Instructions

What follows is an English translation of the instructions for least-revenue auctions with private and common values (LR-PC). Instructions from the remaining treatments are available upon request.

SLIDE No.1

These instructions will explain how you can earn money based on your decisions and the decisions of other participants during this part of the experiment. We recommend that you read the instructions carefully, because your earnings may be affected if you do not understand them. If you have any questions regarding there instructions, please raise your hand and we will answer your question privately.

SLIDE No.2

Earnings in the experiment

From now on, participants will interact only through computers. If you disobey the rules, we will end the experiment and ask you to leave without your accumulated earnings. The amounts in the experiment are denominated in Experimental Pesos (E$). At the end of the experiment we will convert your accumulated earnings to Quetzales (Q1 = E$4) and we will pay it in cash (in Quetzales)

SLIDE No.3

The experiment consists in a series of periods. The computer will act as a seller and the participants will act as buyers of a good whose VALUE is the same for all participants. For each seller there will be 3 buyers. All buyers will have a COST of obtaining the good which will likely be different for each person.

You can make money if: 1) You make the lowest REQUEST of the AMOUNT. 2) The AMOUNT received is higher than the COST of obtaining the good.

SLIDE No.4

Each period, groups of 3 buyers are chosen randomly. Buyers can obtain a good that has a VALUE. This VALUE is the same for all buyers and represents how much the good being sold in that period is worth.

However, no one will know the VALUE of the good before the period begins. When the period begins, each buyer will receive an ESTIMATE of the VALUE.

SLIDE No.5

At the beginning of the period, each potential buyer will receive his own ESTIMATE of the VALUE. The ESTIMATE of the VALUE will be a number chosen at random between 100 and 200.

All ESTIMATES of the VALUE in the mentioned range have the same probability of being selected and are independent from the ESTIMATES of the VALUE of other buyers and those of other periods.

SLIDE No.6

In other words, in each period you will have an ESTIMATE of VALUE which is likely to be different from the ESTIMATES of VALUE of other buyers and ESTIMATES of VALUE in other periods.

In each period, the VALUE of the good will be the average of the ESTIMATES of VALUE of the 3 buyers of each group. Since all ESTIMATES of VALUE are between 100 and 200, the VALUE will be in this range, and will be the same for all 3 buyers.

SLIDE No.7

For example, if your ESTIMATE of VALUE is 182.60 and the ESTIMATES of the other 2 buyers are 109.42 and 167.31, the VALUE of the good (for any of the 3 participants) would be 153.11.

(182.60 + 109.42 + 167.31) = 153.11 3

SLIDE No.8

Each buyer will have a COST of obtaining the good. This COST will likely be different for each buyer. This COST is only incurred by the buyer of the good, and is paid in addition to the PRICE paid to the seller.

In each period, the COST of each buyer is assigned randomly. All COSTS between E$0 and E$50 are equally likely to be chosen. COSTS do not depend on the COSTS of other participants or the COSTS in other periods.

In other words, in each period you will have a COST (between E$0 and E$50) which will likely be different than the COST of other potential buyers and different from the COSTS you had in previous periods.

SLIDE No.9

At the beginning of the period, each buyer will know his ESTIMATE of the VALUE of the good as well as his COST for obtaining the good. Each buyer can then make a REQUEST of an AMOUNT of the VALUE of the good. The person who makes the lowest REQUEST of an AMOUNT will buy the good. He will pay the difference between the VALUE and his REQUEST. In case of a tie between two or more REQUESTS, the buyer will be determined randomly.

SLIDE No.10

In other words, the buyer will get the AMOUNT of the VALUE of the good (net of the price paid to the seller). The AMOUNT obtained by the buyer cannot be higher than the VALUE of the good. Whenever the REQUEST of the AMOUNT is less than the VALUE of the good, the buyer will get that AMOUNT. If the REQUEST of the AMOUNT is larger than the VALUE of the good, the AMOUNT obtained by the buyer will equal the VALUE.

SLIDE No.11

At the end of the period, your screen will display the REQUESTS of an AMOUNT of all buyers (ranked lowest to highest), as well as the VALUE of the good, the AMOUNT obtained by the buyer, and your EARNINGS.

For the person with the lowest REQUEST of an AMOUNT, the EARNINGS will be: AMOUNT Obtained − COST = EARNINGS

All others will have PROFIT of: 0 Notice that the buyer could earn money if the AMOUNT obtained is lower than its COST. Also notice that the buyer could lose money if the AMOUNT is higher than its COST.

SLIDE No.12

For example, if you make a REQUEST of an AMOUNT of 34 and your REQUEST is the lowest, you will buy the good. If the VALUE is 163 in that period and your COST is 24, your EARNINGS will be: 34 − 24 = 10

If your REQUEST of an AMOUNT is not the lowest, then you do not purchase the good and your EARNINGS is 0. For example, if your REQUEST of an AMOUNT is 42 and this is not the lowest REQUEST, you will not purchase the good and will have EARNINGS of 0 in that period.

SLIDE No.13

In each period, groups will be randomly reassigned. That is, you will likely NOT interact with the same people every period.

Moreover, you will never know the identity of the other participants in your group nor will they know yours.

SLIDE No.14

At the beginning of the experiment, all participants will receive an endowment of E$500. If at any point during the experiment you have a loss greater than your balance, you cannot continue in the experiment. You will then have to wait quietly until the end of the experiment to receive your participation payment.

At the end of the experiment, while we prepare your payments, you will be asked to quietly fill out a short questionnaire.

SLIDE No.15

Summary

You and two other people will be potential buyers for a good the computer will be selling.

In each period, you can make a REQUEST of an AMOUNT to try to buy the good.

The buyer with the lowest REQUEST of an AMOUNT will buy the good. When the REQUEST is lower than the VALUE, the buyer will obtain the AMOUNT REQUESTED. The buyer will also pay the COST of obtaining the good.

SLIDE No.16

Summary

Whoever buys the good will make money if his REQUEST obtained is higher than the COST to obtain it.

EARNINGS (if you buy the good) = AMOUNT Obtained – COST

EARNINGS (if you do not buy the good) = 0

Derivation of equilibria

Derivation of cursed equilibrium in FP-PC auctions Consider bidder i who privately observes common value signal v_i and private cost c_i (so that $s_i = \frac{v_i}{n} - c_i$). The other bidders $j \neq i$ are bidding according to the differentiable and monotonically increasing bid function $\rho(s_j)$ where $s_j = \frac{v_j}{n} - c_j$. Bidder i incorrectly believes that bidders $j \neq i$ only bid $\rho(s_j)$ with probability $(1-\chi)$ and bids $E(\rho(s))$ with probability χ. Bidder i bids b. Given χ, bidder i incorrectly believes her expected profit to be

$$\begin{aligned}&\Pi_i^{\chi}(b, s_i)\\&\quad = F_s\big(\rho^{-1}(b)\big)^{n-1}\left(s_i + \left(\frac{n-1}{n}\right)\big((1-\chi)E\big(v|s \leq \rho^{-1}(b)\big) + \chi E(v)\big) - b\right).\end{aligned}$$

Taking the derivative with respect to b and noting that in a symmetric cursed equilibrium it must be the case that $b = \rho(s_i)$ leaves us with the differential equation

$$\begin{aligned}&(n-1)F_s(s_i)^{n-2}\frac{f_s(s_i)}{\rho'(s_i)}\big(s_i - \rho(s_i)\big)\\&\quad + (n-1)F_s(s_i)^{n-2}\frac{f_s(s_i)}{\rho'(s_i)}\left(\left(\frac{n-1}{n}\right)\big((1-\chi)E(v|s \leq s_i) + \chi E(v)\big)\right)\end{aligned}$$

$$+ F_s(s_i)^{n-1}\left(\left(\frac{n-1}{n}\right)(1-\chi)\left(\big(E(v|s=s_i)-E(v|s\le s_i)\big)\frac{f_s(s_i)}{F_s(s_i)\rho'(s_i)}\right)\right)$$
$$- F_s(s_i)^{n-1} = 0.$$

This can be written as

$$\frac{d}{ds_i}\left(F_s(s_i)^{n-1}\left(\rho(s_i)-\left(\frac{n-1}{n}\right)(1-\chi)E(v|s\le s_i)\right)\right)$$
$$= (n-1)F_s(s_i)^{n-2}f_s(s_i)\left(s_i+\left(\frac{n-1}{n}\right)\chi E(v)\right).$$

Integrate both sides of this equation, and note that the initial condition is $\rho(s_L) = (\frac{n-\chi(n-1)}{n})v_L + \chi(\frac{n-1}{n})E(v) - c_H$. This leaves us with

$$F_s(s_i)^{n-1}\left(\rho(s_i)-\left(\frac{n-1}{n}\right)(1-\chi)E(v|s\le s_i)\right)$$
$$= \int_{s_L}^{s_i}(n-1)F_s(t)^{n-2}f_s(t)t\,dt$$
$$+ \left(\left(\frac{n-1}{n}\right)\chi E(v)\right)\int_{s_L}^{s_i}(n-1)F_s(t)^{n-2}f_s(t)dt.$$

This can be rewritten as

$$F_s(s_i)^{n-1}\left(\rho(s_i)-\left(\frac{n-1}{n}\right)(1-\chi)E(v|s\le s_i)\right)$$
$$= F_s(s_i)^{n-1}E(y_1|y_1\le s_i) + \left(\left(\frac{n-1}{n}\right)\chi E(v)\right)F_s(s_i)^{n-1},$$

where y_1 is the highest signal of the other $n-1$ bidders. That is, $y_1 = \max_{j\in N_{-i}} s_j$. Solving for $\rho(s_i)$ leaves us with the cursed equilibrium bid function:

$$\rho(s_i) = \left(\frac{n-1}{n}\right)\big((1-\chi)E(v|s\le s_i)+\chi E(v)\big) + E(y_1|y_1\le s_i).$$

Plugging in the cursed equilibrium bid function, we see that the actual expected profit of bidder i in this cursed equilibrium is

$$\Pi_i\big(\rho(s_i), s_i\big)$$
$$= F_s(s_i)^{n-1}\left(s_i - E(y_1|y_1\le s_i) - \chi\left(\frac{n-1}{n}\right)\big(E(v)-E(v|s\le s_i)\big)\right).$$

Integrating over s, we find that the actual ex ante expected profit of bidder i is

$$E\big(\Pi_i^{FP\text{-}PC}\big(\rho(s), s\big)\big)$$
$$= \int_{s_L}^{s_H}F_s(t)^{n-1}f_s(t)t\,dt - \int_{s_L}^{s_H}F_s(t)^{n-1}E(y_1|y_1\le t)f_s(t)dt$$
$$- \chi\left(\frac{n-1}{n}\right)E(v)\int_{s_L}^{s_H}F_s(t)^{n-1}f_s(t)dt$$
$$+ \chi\left(\frac{n-1}{n}\right)\int_{s_L}^{s_H}F_s(t)^{n-1}f_s(t)E(v|s\le t)dt.$$

This can be written as

$$
\begin{aligned}
&E\big(\Pi_i^{FP\text{-}PC}\big(\rho(s), s\big)\big) \\
&\quad = \left(\frac{1}{n}\right)E(Y_1) - \int_{s_L}^{s_H}\int_{s_L}^{t}(n-1)F_s(z)^{n-2}f_s(z)zdzf_s(t)dt \\
&\qquad - \chi\left(\frac{n-1}{n}\right)E(v)\left(\frac{1}{n}\right) + \chi\left(\frac{n-1}{n}\right)\left(\frac{1}{n}\right)E(v|s \le Y_1),
\end{aligned}
$$

where Y_1 is the highest of the n draws of s. By changing the order of integration in the second term, this reduces to

$$
\begin{aligned}
&E\big(\Pi_i^{FP\text{-}PC}\big(\rho(s), s\big)\big) \\
&\quad = \left(\frac{1}{n}\right)E(Y_1) - \int_{s_L}^{s_H}(n-1)F_s(z)^{n-2}f_s(z)z\big(1-F_s(z)\big)dz \\
&\qquad - \chi\left(\frac{n-1}{n}\right)E(v)\left(\frac{1}{n}\right) + \chi\left(\frac{n-1}{n}\right)\left(\frac{1}{n}\right)E(v|s \le Y_1).
\end{aligned}
$$

Since the density function for the second highest of the n draws of s (Y_2) is given by $n(n-1)F_s(\cdot)^{n-2}f_s(\cdot)(1-F_s(\cdot))$, this simplifies to

$$
\begin{aligned}
E\big(\Pi_i^{FP\text{-}PC}\big(\rho(s), s\big)\big) = {} & \left(\frac{1}{n}\right)\big(E(Y_1) - E(Y_2)\big) \\
& - \chi\left(\frac{n-1}{n}\right)\left(\frac{1}{n}\right)\big(E(v) - E(v|s \le Y_1)\big).
\end{aligned}
$$

The ex ante expected profit of the winner in this cursed equilibrium is then

$$
E\big(\Pi_{winner}^{FP\text{-}PC}\big) = E(Y_1) - E(Y_2) - \chi\left(\frac{n-1}{n}\right)\big(E(v) - E(v|s \le Y_1)\big).
$$

Total expected surplus in this auction is given by $W = E(V) - E(c|s = Y_1)$. Thus, expected revenue in this cursed equilibrium is $R^{FP\text{-}PC} = W - E(\Pi_{winner}^{FP\text{-}PC})$.

Derivation of the equilibrium in FP-C auctions Consider bidder i who privately observes common value signal v_i. The cost of winning the auction is $\bar{c} \in (0, v_L)$. The other bidders $j \neq i$ are bidding according to the differentiable and monotonically increasing bid function $\beta(v_j)$. Bidder i incorrectly believes that bidders $j \neq i$ only bid $\beta(v_j)$ with probability $(1-\chi)$ and bids $E(\beta(v))$ with probability χ. Bidder i bids b. Given χ, she incorrectly believes that her expected profit is

$$
\begin{aligned}
&\Pi_i^{\chi}(b, v_i) \\
&\quad = F\big(\beta^{-1}(b)\big)^{n-1}\left(\frac{v_i}{n} + \left(\frac{n-1}{n}\right)\big((1-\chi)E\big(v|v \le \beta^{-1}(b)\big)\right. \\
&\qquad \left. + \chi E(v)\big) - \bar{c} - b\right).
\end{aligned}
$$

Taking the derivative with respect to b and noting that in a cursed equilibrium it must be the case that $b = \beta(v_i)$, we are left with an ordinary differential equation:

$$(n-1)F(v_i)^{n-2}\frac{f(v_i)}{\beta'(v_i)}\left(\left(\frac{n-1}{n}\right)\big((1-\chi)E(v|v\le v_i)+\chi E(v)\big)\right)$$
$$+(n-1)F(v_i)^{n-2}\frac{f(v_i)}{\beta'(v_i)}\left(\frac{v_i}{n}-\bar{c}-\beta(v_i)\right)$$
$$+F(v_i)^{n-1}\left(\left(\frac{n-1}{n}\right)(1-\chi)\left(\big(v_i-E(v|v\le v_i)\big)\frac{f(v_i)}{F(v_i)\beta'(v_i)}\right)-1\right)=0.$$

The initial condition is $\beta(v_L)=(\frac{n-\chi(n-1)}{n})v_L+\chi(\frac{n-1}{n})E(v)-\bar{c}$. Notice that the above differential equation can be written as

$$\frac{d}{dv_i}\left(F(v_i)^{n-1}\left(\beta(v_i)-\left(\frac{n-1}{n}\right)(1-\chi)E(v|v\le v_i)\right)\right)$$
$$=(n-1)F(v_i)^{n-2}f(v_i)\left(\frac{v_i}{n}+\left(\frac{n-1}{n}\right)\chi E(v)-\bar{c}\right).$$

Integrating both sides leaves us with

$$F(v_i)^{n-1}\left(\beta(v_i)-\left(\frac{n-1}{n}\right)(1-\chi)E(v|v\le v_i)\right)$$
$$=\int_{v_L}^{v_i}(n-1)F(t)^{n-2}f(t)\left(\frac{t}{n}+\left(\frac{n-1}{n}\right)\chi E(v)-\bar{c}\right)dt.$$

Simplifying this yields the equilibrium bid function

$$\beta(v_i)=\left(\frac{n-1}{n}\right)\big((1-\chi)E(v|v\le v_i)+\chi E(v)\big)+\left(\frac{1}{n}\right)E(z_1|z_1\le v_i)-\bar{c},$$

where z_1 is the highest signal of the other $n-1$ bidders. That is, $z_1=\max_{j\in N_{-i}}v_j$.

Plugging in the cursed equilibrium bid function, we find the actual expected profit of bidder i in this cursed equilibrium:

$$\Pi_i\big(\beta(v_i),v_i\big)$$
$$=F(v_i)^{n-1}\left(\frac{v_i}{n}-\chi\left(\frac{n-1}{n}\right)\big(E(v)-E(v|v\le v_i)\big)-\left(\frac{1}{n}\right)E(z_1|z_1\le v_i)\right).$$

Integrating over v we find the actual ex ante expected profit of bidder i is

$$E\big(\Pi_i^{FP\text{-}C}\big(\beta(v),v\big)\big)=\int_{v_L}^{v_H}F(t)^{n-1}f(t)\frac{t}{n}dt$$
$$-\left(\frac{1}{n}\right)\int_{v_L}^{v_H}F(t)^{n-1}E(z_1|z_1\le t)f(t)dt$$
$$-\chi\left(\frac{n-1}{n}\right)E(v)\int_{v_L}^{v_H}F(t)^{n-1}f(t)dt$$
$$+\chi\left(\frac{n-1}{n}\right)\int_{v_L}^{v_H}F(t)^{n-1}f(t)E(v|v\le t)dt.$$

This can be written as

$$
\begin{aligned}
&E\big(\Pi_i^{FP\text{-}C}\big(\beta(v), v\big)\big) \\
&\quad = \left(\frac{1}{n^2}\right)E(Z_1) - \left(\frac{1}{n}\right)\int_{v_L}^{v_H}\int_{v_L}^{t}(n-1)F(u)^{n-2}f(u)u\,du\,f(t)\,dt \\
&\qquad - \chi\left(\frac{n-1}{n}\right)E(v)\left(\frac{1}{n}\right) + \chi\left(\frac{n-1}{n}\right)\left(\frac{1}{n}\right)E(v|v \le Z_1),
\end{aligned}
$$

where Z_1 is the highest of the n draws of v. By changing the order of integration in the second term, this reduces to

$$
\begin{aligned}
&E\big(\Pi_i^{FP-C}\big(\beta(v), v\big)\big) \\
&\quad = \left(\frac{1}{n^2}\right)E(Z_1) - \left(\frac{1}{n}\right)\int_{v_L}^{v_H}(n-1)F(u)^{n-2}f(u)u\big(1-F(u)\big)du \\
&\qquad - \chi\left(\frac{n-1}{n}\right)E(v)\left(\frac{1}{n}\right) + \chi\left(\frac{n-1}{n}\right)\left(\frac{1}{n}\right)E(v|v \le Z_1).
\end{aligned}
$$

Since the density function for the second highest of the n draws of v (Z_2) is given by $n(n-1)F(\cdot)^{n-2}f(\cdot)(1-F(\cdot))$, this simplifies to

$$
\begin{aligned}
&E\big(\Pi_i^{FP\text{-}C}\big(\beta(v), v\big)\big) \\
&\quad = \left(\frac{1}{n^2}\right)\big(E(Z_1) - E(Z_2)\big) - \chi\left(\frac{n-1}{n}\right)\left(\frac{1}{n}\right)\big(E(v) - E(v|v \le Z_1)\big).
\end{aligned}
$$

The ex ante expected profit of the winner in this cursed equilibrium is then

$$
\begin{aligned}
&E\big(\Pi_{winner}^{FP\text{-}C}\big) \\
&\quad = \left(\frac{1}{n}\right)\big(E(Z_1) - E(Z_2)\big) - \chi\left(\frac{n-1}{n}\right)\big(E(v) - E(v|v \le Z_1)\big).
\end{aligned}
$$

Total expected surplus in this auction is given by $X = E(V) - \bar{c}$. Thus, expected revenue in this cursed equilibrium is $R^{FP\text{-}C} = X - E(\Pi_{winner}^{FP\text{-}C})$.

Derivation of the equilibrium in LR-PC auctions Consider bidder i who privately observes c_i. The other bidders $j \neq i$ are bidding according to the differentiable and monotonically decreasing bid function $\zeta(c_j)$. Bidder i incorrectly believes that bidders $j \neq i$ only bid $\zeta(c_j)$ with probability $(1-\chi)$ and bids $E(\zeta(c))$ with probability χ. Bidder i bids b. Notice that for any given $\chi \in [0,1)$ the expected profit of bidder i is the same as if $\chi = 0$. Thus, any symmetric cursed equilibrium will also be a symmetric Bayesian Nash equilibrium. This expected profit is given by

$$
\Pi_i(b, c_i) = \big(1 - G\big(\zeta^{-1}(b)\big)\big)^{n-1}(b - c_i).
$$

The first order condition associated with this problem is

$$
-(n-1)\big(1 - G\big(\zeta^{-1}(b)\big)\big)^{n-2}\frac{g(\zeta^{-1}(b))}{\zeta'(\zeta^{-1}(b))}(b - c_i) + \big(1 - G\big(\zeta^{-1}(b)\big)\big)^{n-1} = 0.
$$

In equilibrium, it must be the case that $b = \zeta(c_i)$. Utilizing this, we are left with an ordinary differential equation

$$
-(n-1)\big(1 - G(c_i)\big)^{n-2}g(c_i)\big(\zeta(c_i) - c_i\big) + \big(1 - G(c_i)\big)^{n-1}\big(\zeta'(c_i)\big) = 0.
$$

The initial condition is $\zeta(c_H) = c_H$. Notice that the above differential equation can be written as

$$\frac{d}{dv_i}\left(\left(1 - G(c_i)\right)^{n-1}\left(\zeta(c_i)\right)\right) = -(n-1)\left(1 - G(c_i)\right)^{n-2} g(c_i)c_i.$$

Integrating both sides leaves us with

$$\left(1 - G(c_i)\right)^{n-1}\left(\zeta(c_i)\right) = \int_{c_i}^{c_H} (n-1)\left(1 - G(t)\right)^{n-2} tg(t)dt.$$

Simplifying this yields the equilibrium bid function

$$\zeta(c_i) = E(u_{n-1}|u_{n-1} \geq c_i),$$

where $u_{n-1}$is the smallest of $n-1$ draws of c.

The equilibrium expected profit of bidder i is then

$$\Pi_i\left(\zeta(c_i), c_i\right) = \int_{c_i}^{c_H} (n-1)\left(1 - G(t)\right)^{n-2} tg(t)dt - \left(1 - G(c_i)\right)^{n-1} c_i.$$

The ex ante expected profit of bidder i is found by integrating with respect to c.

$$E\left(\Pi_i^{LR\text{-}PC}\left(\zeta(c), c\right)\right)$$
$$= \int_{c_L}^{c_H} \int_{t}^{c_H} (n-1)\left(1 - G(u)\right)^{n-2} ug(u)dug(t)dt - \int_{c_L}^{c_H} \left(1 - G(t)\right)^{n-1} tg(t)dt.$$

This simplifies to

$$E\left(\Pi_i^{LR\text{-}PC}\left(\zeta(c), c\right)\right) = \left(\frac{1}{n}\right)E(U_{n-1}) - \left(\frac{1}{n}\right)E(U_n),$$

where U_{n-1} is the second lowest of n draws of c. Thus the ex ante expected profit of the winner is given by $E(\Pi_{winner}^{LR\text{-}PC}) = E(U_{n-1}) - E(U_n)$. Since the total expected surplus in this auction is given by $D = E(V) - E(c|c = U_n)$, expected revenue in this equilibrium is $R^{LR\text{-}PC} = D - E(\Pi_{winner}^{LR\text{-}PC})$.