$$

$$n(\theta) \geq 0.$$

The first-order conditions can be characterized by the following equations:

$$(1) \quad U'(w_1) = \gamma_1$$

$$(2) \quad U'(w_2(\theta)) = \frac{\gamma_1[\lambda-q(\theta))+(1-\lambda)(1-l(\theta))]}{[(\lambda+\gamma_2)(1-q(\theta))+(1-\lambda-\gamma_2-\gamma_3(\theta))(1-l(\theta))]}$$

$$(3) \quad U'(w'+s_q(\theta)) = \frac{\lambda\gamma_1}{(\lambda+\gamma_2+\gamma_3)}$$

$$(4) \quad U'(B+s_l(\theta)) = \frac{\gamma_1(1-\lambda) + \gamma_3(\theta)U'(w'+s_l(\theta))}{(1-\lambda-\gamma_2)-\gamma_3(\theta)}$$

$$
(5)\quad q(\theta) = \begin{cases} 1 & \text{if} \quad W(\theta) \cdot \theta f'((1\text{-}A)\ [1-l(\theta)]N+n(\theta)) > 0 \\ q^*(\theta) & \text{where} \quad W(\theta) \cdot \theta f'([\lambda(1-q^*(\theta)+(1-\lambda)(1-l)]N+n(\theta)) = 0 \\ 0 & \text{if} \quad W(\theta) - \theta f'([1-(1-\lambda)l]N+n(\theta)) < 0 \end{cases}
$$

where

$$
W(\theta) = w' + \{U(w'+s_q) - U(w_2) - U'(w'+s_q)[(w'+s_q) - w_2]\}/U'(w'+s_q)
$$

$$
(6)\quad l(\theta) = \begin{cases} 1 & \text{if} \quad K(\theta) \cdot \theta f'(\lambda(1-q(\theta)+n(\theta)) < 0 \\ l^*(\theta) & \text{where} \quad K(\theta) - \theta f'([\lambda(1-q(\theta)+(1-\lambda)(1-l^*(\theta))]N+n(\theta)) = 0 \\ 0 & \text{if} \quad K(\theta) \cdot \theta f'((1-\lambda q(\theta))N+n(\theta)) < 0 \end{cases}
$$

where

$$
\begin{aligned} K(\theta) = B + \{1/U'(w_2)[U(B+s_l(\theta)) - U(w_2(\theta))] \\ - [B+s_l-w_2] + U'(w_2)[U(B+s_l) \cdot U(w'+s_l(\theta))]\} \end{aligned}
$$

$$
(7)\quad n(\theta) = \begin{cases} \infty & \text{if} \quad w' \cdot \theta f'(\infty) > 0 \\ n^*(\theta) & \text{where} \quad w' - \theta f'(\lambda(1-q(\theta)+(1-\lambda)(1-l(\theta))]N+n^*(\theta)) = 0 \\ 0 & \text{if} \quad w' - \theta f'(\lambda(1-q(\theta)+(1-\lambda)(1-l(\theta))]N) < 0 \end{cases}
$$

$$
(8)\quad \gamma_2 c''(\lambda) = \gamma_1 \int q\{w_2(\theta) - (\theta f'(.)+s_q(\theta))\}g(\theta)d\theta.
$$

From equations (5), (6), (7), and (8) we obtain:

$q(\theta) = 1$, $l(\theta) > 0$, $n(\theta) = 0$ when $\theta < \theta_L$

$q(\theta) = 1$, $l(\theta) = 0$, $n(\theta) = 0$ when $\theta_L < \theta < \theta_H$

$q(\theta) = 1$, $l(\theta) = 0$, $n(\theta) > 0$ when $\theta > \theta_H$

$$
(b1)\quad U'(w_2(\theta)) = \frac{\gamma_1(1-\lambda)}{(1-\lambda-\gamma_2-\gamma_3(\theta))}
$$

where $\theta_L f'([1-\lambda]N) = B$, $\theta_H f'([1-\lambda]N) = w'$.

The solution to this problem is identical to that given in the previous section except for the inclusion of the costate variable, $\gamma_3(\theta)$, which becomes binding in "bad enough" states of nature. It can be shown that when $\gamma_3(\theta) > 0$, the severance payment offered to departing workers increases, while the wage offered to job stayers and the severance payment to laid-off workers decreases. In addition, there will be fewer layoffs than in a Walrasian market or overemployment. This occurs when a large fraction of a given cohort of workers is being laid off. When productivity is high enough or, equivalently, when there are few layoffs, the incentive-compatibility constraint holds and $\gamma_3(\theta) = 0$. However, when productivity is low, $\gamma_3(\theta)$ must be greater than zero for the incentive-compatibility constraint to hold. Since $q(\theta) = 1$, when $\theta < \theta_L$ the incentive-compatibility constraint becomes

$$U(w'+s_q(\theta)) \geq l(\theta)U(w'+s_l(\theta)) + (1-l(\theta))U(w_2(\theta)).$$

In order for workers to engage in on-the-job search in the first period, we know that $w'+s_q(\theta) > w_2(\theta)$. Hence the above constraint fails when $l(\theta)$ is near one. Four margins of adjustment occur in order for the incentive-compatibility constraint to hold: First, from (6), since U(C) is concave $l(\theta)$ must decrease, that is, there is overemployment. Second, from (b) and (d), both $w_2(\theta)$ and $s_l(\theta)$ must decrease. Finally, from (3), $s_q(\theta)$ must increase. These adjustments occur when $\gamma_3(\theta)$ is positive. If $\gamma_3(\theta)$ were negative, the incentive-compatibility constraint would be violated.

Involuntary unemployment occurs when a large fraction of the firm's labor force is laid off. This condition seems particularly strong; however, it does not seem unreasonable if the condition is interpreted to be a plant closing.

The model predicts that severance payments to both quits and layoffs will be state-independent except during downturns. During severe downturns, the severance payment or bonus offered in the first phase of the labor-force adjustment will actually increase, so that workers who find jobs will truthfully reveal their job offers. In addition, during these downturns the severance payments to laid-off workers will decrease so that they are involuntarily laid off.

V. A Two-Sector Implicit Contracting Model

This section extends the analysis of the previous sections by explicitly modeling the second sector. Instead of assuming that job-finders receive a wage exogenously given to be w', workers who switch sectors enter a spot market and are paid their marginal productivity. It is shown that a two-sector implicit contracting model helps explain why quits are procyclical.

Each sector of the economy has many identical firms. Both sectors are identical in period one, but differ according to the technological shock affecting their sector in the second period. The first-period production function for sector A and sector B is given by $F(N_{1A})$ and $F(N_{1B})$, respectively. In the second period there is a shock to production, θ_A and θ_B, where θ' denotes the vector (θ_A, θ_B). The second-period production function for sector A firms is given by $\theta_A f(N_A)$, while the production function for sector B firms is given by $\theta_B f(N_{2B})$. It is assumed that θ_A and θ_B are independent and have the same density function, $g(\theta_A)$ and $g(\theta_B)$. At the beginning of period two, everyone can costlessly observe the state of nature θ'.

The economy is inhabited by 2N agents. Due to industry- or sector-specific human capital, which agents acquire by working in a sector during the first period, an agent cannot work in the other sector during the second period without additional training. For a worker in sector A [B] in the first period to be productive in sector B [A] in the second period, he must expend a cost $c(\lambda_A)$ [$c(\lambda_B)$]. However, training is not perfect; a worker who undergoes training may or may not learn the skills necessary to switch sectors. A first-period employee of sector A [B] is successful in his attempt to be productive in the other sector with probability λ_A [λ_B]. Workers must undertake this investment in period one before the realization of θ_A and θ_B.

A worker's skills are not left entirely to chance. A worker can increase the probability that he will be productive in the other sector by spending more on training in the first period. That is, the more a worker invests in learning the skills of the other firm (the higher is $c(\lambda_i)$ i=A,B), the greater the probability that he will become productive in the other sector (the larger is λ_i). The same restrictions as earlier are placed on $c(\lambda_i)$.

A worker who learns the skills necessary to work in the other sector may or may not receive a job offer to work in that sector. A worker in sector A [B] who is also productive in sector B [A] receives a job offer from that sector with probability $h_B(\theta')$ ($h_A(\theta')$), where $h_A(\theta')$ and $h_B(\theta')$ are chosen by firms A and B, respectively. Therefore, $\lambda_A h_B(\theta')$ is the probability that a worker in sector A will receive an offer to work in sector

B. However, as in the previous sections, only a fraction, $q_A(B')$, (chosen by firm A) of these workers will be hired by sector B.

A worker currently working in sector A who is hired by sector B receives a wage, $w'_B(\theta')$. Since this wage is determined in a spot market, second-period wages must equal the worker's marginal productivity, $w'_B(\theta') = \theta_B f'(N_{2B})$. competition for workers who change jobs ensures that this equality holds. In addition to a wage of $w'_B(\theta')$, firm A chooses a severance payment of $s_{qA}(\theta')$ to pay its departing workers.

Unlike the previous section, which tried to rationalize the existence of involuntary layoffs, this section is not concerned with whether a layoff is voluntary or involuntary. Thus, we will keep the assumption of section III by assuming that a firm can observe whether a previous employee starts work at another firm and thus can condition its severance payment on this realization. We also assume that firms can observe which sector an ex-employee works for and can condition its severance payment on this realization. Since all firms in a given sector are identical, firms do not give severance payments to workers wishing to work in the same sector. In fact, the contract may call for the firm to tax workers to prevent them from working at a different firm within the same sector. Because there is no benefit to working at a different firm within the same sector, the optimal contract does not allow for that possibility. These assumptions allow us to model the problem as if each sector were comprised of one representative firm.

The analysis assumes that firms do not have implicit contracts with the workers in the alternate sector. Otherwise, in period one, a firm in sector A would promise a second-period wage (conditional on θ') to workers in sector B who wish to switch sectors. Firms would do this in order to induce workers in the other sector to acquire the skills necessary for work in their sector.

However, by assuming that each sector consists of many identical firms, no one firm would have an incentive to make such a promise: it would not change the incentive for workers in the other sector to engage in on-the-job training.

Given these restrictions, second-period employment for a firm in sector A and a firm in sector B is given by the following equations:

$$N_{2A} = [(1-\lambda_A h_B)(1-l_A) + \lambda_A h_B(1-q_A)]N_{1A} + h_A \lambda_B q_B N_{1B}$$

$$N_{2B} = [(1-\lambda_B h_A)(1-l_B) + \lambda_B h_A(1-q_B)]N_{1B} + h_B \lambda_A q_A N_{1A}.$$

As in the previous sections, a worker signs a contract with his firm specifying the second-period wage, the severance payments, and separation probabilities contingent on the state of nature in the second period, θ', as well as on the first-period wage. Contracts are chosen in the first period to maximize the utility of the representative worker subject to a given level of profits and the incentive-compatibility constraint.

Firms are assumed to be Nash competitors; they assume that their choice of a contract has no effect on the contract offered by the other firms (the other sector). The optimal contract for firm A is then to choose

$\{w_{1A}$, $w_{2A}(\theta')$, $w'_A(\theta')$, $l_A(\theta')$, $q_A(\theta')$, $s_{lA}(\theta')$,

$s_{qA}(\theta')$, $h_A(\theta')$, $\lambda_A\}$ to maximize

$$U(w_{1A}) - c(\lambda_A) + \iint\{h_B(\theta')\lambda_A(1-q_A(\theta'))U(w_{2A}(\theta'))g(\theta_A)g(\theta_B)d\theta_A d\theta_B$$

$$+ \iint h_B(\theta')\lambda_A q_A(\theta')U(w'_B(\theta')+s_{qA}(\theta'))g(\theta_A)g(\theta_B)d\theta_A d\theta_B$$

$$+ \iint(1-h_B(\theta')\lambda_A)(1-l_A(\theta'))U(w_{2A}(\theta'))g(\theta_A)g(\theta_B)d\theta_A d\theta_B$$

$$+ \iint(1-h_B(\theta')\lambda_A)l_A(\theta')U(B+s_{1A}(\theta'))g(\theta_A)g(\theta_B)d\theta_A d\theta_B$$

s.t.

$$
\begin{aligned}
& f(N_1) - w_{1A}N_1 \\
& + \iint \{\theta_A f([h_B(\theta')\lambda_A(1-q_A(\theta'))+(1-h_B(\theta')\lambda_A)(1-l_A(\theta'))]N_1 + \\
& \qquad h_A(\theta')\lambda_B q_B N_B)\} g(\theta_A)g(\theta_B)d\theta_A d\theta_B \\
& - \iint \{[(1-q_A(\theta'))h_B(\theta')\lambda_A + \\
& \qquad (1-h_B(\theta')\lambda_A)(1-l_A(\theta'))]w_{2A}(\theta')N_1\} g(\theta_A)g(\theta_B)d\theta_A d\theta_B \\
& - \iint \{h_B(\theta')\lambda_A q_A(\theta')s_{qA}(\theta')N_1 - \\
& \qquad (1-h_B(\theta')\lambda_A)l_A(\theta')s_{1A}(\theta')N_1\} g(\theta_A)g(\theta_B)d\theta_A d\theta_B \\
& - \iint h_A\lambda_B q_B N_B w'_A(\theta')g(\theta_A)g(\theta_B)d\theta_A d\theta_B \geq 0
\end{aligned}
$$

s.t.

$$
\begin{aligned}
& \iint h_B(\theta')(1-q_A(\theta'))U(w_{2A}(\theta'))g(\theta_A)g(\theta_B)d\theta_A d\theta_B \\
& + \iint h_B(\theta')q_A(\theta')U(w'_A(\theta')+s_{qA}(\theta'))g(\theta_A)g(\theta_B)d\theta_A d\theta_B \\
& - \iint h_B(\theta')(1-l_A(\theta'))U(w_{2A}(\theta'))g(\theta_A)g(\theta_B)d\theta_A d\theta_B \\
& + h_B\theta')l_A(\theta')U(B+s_{1A}(\theta'))g(\theta_A)g(\theta_B)d\theta_A d\theta_B - c'(\lambda_A)=0.
\end{aligned}
$$

The first-order conditions can be characterized by the following equations

(1) $U'(w_{1A}) = \gamma_{1A}$

(2) $$U'(w_{2A}(\theta')) = \frac{\gamma_{1A}[h_B\lambda_A(1-q_A(\theta'))+(1-h_B\lambda_A)(1-l_A(\theta'))]}{[(\lambda_A+\gamma_{2A})h_B(1-q_A(\theta'))+(1-h_B(\lambda_A+\gamma_{2A}))(1-l_A(\theta'))]}$$

(3) $$U'(w'(\theta')+s_q(\theta')) = \frac{\lambda_A\gamma_{1A}}{\lambda_A+\gamma_{2A})}$$

(4) $$U'(B+s_{1A}(\theta')) = \frac{\gamma_{1A}(1-h_B\lambda_A)}{(1-h_B(\lambda_A+\gamma_{2A}))}$$

(5a) $$q(\theta') = \begin{cases} 1 & \text{if } W(\theta') - \theta f'(N_{2A}) > 0 \\ q^*(\theta') & \text{if } W(\theta') - \theta f'\blacksquare \quad = 0 \\ 0 & \text{if } W(\theta') - \theta f'(N_{2A}) < 0 \end{cases}$$

where

$$W(\theta') = w'_B + \{U(w'_B+s_q) - U(w_{2A}) - U'(w'_B+s_{qA})[(w'_B+s_{qA}) - w_{2A}]\}/U'(w'_B+s_{qA})$$

$$(5b)\quad l(\theta') = \begin{cases} 1 & \text{if } B - \theta f'(N_{2A}) > 0 \\ l^*(\theta') & \text{if } B - \theta f'(N_{2A}) = 0 \\ 0 & \text{if } B - \theta f'(N_{2A}) < 0 \end{cases}$$

$$(6)\quad h_A\{f'(.) - w_A'(\theta')\} = 0$$

$$(7)\quad \gamma_{2A}c''(\lambda_A) = \gamma_{1A}\int h_B q_A(\theta')\{w_{2A}(\theta')-(\theta f'(N_{2A})+s_{qA}(\theta'))\}g(\theta_A)g(\theta_B)d\theta_A d\theta_B.$$

Since sector B is identical, the following consistency conditions must also hold (all variables are taken to solve the preceding first-order conditions):

$$l_A(\theta_A,\theta_B) = l_B(\theta_B,\theta_A),\ q_A(\theta_A,\theta_B) = q_B(\theta_B,\theta_A)$$

$$h_A(\theta_A,\theta_B) = h_B(\theta_B,\theta_A),\ w_{2A}(\theta_A,\theta_B) = w_{2B}(\theta_B,\theta_A)$$

$$s_{1A}(\theta_A,\theta_B) = s_{1B}(\theta_B,\theta_A),\ s_{qA}(\theta_A,\theta_B) = s_{qB}(\theta_B,\theta_A)$$

$$w_{1A} = w_{1B},\ \lambda_A = \lambda_B,\ h_B\{\theta f'(N_{2B}) - w'(\theta')\} = 0.$$

The following equations summarize the dynamics of the system. Because of the above consistency conditions, we denote i, j = (A, B) where i = j.

$0 < l_i(\theta') < 1,\ q_i(\theta') = 1,\ h_i(\theta') = 0$ when $\theta_i \le \theta_L(\theta_j)$

$l_i(\theta') = 0,\ q_i(\theta') = 1,\ 0 < h_i(\theta') < 1$ when $\theta_L(\theta_j) < \theta_i \le \theta_M(\theta_j)$

$l_i(\theta') = 0,\ q_i(\theta') = 1,\ h_i(\theta') = 1$ when $\theta_M(\theta_j) < \theta_i \le \theta_H(\theta_j)$

$l_i(\theta') = 0,\ 0 < q_i(\theta') < 1,\ h_i(\theta') = 1$ when $\theta_i > \theta_H(\theta_j)$

$\theta_L(\theta_j)$, $\theta_M(\theta_j)$, $\theta_H(\theta_j)$ are determined as follows:

$\theta_L(\theta_j)$ solves $\theta_L(\theta_j)f'([1-\lambda h_j(\theta_j,\theta_L)]N_{1j}) = B$

where

$$h(\theta_j,\theta_L) = \begin{cases} 0 & \text{if } \theta_j f'(N_1) - B < 0 \\ \text{indeterminate} & \text{if } \theta_j = \theta_L \\ 1 & \text{if } \theta_j f'([1+\lambda]N_1) - B > 0. \end{cases}$$

$\theta_M(\theta_j)$ solves $\theta_M(\theta_j)f'([1+\lambda[q(\theta_j,\theta_M)-h(\theta_j,\theta_M])N^1) = B$

where

$q(\theta_j,\theta_M) = 1,\ h(\theta_j,\theta_M) = 0$ if $\theta_j f'([1-\lambda)(1-1(\theta_j,\theta_L))]N_1) = B$
for some $0 < 1(\theta_j,\theta_M) < 1$

$q(\theta_j,\theta_M) = 1,\ h(\theta_j,\theta_M) = 1$ if $\theta_j f'(N_1) \leq W(\theta_A,\theta_B)$

$h(\theta_j,\theta_M) = 1,\ 0 < q(\theta_j,\theta_M) < 1$ if $\theta_j f'([1+\lambda(1-q(\theta_j,\theta))]N_1) = W(\theta_A,\theta_B)$
for some $0 < q(\theta_j,\theta_M) < 1$

$q(\theta_j,\theta_M) = 0,\ h(\theta_j,\theta_M) = 1$ if $\theta_j f'([1+\lambda]N_1) > W(\theta_A,\theta_B)$

where

$$W(\theta_A,\theta_B) = w'_B + \{U(w'_B+s_{qA}) - U(w_{2A}) - U'(w'_B+s_{qA})[(w'_B+s_{qA}) - w_{2A}]\}/U'(w'_B+s_{qA})$$

and

$$U'(w_{2i}) = \frac{\gamma_{1i}(1-\lambda)}{(1-(\lambda_i+\gamma_{2i}))}.$$

$\theta_H(\theta_j)$ solves $\theta_H(\theta_j)f'([1+\lambda(1-h(\theta_j,\theta_H))]N_1) = W(\theta_A,\theta_B)$

where $h(\theta_j,\theta_H) = h(\theta_j,\theta_M)$.

The above conditions imply that the following hold:

(2a) $$U'(w_{2i}(\theta')) = \frac{\gamma_{1i}(1-h_j\lambda_i)}{(1-h_j(\lambda_i+\gamma_{2i}))} \text{ for } \theta_i \leq \theta_H(\theta')$$

(2b) $$U'(w_{2i}(\theta')) = \frac{\gamma_{1i}(1-h_j\lambda_i q_i(\theta'))}{(1-h_j(\lambda_i+\gamma_{2i}))} \text{ for } \theta_i > \theta_H(\theta').$$

The model predicts that quits can occur in equilibrium even when the productivity shocks in the two industries are identical. This contrasts with a Walrasian model where the number of quits depends on the dispersion of the productivity shocks across sectors. The model also predicts that quits will generally be procyclical. For example, if $\theta_i = \theta_j$ and if demand is low in both sectors, no quits occur, because neither industry is willing to hire workers from the other industry. As productivity in both industries gets progressively better, quits increase discontinuously from 0 to 2X. That is, quits increase until everyone who is productive in the other sector switches sectors. This discontinuity results from the assumption that the shocks to the two sectors are identical, $\theta_i = \theta_j$. As soon as industry A and industry B find it profitable to hire a worker from the other industry, each will then find it profitable to hire one more worker to replace the worker who shifted sectors. This process continues until h = 1.

When the shock increases in only one sector, this discontinuity does not occur. When the sector with the good technological shock finds it profitable to hire a worker from the other sector, the low-shock sector will respond by laying off one fewer worker. Thus, the model also predicts that there should be more layoffs within each industry (or that layoffs will occur sooner) if both θ_i and θ_j are low rather than if there is a downturn that is confined to only one sector.

While the model in general predicts that quits should be procyclical, quits may start decreasing when productivity increases in only one of the sectors. This occurs when demand is unusually high in only one of the sectors, so that the sector will find it profitable to retain workers instead of letting them quit, $q < 1$. The model has a bias toward quits because of the need to promote on-the-job training. However, when the technology shock to a particular industry is very high, this bias is not as important as the need to retain workers. When productivity increases in both sectors, this turning point does not occur, because the incentive to let workers quit is greater, the more the other sector pays to newly hired workers.

Wages respond as follows: second-period wages for those who stay with their original firm depend on the state of nature in both sectors. From (2a) and (2b), wages either decrease or remain constant when the other sector becomes more productive, and wages increase (or remain constant) with increases in the productivity affecting their own sector.

These wage changes result from the need to promote on-the-job training. The more people who switch sectors, the greater the effect (ex ante) of a high wage differential between those who switch sectors and those who stay. Thus, the higher the shock affecting sector B, the lower the wage that will be paid in sector A to job stayers. Similarly, when the technological shock to industry A is very high, fewer workers will switch sectors and, thus, higher wages will be paid to job stayers.

Severance payments to quits increase with the wage paid by the other sector, so that the wage plus severance payment is constant over all states of nature. This implies that if one wanted to generate involuntary layoffs in this two-sector model, the productivity shock would have to be very low in one of the sectors and quite low in the other sector. This corresponds to job finders receiving a very low severance payment and a large chance that they would be laid off with a larger severance payment if they did not admit to receiving a job offer.

This analysis suggests that one way to generate involuntary layoffs is for job finders to want to pretend that they did not receive a job offer in order to collect the severance payment to laid-off workers. That is, involuntary unemployment can be explained by understanding why severance payment to quits is low. This might occur if the informational restrictions of this section were loosened. For example, it has been assumed that an employer could observe whether or not a worker quit to accept a job in the same sector. If employers could not observe whether this occurred, then severance payments would have to be restrained to prevent workers from switching jobs within the same sector.

VI. Conclusions

This paper builds a two-sector implicit contracting model in order to investigate the conditions under which involuntary unemployment can result and to help understand why quits are procyclical. The results are encouraging: under certain conditions quits can be procyclical and layoffs can be countercyclical, and some layoffs may be involuntary. To achieve this result, the conditions were that firms cannot observe a worker's search/training intensity and that firms cannot monitor which workers receive job offers. Involuntary unemployment results in order to induce workers to reveal successful search efforts.

The paper also shows that firms will have a two-tier procedure for adjusting their labor force to current economic conditions. In the first round, workers with outside offers leave the firm; in the second round, the firm adjusts its labor force by either laying off additional workers or hiring new workers. The model implies that workers will leave firms in sector A for firms in sector B, and at the same time, firms in sector A will hire additional workers from sector B. This occurs because firms have to offer contracts in order to give workers incentives to engage in on-the-job search/training. This implies that firms subsidize workers when they leave, and they let workers leave more often than would happen in a Walrasian market.

One frequent criticism of the above analysis is the implication that firms are subsidizing workers to engage in more on-the-job search/training. Ex ante contracts will be chosen so that workers will find it optimal to engage in such search activity; however, ex post, it would not be surprising to think that firms are in some sense antagonistic to such activity. Firms will, of course, wish that none of their workers are successful in their job search. Similarly, another way of thinking about the problem is that firms sign contracts that reduce worker mobility in order to partially insure workers against income changes.

This paper shows why complete insurance to laid-off workers would not be optimal, given the incentive-compatibility constraints. Additional empirical work is necessary to answer the question of whether the amount of severance payments predicted by models such as this occurs in the world. State-mandated unemployment benefits are one reason that the amount of severance payments offered by firms might not be that extensive. Theory suggests that the two are substitutes; thus, increases in state-provided unemployment insurance should decrease private severance-payment programs. Future empirical work can be conducted to see if privately financed unemployment benefits decrease with increases in state-provided unemployment insurance.

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