Economics Bulletin

Appendix and Supplemental material not intended for publication-Round 1

Submission Number:EB-12-00424

Detailed derivations and sample instructions used for experiments.

Submitted: Jun 03 2012. **Revised:** September 07, 2012.

A Supplementary materials

A.1 Detailed derivations

A.1.1 Participation constraint

If the employer is trying to induce $e = 1$, the PC constraint is given by:

$$E_1 U(w, c_1, R - w) \geq U(0,0,0) \Leftrightarrow$$
$$\pi_1 U(w_h, c_1, R_h - w_h) + (1-\pi_1) U(w_l, c_1, R_l - w_l) \geq U(0,0,0),$$

Using the properties of the exponential function we have $u(w(1+2\alpha) - c - \alpha R) = \frac{u[w(1+2\alpha)]}{u(c)u(\alpha R)}$. Thus, the PC constraint becomes:

$$\pi_1 \frac{u\left[w_h(1+2\alpha)\right]}{u(\alpha R_h)u(c_1)} + (1-\pi_1)\frac{u\left[w_l(1+2\alpha)\right]}{u(\alpha R_l)u(c_1)} \geq U(0,0,0) = -1$$
$$u\left[w_h(1+2\alpha)\right] \geq -u(\alpha R_h)\left[\frac{u\left[w_l(1+2\alpha)\right]}{u(\alpha R_l)}\frac{(1-\pi_1)}{\pi_1} + \frac{u(c_1)}{\pi_1}\right].$$

Further noting that $\frac{u(a)}{u(b)} = -u(a-b)$, $u^{-1}(-xy) = u^{-1}(x) + u^{-1}(y)$, and $u^{-1}(x) = -\frac{1}{\gamma}\ln(-x)$, the constraint can be rewritten as (3). When the worker is inequity-neutral ($\alpha = 0$), the PC constraint reduces to $w_h \geq -\frac{1}{\gamma}\ln\left[u(w_l)\frac{(1-\pi_1)}{\pi_1} - \frac{u(c_1)}{\pi_1}\right]$. If the worker is also risk-neutral, the PC constraint becomes $w_h \geq -\frac{(1-\pi_1)}{\pi_1}w_l + \frac{c_1 + \pi_1\alpha R_h + (1-\pi_1)\alpha R_l}{\pi_1(1+2\alpha)}$.

A.1.2 Incentive constraint

The IC constraint is given by:

$$E_1 U(w, c_1, R - w) \geq E_0 U(w, c_0, R - w) \Leftrightarrow$$

$$\pi_1 U(w_h, c_1, R_h - w_h) + (1-\pi_1) U(w_l, c_1, R_l - w_l)$$
$$\geq \pi_0 U(w_h, c_0, R_h - w_h) + (1-\pi_0) U(w_l, c_0, R_l - w_l).$$

Using the properties of $u(x)$ it becomes:

$$\pi_1 \frac{u\left[w_h(1+2\alpha)\right]}{u(\alpha R_h)u(c_1)} + (1-\pi_1)\frac{u\left[w_l(1+2\alpha)\right]}{u(\alpha R_l)u(c_1)} \geq \pi_0 \frac{u\left[w_h(1+2\alpha)\right]}{u(\alpha R_h)u(c_0)} + (1-\pi_0)\frac{u\left[w_l(1+2\alpha)\right]}{u(\alpha R_l)u(c_0)}$$
$$\frac{u\left[w_h(1+2\alpha)\right]}{u(\alpha R_h)} \leq \frac{u\left[w_l(1+2\alpha)\right]}{u(\alpha R_l)}\frac{(1-\pi_0)u(c_1) - (1-\pi_1)u(c_0)}{\pi_1 u(c_0) - \pi_0 u(c_1)}.$$

Noting that $u^{-1}(xy) = u^{-1}(x) + u^{-1}(-y)$, the constraint can be further rewritten as (4). Note that the constraint reduces to $w_h \geq w_l + \left\{-\frac{1}{\gamma}\ln\left(\frac{(1-\pi_0)u(c_1) - (1-\pi_1)u(c_0)}{\pi_1 u(c_0) - \pi_0 u(c_1)}\right)\right\}$ when the worker is inequity-neutral. When the worker is risk-neutral but inequity-averse the constraint becomes $w_h \geq w_l + \frac{1}{(1+2\alpha)}\frac{(c_1 - c_0)}{(\pi_1 - \pi_0)} + \frac{\alpha}{(1+2\alpha)}(R_h - R_l)$.

A.1.3 Feasibility constraint

The FC constraint is given by

$$E_1\Pi(w_l, w_h) \geq \max_{(w_l,w_h)} E_0\Pi(w_l, w_h). \tag{10}$$

When maximizing $E_0\Pi(w_l, w_h)$ on the RHS of (10) the employer needs only to worry about the PC constraint, which in this case is given by:

$$\begin{aligned} E_0U(w, c_0, R - w) &\geq U(0,0,0) \Leftrightarrow \\ \pi_0 U(w_h, c_0, R_h - w_h) + (1 - \pi_0)U(w_l, c_0, R_l - w_l) &\geq U(0,0,0) \Leftrightarrow \\ \pi_0 u(w_h(1 + 2\alpha) - \alpha R_h - c_0) + (1 - \pi_0)u(w_l(1 + 2\alpha) - \alpha R_l - c_0) &\geq u(0). \end{aligned} \tag{11}$$

Since the employer's profit decreases in wages and the LHS of (11) increases in wages, the PC constraint is binding.

Due to the concavity of the worker's utility function, the cheapest way for the employer to satisfy the constraint is by fully insuring the worker against uncertainty since $Eu(x) \leq u(Ex)$. Therefore, wages should be such that the worker's utility is constant in both states of nature and is equal to the utility of the expected net wage. Furthermore, from (11) this expected net wage should be zero:

$$\pi_0 \left[w_h(1 + 2\alpha) - \alpha R_h - c_0\right] + (1 - \pi_0) \left[w_l(1 + 2\alpha) - \alpha R_l - c_0\right] = 0 \Leftrightarrow$$

$$w_h = \frac{c_0 + \alpha \left\{(1 - \pi_0)R_l + \pi_0 R_h\right\}}{\pi_0(1 + 2\alpha)} - \frac{(1 - \pi_0)}{\pi_0} w_l.$$

Using this linear relationship, the highest profit of the employer who decides not to induce high effort is:

$$\begin{aligned} \max_{(w_l,w_h)} E_0\Pi(w_l, w_h) &= \max_{(w_l,w_h)} \pi_0(R_h - w_h) + (1 - \pi_0)(R_l - w_l) \\ &= \frac{\left(\pi_0 R_h + (1 - \pi_0)R_l\right)(1 + \alpha) - c_0}{(1 + 2\alpha)}. \end{aligned} \tag{12}$$

Thus, (10) becomes:

$$\begin{aligned} \pi_1(R_h - w_h) + (1 - \pi_1)(R_l - w_l) &\geq \frac{\left(\pi_0 R_h + (1 - \pi_0)R_l\right)(1 + \alpha) - c_0}{(1 + 2\alpha)} \Leftrightarrow \\ w_h &\leq \frac{\left[(1 + 2\alpha)\pi_1 - (1 + \alpha)\pi_0\right](R_h - R_l) + aR_l + c_0}{\pi_1(1 + 2\alpha)} - \frac{(1 - \pi_1)}{\pi_1} w_l. \end{aligned}$$

A.1.4 Optimal contract

Let us consider the wage contract at the intersection of the PC and IC constraints. It can be found by simultaneously solving the expressions in (3) and (4) with equality. The resulting wages (w_l^*, w_h^*) are implicitly characterized by the following system:

$$-\frac{u\left[w_l^*(1+2\alpha)\right]}{u(\alpha R_l)} = u(c_0) - \frac{\pi_0}{\pi_1 - \pi_0}(u(c_1) - u(c_0)) \tag{13}$$
$$-\frac{u\left[w_h^*(1+2\alpha)\right]}{u(\alpha R_h)} = u(c_1) + \frac{(1-\pi_1)}{(\pi_1 - \pi_0)}(u(c_1) - u(c_0)).$$

Since $c_1 > c_0$ and $0 < \pi_0 < \pi_1 < 1$, the first equation of the system (13) implies that $w_l^* < \frac{c_0+\alpha R_l}{(1+2\alpha)}$. It can be shown that the slope $\frac{dw_h}{dw_l}$ of the PC constraint in (3) is steeper than $-\frac{(1-\pi_1)}{\pi_1}$, the slope of the iso-profit lines, whenever $w_l < \frac{c_1+\alpha R_l}{(1+2\alpha)}$. And since the low-revenue wage w_l^* satisfies this inequality (recall that $c_1 > c_0$), the PC constraint is steeper than the iso-profit lines for all $w_l \leq w_l^*$, i.e. left of the intersection of the PC and the IC constraints. Therefore, the pair of wages (w_l^*, w_h^*) found at the intersection of the PC and the IC constraints are the unique profit maximizing wage contract. Explicitly solving (13) for (w_l^*, w_h^*) gives us (6).

When the worker does not care about inequity, the left-hand side of the two equations in (13) reduce to $u(w_l^*)$ and $u(w_h^*)$:

$$u(w_l^*) = u(c_0) - \frac{\pi_0}{\pi_1 - \pi_0}(u(c_1) - u(c_0)) \tag{14}$$

$$u(w_h^*) = u(c_1) + \frac{(1-\pi_1)}{(\pi_1 - \pi_0)}(u(c_1) - u(c_0)) \tag{15}$$

Since $c_1 > c_0$ and $0 < \pi_0 < \pi_1 < 1$, we can conclude that $w_l^* \leq c_0$ and $w_h^* \geq c_1$. Thus, regardless of the worker's attitude to risk the low-revenue wage is at most as high as the cost of low effort. In contrast, when agents are averse to inequity, the two inequalities in (13) imply that not only the bounds vary with the magnitude of the employer's revenue, but whenever $R_l > 2\delta$, the upper bound for w_l is above c_0.

A.2 Sample experimental instructions

Instructions

This is an experiment in the economics of market decision making. SFSU has provided funds for conducting this research. The instructions are fairly straightforward, and if you follow them carefully and make good decisions you may earn a CONSIDERABLE AMOUNT OF MONEY which will be PAID TO YOU IN CASH at the end of the experiment.

This experiment does not involve any tricks or deception.

General information:

1. The experiment will consist of 4 Parts.
2. In Part I you will be randomly assigned a role of an employer or a worker.
3. In Part II of the experiment you will switch roles so that employers become workers and workers become employers.
4. In Part III of the experiment you will switch roles back again, and so on.
5. Each Part will consist of 6 periods.
6. In each period you will be randomly and anonymously matched into pairs consisting of one employer and one worker.
7. In the subsequent period you will be matched with another randomly chosen participant so that you are likely to be paired with a different person in every period.
8. At the end of the experiment you will be asked to fill out a questionnaire and paid your earnings in cash.
9. Your cash payment will consist of $8 show-up payment + your earnings in a randomly selected period from ANY of the Parts of the experiment. Therefore, you should treat every period as if it was the one that will be paid off on.

Setup:

1. An employer who hires a worker will earn revenue: either high revenue ($60) or low revenue ($10 or $20)
2. The amount of low revenue will alternate from period to period. Below, all explanations are given for the low revenue of $10 but the same logic applies when the low revenue is $20
3. Each period starts with the employer making a wage offer to the worker.
4. Wage offer will consist of WAGE60 (paid when revenue is $60) and WAGE10 (paid when revenue is $10)
5. The worker can either accept the offer or reject it.
6. If the offer is rejected, the period ends and no revenue is earned.
7. If the offer is accepted, the worker decides how much effort to make.
8. The worker's decision affects the chances of high and low revenue that the employer earns
9. If the worker chooses low effort, the chances of $60 revenue are 3 out of 10 (3/10).
10. At the cost of $4 the worker can choose high effort and increase the chances of $60 revenue to 7 out of 10 (7/10).
11. After the worker makes the choice, the computer randomly selects a number between 1 and 10 (all numbers are equally likely)
12. If the worker chose low effort the revenue is $60 for numbers 1-3 and $10 for numbers 4-10

13. If the worker chose high effort the revenue is \$60 for numbers 1-7 and \$10 for numbers 8-10

14. Note that for numbers 4-7 the revenue is \$60 if the worker chose high effort and \$10 if the worker chose low effortEarnings:

1. Everybody will have a starting balance of \$5
2. If the wage offer is rejected, both the employer and the worker earn \$5
3. Otherwise, the employer's earnings will be \$5 + revenue – wage.
4. And the worker's earnings will be \$5 + wage - \$4 (-\$4 only if high effort)

Example 1:

- Employer offers WAGE60 = \$0 and WAGE10 = \$0
- Worker rejects the offer
- Employer gets: \$5 (initial balance); Worker gets: \$5 (initial balance)

Example 2:

- Employer offers WAGE60 = \$0 and WAGE10 = \$0
- Worker accepts the offer and chooses low effort
- Random number selected is 5 (revenue is \$10 for low effort)
- Employer's earnings: \$5 (initial balance) + \$10 (revenue) - \$0 (wage);
- Worker's earnings: \$5 (initial balance) + \$0 (wage) - \$0 (cost of low effort)

Example 3:

- Employer offers WAGE60 = \$60 and WAGE10 = \$10
- Worker accepts the offer and chooses high effort
- Random number selected is 5 (revenue is \$60 for high effort)
- Employer's earnings: \$5 (initial balance) + \$60 (revenue) - \$60 (wage);
- Worker's earnings: \$5 (initial balance) + \$60 (wage) - \$4 (cost of high effort)

To summarize:

1. You will be randomly assigned the role of an employer or a worker and switch roles in every Part of the experiment.
2. In every period, you will be paired randomly with another participant.
3. In every period, the employer will move first by offering a two-part wage: the wage that depends on the level of revenue.
4. Worker can reject the offer or accept it and determine the chances of \$60 revenue.
5. At the cost of \$4, the worker can increase the chances from 3/10 to 7/10
6. The level of the revenue (high or low) will be determined randomly in accordance with the chances chosen by the worker.
7. The amount of low revenue will switch every period between \$10 and \$20
8. The worker and the employer will be paid according to the outcome.
9. One period chosen at random will be used to determine your cash payment (+\$8 show-up payment)

Quiz:

1. You are likely to be paired with a different person in every period.

True False

1. If your role is "Employer" in Part I, what will be your role in Part II?

a) Employer b) Worker c) Random

2. A single randomly chosen period from the entire experiment will be used to make cash payments

True False

3. Suppose employer's offer is WAGE60 = \$60 and WAGE10 = \$10. Revenue is randomly determined to be \$10. What is the wage paid to the worker?

a) \$60 b) \$10 d) \$30

4. What is the cost to the worker of making high effort? ______

5. The cost of high effort is the same whether the revenue turns out to be \$60 or \$10

True False

6. What is the result(s) of making high effort?

a. Worker incurs a cost

b. Employer incurs a cost

c. It increases the chances of \$60 revenue and WAGE60

d. a) and c)

7. If the employer's offer is rejected what are the earnings for the employer and the worker (excluding show-up payment but including the initial balance)?

a) \$0 b) \$5 d) \$60

8. High effort guarantees \$60 revenue while low effort guarantees \$10 revenue

True False

9. The amount of low revenue will switch between \$10 and \$20

True False