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Backward- bending of Labor Supply Function and Free Riders

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Abstract

It seems like that backward- bending of labor supply function can be observed in Central Asian Countries such as Uzbekistan and Kazakhstan. People's basic needs of life are satisfied and they do not increase labor supplies even if wage increases. It is possible to find some cases in which slowdowns increase, when a manager in a firm enforces penalties for workers have slowdowns. This phenomenon occurs because a worker prefers the position of equilibrium on the labor supply function always in the upper direction. This article explains the increase of free-riders by penalties and how to avoid them.

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I Introduction

Mikhail Gorbachev, the secretary-general of the former Soviet Union, started to conduct policies of Perestroika, Glasnost, and The New Thinking Diplomacy in 1989. These sequential policies brought the disassembling of the former Soviet-Union, as a result. In East European Countries and Central Asian Countries, the process of liberalization and transformation was begun to implement, from the Socialism to Capitalism.

Since then, about 20 years passed, then, it is possible to categorize post-socialist countries into two groups. One is the group which is composed of East European countries, such as Poland, Hungary, and Czech; another is the group which is composed of central Asian countries, such as Kazakhstan, Uzbekistan, and Kyrgyz. The former already has become a member of EU and maintains the steady economic growth driven by the direct investment from abroad. The latter still remains stagnant economic condition.

In the beginning of the liberalization, economists have argued several points about transitional economies. For instance, their utility functions may have been distorted through the socialist regime. This phenomenon has meant that they have a possibility to have problems peculiar to post-socialism countries, such as backward- bending of labor supply function. Then, they may have some restrictions for economic growth such as the high propensity to consume. However, East European countries have succeeded to keep steady economic growth rates lead by foreign direct investment and privatization of public

enterprises. They have restored the production several years after the beginning of liberalization. They maintain growth mechanism with keeping high propensity to consume.

On the contrary, in Central Asian countries, inflow of direct investment has not showed increase. Then, these economies remain stagnant. Their privatization has been slow in implementation or implemented only nominally in many cases. Proper problems in post-socialist countries such as backward- bending of labor supply function can be found. As a rule, it is not possible to find bright prospect for these economies. However, of course, oil producing countries such as Kazakhstan has started to record high economic growth rates lead by inflow of foreign direct investment.

Under the socialist regime, full employment has been guaranteed. Then, it has shortage of mechanism to adjust wage flexibly to labor productivity. At the same time, if workers earn large income, it has been difficult to gain corresponding utility because they have had problems in quality and variety in consumption goods. In Central Asia, workers have been satisfied with the minimum standard level of living which guarantees the basic needs of them such as food, clothing, shelter and education. Through the socialist regime, this point of view about labor and utility has been built.

In the reality, it is possible to find the custom, so called 'Gobonzil' in Kazakhstan or Uzbekistan[1]. Lee[2002] studied this field. Farmers in this area do not cultivate 100% of their arable lands. They cultivate substantial parts of their arable lands and lease the rest to sharecroppers. Sharecroppers are Koreans who immigrated before the World War II. Then, they are different with Kazakhstan or Uzbekistan people in the point of view about labor and utility. In this area, people have obtained a possibility of rich life after the

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liberalization; however, still, this custom is popular. They abandon the chance of income earning and prefer time to increase of income. On the background of this behavior, it is possible to assume backward- bending of labor supply function. Workers who have this type of labor supply function decrease labor-supply when labor demand curve shift upward or wage increase. Then, it becomes easier for them to have slowdown of working with given working-hour.

Hanoch[1965] presented firstly, the idea of backward-bending of labor supply function. Usually, it is said that leisure should be an inferior good at low level of income and a normal good at higher income when the supply of labor have a shape of backward-bending. A different view of the same phenomenon is that the income elasticity of leisure should increase with an increase of income for the supply of labor to change direction. He showed these views are false and provided an example of an ordinal utility function which is homothetic, that is, it is characterized by unitary income elasticity of both leisure and earnings everywhere; nevertheless, it gives rise to a backward-bending supply of labor. As an application of his idea, he analyzed the relationship of the interest rate and supply of savings.

Link and Settle[1981] explained the example of shortage of registered nurse. The usual idea is to increase the flow of services from the stock of registered nurses by increasing the wage. The effectiveness of this idea depends on the shape of the labor supply function of the nurses. If it is the backward-bending, the effectiveness will disappear.

Shapiro and Stiglitz[1984] showed the idea of allowing workers a choice of hours and effort. Dickinson[1999] yielded backward-bending hour supply curve, where workers are paid based on their effort. This result is supported by his laboratory experiments.

Lin[2003] presented an explanation of the backward-bending labor supply curve that is not based on the assumption that the income effect dominates the substitution effect. The classical labor supply theory treats working hours and work effort as being similar. However, he treats them as different variables in an efficiency wage model. A wage rate increase is shown to give rise to two direct substitution effects that motivate the worker to provide effort and hours. When a greater effort exerts a cross substitution effect that reduces hours, the hour supply curve has backward-bending without an income effect.

This brief history of the field of backward-bending supply curve is from Hanoch[1965] and Lin[2003].

II Model

I follow the formulation and result of Hanoch[1965]. In the Figure 1, x axis indicates the leisure x, and y axis indicates the earning $y = \omega (x_0 - x)$. x_0 means the maximum hours available for leisure, 24 hours, and ω is the wage. Each of $I_1, I_2,$ and I_3 shows indifference curves. Indifference curves are assumed to be downward sloping and convex. They are derived from an usual utility function $V(x,y)$. The broken line LL indicates the locus of points of equilibrium for individual with variable wage, ω. The supply of labor is $h = x_0 - x$. In the Figure1, the curve LL shows thebackward-bending of supply of labor. $h(\omega)$ is the response of supply of labor toward the wage ω. $\dfrac{dh}{d\omega}$ is positive in the beginning and becomes negative for

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the higher ω .

The individual maximizes $V(x,y)$, with the constraint $y = \omega(x_0 - x)$. It is possible to change this equation as follows.

$$\tfrac{1}{\omega}y + 1 \cdot x = 1 \tag{1}$$

$P_y = 1/\omega$ is the price of earning. $P_x = 1$ means that leisure is the numeraire.

Now, we assume the utility is constant, V_0 . Then,

$$-\frac{dy}{dx} = \frac{V_x}{V_y} = \frac{P_x}{P_y} = \omega \tag{2}$$

Second order conditions are as follows with keeping utility constant..

$$\frac{d^2y}{d^2x} > 0 \tag{3}$$

Here, it is assumed that the utilitiliy, $V(x,y)$ is a homothetic function. ρ is a scalar and positive.

$$-\frac{dy}{dx} = \frac{V_x(\rho x',\rho y')}{V_y(\rho x',\rho y')} = \frac{V_x(x',y')}{V_y(x',y')}$$

The marginal rate of substitution of y to x is constant for same value of $\frac{y}{x}$, and is a function of it only.

Therefore,

$$\frac{V_x(x,\,y)}{V_y(x,\,y)} = f(\tfrac{y}{x}) = f(Z) \tag{4}$$

It is possible to find a linear homogeneous utility function

$$V^*(x,\ y) = xU(\tfrac{y}{x}) = xU(Z) \tag{5}$$

$$\frac{dy}{dx} = f(Z), \quad \text{wherer} \quad V^*(x,y) = C \tag{6}$$

From (2) and (3),

$$f(Z) > 0, f'(Z) > 0$$

Then,

$$\frac{dZ}{dx}\Big|_{V=C} = \frac{d(\frac{y}{x})}{dx}\Big|_{V=C} = -\frac{y}{x^2} + \frac{1}{x}\frac{dy}{dx}\Big|_{V=C} = -\frac{1}{x}[Z+f(Z)] \tag{7}$$

When we solve this differential equation, we have,

$$x(Z) = C\exp[-\int_{Z_0}^{Z} \frac{dt}{t+f(t)}] \tag{8}$$

$$y(Z) = ZX = CZ\exp[-\int_{Z_0}^{Z} \frac{dt}{t+f(t)}] \tag{9}$$

Equations (8) and (9) keep the utility level, $V^* = C$. Therefore,

$$V^*(x, \ y) = x\exp[\int_{Z_0}^{Z} \frac{dt}{t+f(t)}] = xU(Z) \tag{10}$$

From (2) and(3), we obtain,

$$U(Z) > ZU'(Z) > 0, \tag{11}$$

$$U''(Z) < 0 \tag{12}$$

The suuply curve of labor ,maximizing V^* is as follows.

$$V_x^* = U(Z) - ZU'(Z) > 0 \tag{13}$$

$$V_y^* = U'(Z) > 0 \tag{14}$$

The equilibrium condition is,

$$\omega = \frac{V_x^*}{V_y^*} = f(Z) = \frac{U(Z)}{U'(Z)} - Z \tag{15}$$

This is along with the curve LL.

Then, it is assumed as follows,

$$W(Z) = \log U(Z) \tag{16}$$

$$\omega = \frac{1}{W'(Z)} - Z \tag{17}$$

$$W'(Z) = \frac{U'(Z)}{U(Z)} = \frac{1}{Z+\omega} \tag{18}$$

Then, we have next equation, using (1).

$$h\omega = y = Zx = Z(1-h) \tag{19}$$

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$h = 1 - x$ is the supply of labor.

Then,

$$h = \frac{Z}{Z+\omega} = ZW'(Z), \quad 0 \le h \le 1, \quad 0 \le \omega \tag{20}$$

From (17),(18),and(20), we have,

$$\frac{dh}{d\omega} = \frac{dh}{dZ} / \frac{d\omega}{dZ} \tag{21}$$

$$\frac{dh}{dZ} = ZW''(Z) + W'(Z) \tag{22}$$

$$\frac{d\omega}{dZ} = \frac{-(W'^2 + W'')}{W'^2} \tag{23}$$

Because, $U''(Z) < 0$,

$$W'' = \frac{d}{dZ}\frac{U'}{U} = \frac{(UU'' - U'^2)}{U^2} < 0, \tag{24}$$

$$W'^2 + W'' = \left(\frac{U'}{U}\right)^2 + (UU'' - U'^2) = \frac{U''}{U} < 0 \tag{25}$$

The change in the supply of labor according to an increase of wage can be decomposed into the substitution effect and the income effect. The substitution effect is always positive and the income effect is negative.

The following example is chosen to show the backward-bending labor supply function.

$$V^*(x,y) = x \exp\left[-\exp\left(-\frac{y}{x}\right)\right] \quad = x \exp[-\exp(-Z)] \tag{26}$$

This is linear homogeneous, with $U(Z) = \exp[-\exp) - Z)]$

$$W(Z) = \log[U(Z)] = -e^{-Z}, \tag{27}$$

$$W'(Z) = -e^{-Z} \tag{28}$$

Using (17) and (18),

$$\frac{dy}{dx} \mid V_0^* = \frac{1}{W'(Z)} - Z = e^Z - Z = e^{\frac{y}{x}} - \frac{y}{x} \tag{29}$$

From (20),

$$h = ZW'(Z) = Ze^{-Z} \tag{30}$$

$$\omega = e^Z - Z \tag{31}$$

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$$\frac{dh}{d\omega}=\frac{dh}{dZ}/\frac{d\omega}{dZ}=\{e^{-Z}(1-Z)\}/\{e^{Z}-1\}=\frac{1-Z}{e^{Z}(e^{Z}-1)}\tag{32}$$

$$\frac{dh}{d\omega}>0 \quad\text{for}\quad Z<1\tag{33}$$

$$\frac{dh}{d\omega}<0 \quad\text{for}\quad Z>1\tag{34}$$

As described above, when the wage, ω increase, firstly, the working hour h increases, then the working hour decreases. The shape of backward-bending of labor supply function was shown. This explanation is from Hanoch[1965].
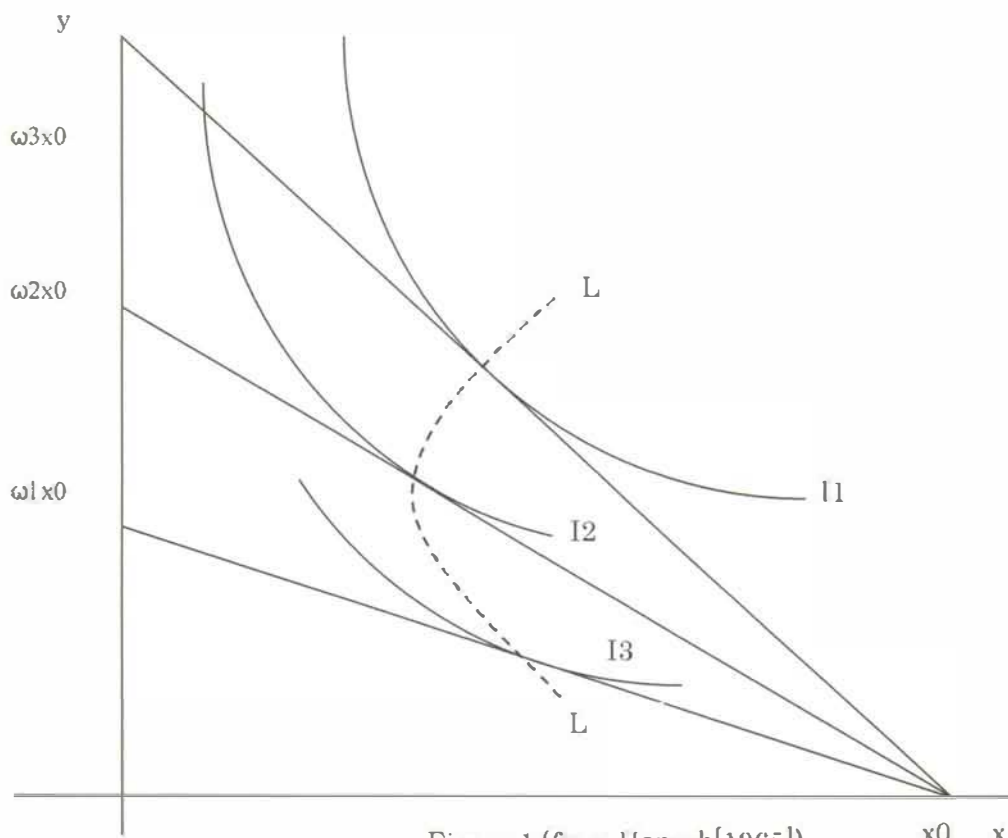

Figure 1 (from Hanoch[1965])

The labor supply curve with backward- bending is shown in Figure 2. Initially, the demand and supply of labors meets at point A. When the labor demand curve shifts to right, the equilibrium point moves to point B. Then, the wage increases when the labor demand increase. However, the labor supply decreases[2].

It is assumed that a manager impose penalty when he find slowdown of employee. The amount of penalty is supposed to be same with the production which is lost by the slowdown. A worker who has a usual labor supply function avoids losing the chance to capture profit. Therefore, it becomes possible to expel free-riders by this rule. However, we have a different situation when a worker has backward- bending labor supply function. He compares two cases, one is the case in which a manager finds his slowdown and enforces a penalty, and another is the case in which a manager can not find his slowdown. He determines his behavior by this comparison. It is assumed that the probability of finding slowdown is 0.5. Also, it is assumed that the amount according to lost production by slowdown should be deducted from worker's salary when his slowdown is found.

Then, if he has slowdown by half of day, his expected wage of a day should be as follows.

$$W^e = 0.5W + 0.5\frac{1}{2}W = 0.75W \tag{35}$$

His slowdown is half of a day and his expected wage for a day is 75% of the contracted wage. In this case, his wage per hour increases. He chooses slowdown. As shown in Figure 3, this worker has been in the equilibrium point A. Then, he has moved to

the equilibrium point B by the decision of slowdown. The working hour has decreased and the expected wage increased.

Now, we conduct optimization of his behavior.

The expected wage per hour is as follows.

$$W^e = \frac{\{1-f(a)\}W + f(a)\{W-aW\}}{1-a}$$

(36)

a is the time of cheating(slowdown) per day.

W is the wage per day and this is a given value.

f(a) is a possibility of finding for cheating.

When the slowdown of worker is found, the penalty is aW.

Now, we optimize the expected wage per hour about the hour of slowdown.

$$
\begin{aligned}
\frac{dW^e}{da} &= W\frac{\{1-af(a)\}'(1-a)-\{1-af(a)\}(1-a)'}{(1-a)^2} \\
&= W\frac{\{-f(a)-af'(a)\}(1-a)+\{1-af(a)\}}{(1-a)^2} \\
&= W\frac{-(1-a)f(a)-a(1-a)f'(a)+1-af(a)}{(1-a)^2} \\
&= W\frac{-f(a)-a(1-a)f'(a)+1}{(1-a)^2}
\end{aligned}
$$

(37)

We assume the possibility of finding $f(a) = ca$

c is a constant value.

Therefore,

$$(37) = W\frac{-ca-a(1-a)c+1}{(1-a)^2}$$

(38)

It is possible to optimize when $-ca - a(1-a)c + 1 = 0$

$$ca^2 - 2ca + 1 = 0$$

$$a = \frac{c-\sqrt{c^2-c}}{c}$$

(39)

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When the time of slowdown is $\dfrac{c-\sqrt{c^2-c}}{c}$, the expected wage per hour is maximized. The utility of worker increases monotonously with the increase of expected wage per hour. Therefore, when the equation of (39) is satisfied, the utility of worker is optimized.

Under the assumption of usual labor supply function, when the equilibrium point moves to the direction of upper right, the utility of worker always increases. At the same time, in the case of backward-bending of labor supply function, when the equilibrium point moves to the upper direction, the utility of worker always increases, also.

To prevent this kind of behavior of workers, a manager should increase the probability of finding slowdown and reinforce the penalty in this model. However, when the degree of curve is very large, the possibility of slowdown still exists. The more fundamental solution to prevent free-riders and promote economic development is to cancel the backward- bending of labor supply function itself. Educational and social activity and PR are needed to change worker's utility and attitude of working in this purpose.

W

B

A

H

Figure 2

W

B

A

H

Figure 3

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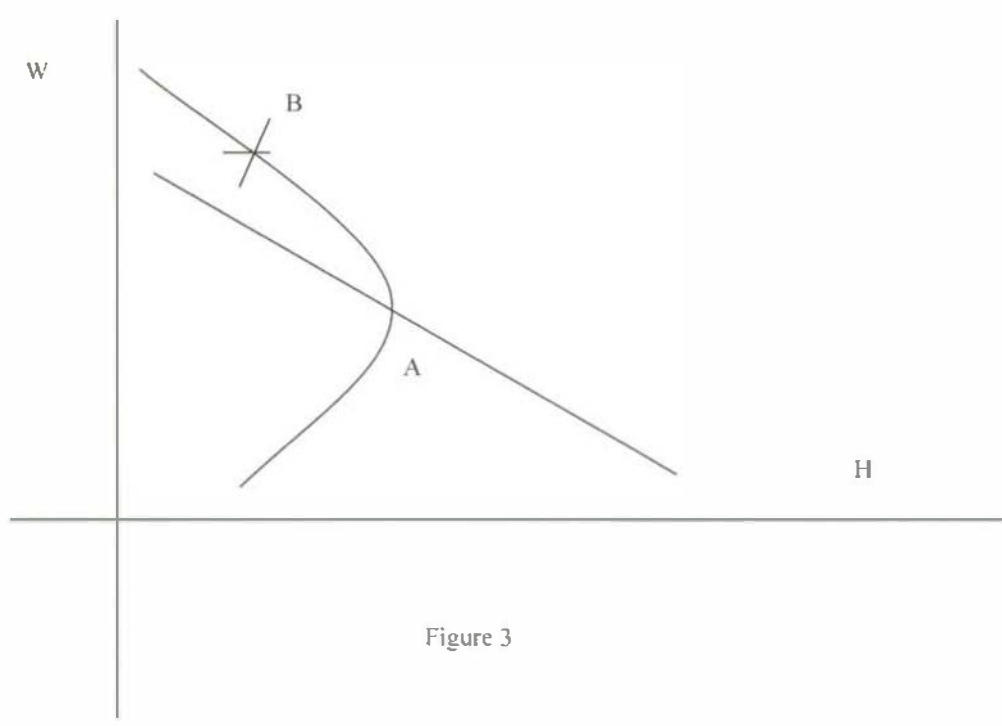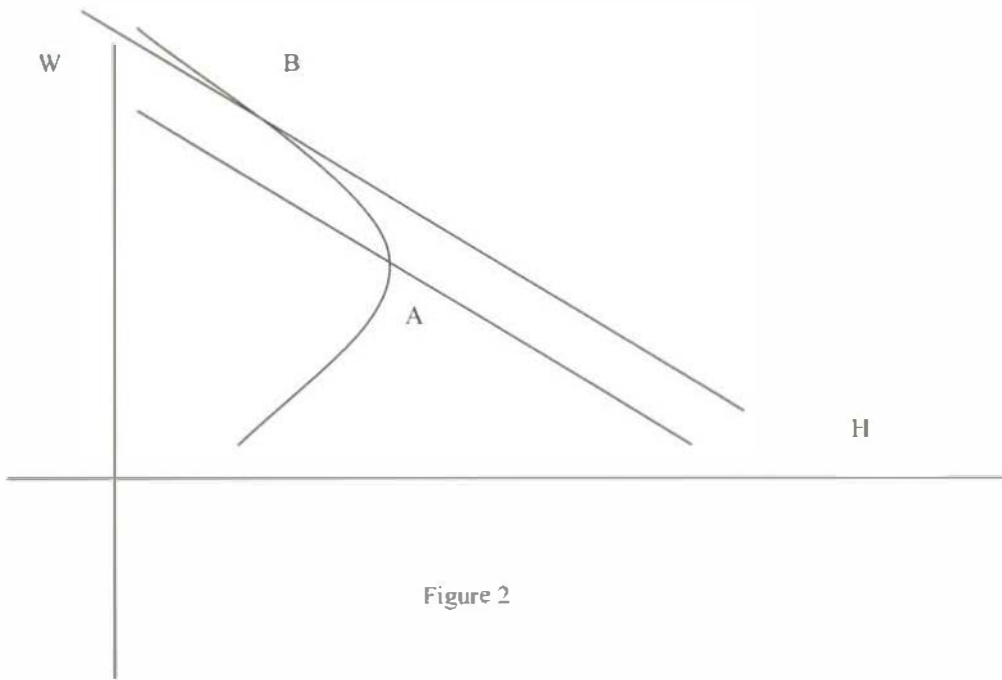
III Conclusion

Now, it is possible to categorize post-socialist countries into two groups. One is the group which is composed of East European countries and another is the group which is composed of Central Asian countries. The former already have become members of EU and maintain the steady economic growth. The latter still remains stagnant economic condition. In Central Asian countries, they have had the custom which shows backward- bending of labor supply function through the socialist's regime. It seems like that it is a factor of economic stagnancy. In this paper, it has been shown that the slowdown of working can be possible in spite of the penalty against it, when the worker have the labor supply function with backward- bending. The more fundamental solution to prevent free-riders and promote economic development is to cancel the backward- bending of labor supply function itself. Educational and social activity and PR are needed to change worker's utility and attitude of working in this purpose.

References

Dickinson, D. (1999). ' An experimental examination of labor supply and work intensities', Journal of Labor Economics, 17, 638-70.

Dmitry V. Myong (2001), "Politics , economy and Koreans in Kazakhstan" translated by K. Yano, Studies of Foreign Affairs 28 (2), Kumamoto-Gakuen University (written in Japanese).

Hanoch, G. (1965). 'The "backward-bending" supply of labor', Journal of Political Economy, 73, 636-42.

Harris, R. and M. P. Todaro 1970. "Migration, Unemployment and Development: A Two Sector Analysis." American Economic Review 60 (1) : 126—142.

Lee A. (2002), "Agriculture of Koreans in Kazakhstan", Economic Reforms in Central Asia, Institute of Developing Economies, Japan External Trade Organization, pp223-241(written in Japanese).

Lin Chung-cheng (2003), "A backward-bending labor supply curve without an income effect" Oxford Economic Papers, 55, 336-343.

Link, C. and Settle, R. (1981). 'Wage incentives and married professional nurses: a case of backward-bending supply?'. Economic Inquiry, 19,144-56.

MacLeod, W.B. and J.M.Malcomson(1988), "Reputation and Hierarchy in Dynamic Models of Employment," Journal of Political Economy 96: 832-854.

Malcomson, J.M.(1984). "Work Incentives, Hierarchy, and Internal Labor Markets," Journal of Political Economy 92: 486-507.

Prendergast, C.(1993), "The Role of Promotion in Inducing Specific Human Capital Acquisition," Quarterly Journal of Economics 108: 523-534.

Shapiro, C. and Stiglitz, J. (1984), 'Equilibrium unemployment as a worker discipline device', American Economic Review, 74. 433-44.

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[1] See Lee[2002]

[2] This is possible because we use the idea of salary not income. The idea of salary is similar to flow and the idea of income is similar to stock.