Labor Market Informational Externalities and Strategic Complementarities among Firms and Workers

Hori, Nobuaki
Department of Economic Engineering, Faculty of Economics, Kyushu University : Associate Professor

https://doi.org/10.15017/10615

出版情報：經濟學研究. 73 (5/6), pp.47-56, 2007-05-31. 九州大学経済学会

Labor Market Informational Externalities and Strategic Complementarities among Firms and Workers

Nobuaki Hori*
Kyushu University
6-19-1 Hakozaki, Higashiku, Fukuoka 812-8581, Japan

April 27, 2007

Abstract

A model of the adverse selection in the second hand labor market is presented. In contrast to the previous literature, we consider the case where the firms are short side and all expected match surplus is taken by the firms. Since the expected level of competence in the second hand market is lower than that of original workers, the firms have an incentive to keep their original workers. For this purpose, the firms may offer them a high wage in advance to prevent them from quitting. However, since the low average quitting rate of the economy results in the low expected competence in the second hand market, it makes the firms' incentive higher to keep the workers inside the firms. These strategic complementarities among the firms may lead to the multiple equilibria of labor market. In contrast to the previous literature, the equilibrium with a low turn over rates allows the higher wages for the original workers inside firms.

1 Introduction

The Japanese labor market is characterized by its lower turn over rates of workers than other developed economies, especially the U.S. Some literature have tried to explain this difference without relying on the difference of technologies and tastes. Previous literature have used an adverse selection mechanism in the labor market in order to generate multiple equilibria,

*e-mail: hori@en.kyushu-u.ac.jp

where an equilibrium corresponds to the Japanese labor market and the other one to the U.S.[1]

In the Japanese equilibrium, workers' endogenously determined outside option wage is so low that most of workers hesitate to quit voluntarily and stay with their original firms. It should be noted that the strategic complementarities among the workers is associated with this mechanism. However, if the wage paid to the remainders is determined by the bargaining between the worker and the firm, the low outside option value for the Japanese workers will make their position weak inside the original firm and they have to also accept lower inside wages. This is a paradox because it is well known that the wages paid to the original workers by the Japanese firms is very high. And we have to introduce some other devices to solve this paradox. The purpose of this short article is to present a simple model to solve this paradox. The key to solve the paradox is the assumption about the secondary labor market.

The remaining of the article are as follows. The next section presents a simple and general labor market model and the section 3 will derive the equilibrium conditions of the model. In the section 4, the initial paradox is solved as a special case of the equilibrium and the final section 5 concludes the argument of this article.

2 Model

In the economy, there are two types of workers. We call one type the competent and the other the incompetents. At the beginning, all workers are employed in firms. We consider one worker to one firm match. The structure regarding to the technology and taste of this model is as follows.

2.1 Competence and disutilities

First the competence of each worker is determined. The workers' difference in competence can be the reflection of various possible components. In this paper, however, we will not pay so much attentions to the process how each individual competence has been determined and simply assume that the competent workers contribute the firm's outputs more than the incompetents. The fraction of the competent is π and the incompetents is $1-\pi$.

[1] See Abe (1994) and Chang and Wang (1995). Acemoglu and Pishcke (1998) aimed at the difference between the U.S. and Germany. But they assume that the firms offer fixed wage in advance.

The workers' competence is general in the sense that the level of a worker's contribution to the output never change even when the worker leaves the original firm and works for another one. For simplicity we assume that with a competent worker, a firm can produce y of outputs and with an incompetent, nothing (0). Therefore the firms have an incentive to exchange the incompetent worker for the competent one. On the other hand, competent or incompetent, workers may have an incentive to leave their original firms due to their individual reasons. In order to capture this idea, we assume that with probability λ, each worker receives a disutility shock θ. If the worker stays with his original firm, he suffers disutility θ and we assume that he can be free from this disutility if he quits and works for a new firm. That is, the disutility is firm specific. We assume that the disutility θ of each worker is a private information. The firm can not observe the disutility shock of its original worker. Moreover we assume that the disutility shock θ follows a distribution function $G(\theta)$ and this is common knowledge and independent of the difference in competence. Firms also have an incentive to retain their original workers due to the reason associated with the second hand labor market explained later.

2.2 Sequence of events

At the beginning, each firm offers a fixed wage w to its original worker. Note that this fixed wage will be actually paid only when the original worker stayed with the firm. If the original worker left, he must find a new job in the second hand labor market and the firm also find a new worker from the labor market. How the outputs are distributed between the new firm and the new worker is explained later in detail. Note that firms are able to commit the future wage only against the incumbent workers and at this point firms can not distinguish the competent worker from the incompetent (only knowing that the worker is competent with the probability π) and observe the disutility θ of the original worker if the shock takes place. Thus if a worker stayed with his original firm he will enjoy a same fixed wage whether he is competent or not.

Given the offered wage by the original firm, each worker decides whether to quit or not comparing the welfare associated with the two options. In an equilibrium, each worker will rationally expect the gain from quitting the original firms. We denote the probability that an original worker quits by q. It is naturally conjectured that q increases in the outside welfare and decreases in the wage offered by the original firm.

After the quitting decision by the original workers, the chance comes to the firm that the incompetent worker could be laid off. Regarding this we can suppose various reasonings. We assume, however, that the those incompetent who have decided to stay could be laid off by their original employer with the probability of μ. μ is considered as the function of various variables which reflect technical and institutional constraints imposed on firm's behaviors. For example, μ will be higher when the firm can more easily find out the incompetent or the labor market practice is flexible and not so severe to firms. It should be noted that this layoff process is crucial to the existences of the multiple equilibria derived from the adverse selection of labor market.

Those workers who have voluntary quitt and been laid off will enter the second hand labor market and find a new job. On the other hand, the firms which have a vacant position will search for a new worker in the second hand labor market. Assuming that the numbers of workers and the firms are equal, we can ensure that all participants of the second hand labor market be able to match to a counter agent. At this point, we assume that firms can not distinguish the types of workers.

Regarding to how the participants of the second hand labor market divide the outputs, we assume the simple Nash bargaining process. In this model, a firm's unique choice variable is the second period wage offered to the original worker. And a worker's unique choice is whether to quit or not. In the following sections we will investigate each stage and agents' behavior in more detail.

3 Symmetric equilibrium

3.1 Quit decision

Workers decide to quit or not, taking the wage offered by firms as given. Therefore we start with the investigation of the worker's quit decision. Let v denote the outside wage obtained in the second hand market. Then workers will quit the original firm when the outside option v is more attractive than staying,

$$v > w - \theta. \tag{1}$$

Using the distribution function of disutility shocks, we obtain the following quit rate function,

$$q(w, v) = \lambda \left(1 - G(w - v)\right). \tag{2}$$

We can easily confirm the next relations.

$$\frac{\partial q(w,v)}{\partial w} = \left(-\frac{\partial q(w,v)}{\partial v}\right) \leq 0. \tag{3}$$

3.2 Second period labor market

Next we show how the wages are determined in the second hand labor market. After the matching, the firm and the worker bargain over the expected surplus from the match. Even at this point we assume that the firms can not find which type of worker they are facing. Therefore after the match, both the competent and incompetent workers obtain the same wage.

Given the average quit rates $\bar{q}$, applying Bayes' rule, we can formulate the ratio of the competent in the second hand labor market as follows;

$$\sigma = \frac{q\pi}{q + (1-q)\mu(1-\pi)} \tag{4}$$

Regarding this, some features are to be noted:

$$\frac{\partial \sigma}{\partial q} = \frac{\mu\pi(1-\pi)}{\{q(w,v) + (1-q(w,v))\mu(1-\pi)\}^2} > 0 \tag{5}$$

and

$$\frac{\partial^2 \sigma}{\partial q^2} < 0. \tag{6}$$

We assume that the worker will take the fraction δ of the expected outputs and the firm $1-\delta$. therefore

$$v = \delta\sigma y, \tag{7}$$

$$s = (1-\delta)\delta\sigma y, \tag{8}$$

It is naturally derived that

$$\frac{\partial v}{\partial q} > 0, \ \frac{\partial^2 v}{\partial q^2} < 0, \tag{9}$$

and

$$\frac{\partial s}{\partial q} > 0, \ \frac{\partial^2 s}{\partial q^2} < 0. \tag{10}$$

In the following analysis, we constraint our attention to the symmetric equilibrium. Then given an uniquely prevailing wage for the original workers

$\bar{w}$, endogenous variables, q, σ, v, s are defined as the functions of $\bar{w}$ which satisfy the following relations.

$$q(\bar{w}) = \lambda \{1 - G(\bar{w} - v(\bar{w}))\}, \tag{11}$$

$$\sigma_h(q(\bar{w})) = \frac{q(\bar{w})\pi}{q(\bar{w}) + (1 - q(\bar{w}))\mu(1-\pi)}, \tag{12}$$

$$v(\bar{w}) = \delta y \sigma(q(\bar{w})), \tag{13}$$

$$s(\bar{w}) = (1-\delta) y \sigma(q(\bar{w})). \tag{14}$$

3.3 Wage setting

Finally we describe the firm's maximization problem. This can be written as

$$\begin{aligned} & \max_{w} \Pi \\ = \; & \{1 - [1 - q(w, v(\bar{w}))] [1 - \mu(1-\pi)]\} s(\bar{w}) \\ & + [1 - q(w, v(\bar{w}))] [1 - \mu(1-\pi)] \left(\frac{\pi y}{1 - \mu(1-\pi)} - w \right), \end{aligned} \tag{15}$$

The first term means that with the probability

$$1 - [1 - q(w, v(\bar{w}))] [1 - \mu(1-\pi)],$$

the firms employ the second period workers from the outside labor market and their expected productivity is $s(\bar{w})$. $[1 - q(w, v(\bar{w}))] [1 - \mu(1-\pi)]$ of the second term is the probability that the original worker remains in the firm. In this case the firm must pay the workers the wage fixed in advance of w, whether the worker is a high type or not. $\pi / [1 - \mu(1-\pi)]$ is the probability that those workers who finally stayed is a high type. Therefore $\pi y / [1 - \mu(1-\pi)]$ is the expected productivity of the original worker on condition that the worker finally stayed in the original firms. The wage set in advance affects the expected profit of a firm through the two effects. The first is the change in the quit rates of the original workers $q(w, v(\bar{w}))$, and the second is the net gain from the left workers.

The marginal benefits from raising wage are given by

$$\left(- \frac{\partial q(w, v(\bar{w}))}{\partial w} \right) \left(\frac{\pi y}{1 - \mu(1-\pi)} - w - s(\bar{w}) \right). \tag{16}$$

$\partial q(w, v(\bar{w}))/\partial w$ is negative when $w \leq \theta_{\max}$ and 0 when $w > \theta_{\max}$. That is, it is no use for the firms to raise the wage over the upper bound of disutility. The marginal costs from raising wage are

$$(1 - q(w, v(\bar{w})))\,[1 - q(w, v(\bar{w}))]\,. \tag{17}$$

$q(w, v(\bar{w}))$ is (weakly) decreasing in w, therefore we can easily find the increasing marginal cost.

In the inner solution case, we have the following first order conditions,

$$\begin{aligned} &\left(-\frac{\partial q(w, v(\bar{w}))}{\partial w}\right)\left(\frac{\pi y}{1 - \mu(1-\pi)} - w - s(\bar{w})\right) \\ = \;& (1 - q(w, v(\bar{w})))\,\{1 - \mu(1-\pi)\} \end{aligned} \tag{18}$$

Note that In the symmetric equilibrium, the optimal wage w^* for each firm must be equal to $\bar{w}$. Considering the above arguments, we could define the symmetric equilibrium of this economy by the following proposition.

Proposition 1 *Symmetric equilibrium $\{w^*, q^*, s^*, v^*\}$ is defined as the solutions of the following system.*

$$\begin{aligned} w^* &= \arg\max_{w} \Pi \\ &= \{1 - [1 - q(w, v^*)]\,[1 - \mu(1-\pi)]\}s^* \\ &\quad + [1 - q(w, v^*)]\,[1 - \mu(1-\pi)]\left(\frac{\pi y}{1 - \mu(1-\pi)} - w\right) \\ s.t.\; w &\geq 0 \end{aligned}$$

$$q^* = \lambda\,(1 - G(w^* - v^*))$$

$$v^* = \frac{\delta q^* \pi y}{q^* + (1 - q^*)\mu(1-\pi)}$$

$$s^* = \frac{(1-\delta) q^* \pi y}{q^* + (1 - q^*)\mu(1-\pi)}$$

In the analysis of the following sections, we assume that G is uniform distribution with support $[-1/2k, 1/2k]$ and k is sufficiently small. Therefore

$$G(\theta) = \frac{1}{2} + k\theta. \tag{19}$$

Then quitting rates $q(w, v)$ is described as

$$q(w, v) = \lambda\left[\frac{1}{2} - k(w - v)\right]. \tag{20}$$

4 Firm regime (the case of $\delta = 0$)

Hereafter, we consider the case of $\delta = 0$. This means that the firm side has full power on the bargaining. In terms of the market, this is equivalent to assuming that the firms (demand side) are short side in the labor market. And we will show that the initial paradox is clearly solved by considering this special case[2].

In this case, after the quitting, workers could not gain over the outside option, 0 and all the surplus from the secondary match comes to the firms.

$$v^*_{\delta=0} = 0, \tag{21}$$

$$s^*_{\delta=0} = y\sigma(q(\bar{w})). \tag{22}$$

Workers will stay in their original firms as long as they could have positive gains from doing so;

$$w - \theta \geq 0. \tag{23}$$

Therefore if a symmetric uniform second period wages $\bar{w}$ for the original workers prevail in the economy, the quitting rates is described as following,

$$\bar{q}(\bar{w}) = \lambda\left(\frac{1}{2} - k\bar{w}\right). \tag{24}$$

In this case, the firm's maximization problem becomes

$$\begin{aligned} & \max_{w} \Pi \\ = \;& \{1 - [1 - q(w,0)]\,[1 - \mu(1-\pi)]\}s^*_{\delta=0} \\ & + [1 - q(w,0)]\,[1 - \mu(1-\pi)]\left(\frac{\pi y}{1 - \mu(1-\pi)} - w\right) \\ s.t.\; w \;\geq\; & 0 \end{aligned}$$

The quitting rate of a worker is not influenced by the other workers' quitting decisions.

Marginal benefits from increasing in w are

$$\left(-\frac{\partial q(w,0)}{\partial w}\right)[1 - (1-\pi)\mu]\left(\frac{\pi y}{1 - \mu(1-\pi)} - w - s^*_{\delta=0}\right).$$

In this points, note that

$$\frac{\partial q(w,0)}{\partial w} = \begin{array}{ll} -\lambda k & \text{when } w < 1/2k \\ 0 & \text{when } w \geq 1/2k \end{array}$$

[2] We can consider that existing literature implicitly assumes $\delta = 1$.

The first order condition for the case of inner solution is given by

$$\left(-\frac{\partial q(w^*,0)}{\partial w}\right)\left(\frac{\pi y}{1-\mu(1-\pi)}-w^*-s^*_{\delta=0}\right)=1-q(w^*,0). \qquad (25)$$

The LHS of the equation represents the marginal benefits of raising wage for the original worker. From the assumption for the quitting rates, we can find that $-\partial q(w,0)/\partial w=\lambda k$, therefore the LHS is decreasing in w. On the other hand, the RHS, the marginal cost of raising wage is increasing in w. Therefore we can find that the above equation has a unique solution. And as to the influence by the change in the outside uniform wage, $\bar{w}$, we have the following results.

Proposition 2 *w^* is (weakly) increasing in $\bar{w}$.*

Proof. The increase in $\bar{w}$ does not change the RHS of (25), however, it raises the LHS of (25), since

$$\frac{\partial s(\bar{q})}{\partial \bar{q}}\frac{\partial \bar{q}(w)}{\partial \bar{w}}>0.$$

The increase in the marginal benefit of raising w results in the increase in the optimal level of w for each individual firm. ■

From this proposition, we can find that the firms are in the position of the strategic complements as to the choice of the wage for the original workers. The higher should the other firms set the wage for the original workers, the higher the optimal wage for each ones. In the case of the strategic complements, there may be multiple symmetric equilibria. One equilibrium is characterized by the low wage for original workers and high turnover rates and the other is the high wage and low turnover.

5 Conclusion

The goal of this short monograph is to present a simple labor market model which can explain the coexistence of the "high wage and low turnover" and "low wage and high turnover" economies. Apart from the existing literature, considering the case that firms are short side of the secondary labor market, we could find that such a difference is generated as multiple equilibria of a unified labor market model. The next problem to consider is whether the case assumed by this article is plausible in the real labor market. For this purpose, more general macroeconomic model, which explicitly contain the job creation and destruction process, will be needed.

References

[1] Acemoglu, D. and J.-S. Pischke (1998) "Why Do Firms Train? Theory And Evidence," *The Quarterly Journal of Economics*, Vol.113, pp78-118.

[2] Abe, Y. (1994) "Specific Capital, Adverse Selection, and Turnover: A Comparison of the United States and Japan," *Journal of the Japanese and International Economies*, Vol.8(3), pp272-292.

[3] Chang, C. and Y. Wang (1995) "A framework for understanding differences in labor turnover and human capital investment," *Journal of Economic Behavior & Organization*, Vol.28(1), pp91-105.

(Associate Professor, Fuculty of Economics, Kyushu University)