A. Bayes Nash Equilibrium Calculations (Online Appendix)

A.1. The Vickrey-Clark-Groves Mechanism

For $S \subseteq \{0,1,2,3\}$, let $v(S)$ indicate the maximum surplus that the coalition of players S can generate (where the seller is player 0). Then VCG profits for bidders $i = 1,2,3$ are

$$\pi_i^{\text{VCG}} \;=\; v(\bar{S}) - v(\bar{S} \setminus \{i\}) \tag{1}$$

where $\bar{S} = \{0,1,2,3\}$ is the grand coalition and $\bar{S} \setminus \{i\}$ is the grand coalition without bidder i. Given these payoffs, it is a dominant strategy for the bidders (of any type) to report their valuations truthfully to the seller. The seller's revenue in the VCG auction is

$$R^{\text{VCG}} \;=\; V_{opt} - \sum_{i=1}^{3} \pi_i^{\text{VCG}}.$$

A.2. The First Price Auction

Since the X-type bidders only value a pair of item, we need only consider their bids for two items; denote the equilibrium bid function for X-type bidder $b : [0,1] \to \mathbb{R}_+$ and let $\phi(b) = b^{-1}(b)$ be its inverse for $b \in [0,\bar{b}]$ with the upper bound $\bar{b}$ to be determined. Since the the Y-type bidders only value a package of three items, we need only consider her bids for three items; denote equilibrium bid function for type Y $B : [0,\alpha] \to \mathbb{R}_+$ for valuation and let $\Phi(b) = B^{-1}(b)$ be its inverse on $b \in [0,\bar{b}]$. As will be confirmed below for each environment, assume for now that the bidding functions are strictly increasing and their inverse functions are therefore well defined.

A.2.1. *XXX* Environment

Exactly two bidders will be awarded their desired packages in the auction. Therefore, each bidder wins if and only if she bids higher than the lowest of her two rivals. Supposing her rivals play according to their equilibrium strategies, let $\pi_X(b,w)$ denote the expected payoff of a bidder with valuation w when she bids b. Payoffs are

$$\pi_X(b,w) \;=\; (w-b)\big(1-(1-\phi(b))^2\big)$$

Equilibrium requires that $\frac{\partial}{\partial b}\pi_X(b,w) = 0$ when evaluated at the equilibrium strategies. This gives us the differential equation:

$$-\big(1-(1-\phi(b))^2\big) + 2\big(1-\phi(b)\big)\phi'(b) \;=\; -(2-w)w - 2(1-w)\big(b(w)-w\big)/b'(w) \;=\; 0$$

together with terminal condition $b(1) = \bar{b}$. This has the solution $b(w) = \frac{w(3-2w)}{3(2-w)}$.

A.2.2. *XXY* Environment

Exactly two bidders will be awarded their desired packages in the auction. Therefore, each bidder wins if and only if she bids higher than the lowest of her two rivals. Supposing her rivals play according to their equilibrium strategies, let $\pi_i(b,w)$ denote the expected payoff of the type i bidder with valuation w when she bids b. Payoffs are

$$\begin{aligned} \pi_X(b,w) &= (w-b)(1-(1-\phi(b))(1-\Phi(b)/\alpha) \\ \pi_Y(b,W) &= (W-b)(1-(1-\phi(b))^2) \end{aligned}$$

Equilibrium requires that $\frac{\partial}{\partial b}\pi_i(b,w)=0$ when evaluated at the equilibrium strategies. This gives us two differential equations to satisfy:

$$\big(1-\phi(b)\big)\Big(1-\frac{\Phi(b)}{\alpha}\Big)-\big(1-\phi(b)\big)\left(\Big(1-\frac{\Phi(b)}{\alpha}\Big)\phi'(b)+\big(1-\phi(b)\big)\frac{\Phi'(b)}{\alpha}\right)-1=0 \tag{2}$$

$$\big(1-\phi(b)\big)^2+2\big(1-\phi(b)\big)\big(\Phi(b)-b\big)\phi'(b)-1=0 \tag{3}$$

together with the terminal conditions $\phi(\bar{b})=1$ and $\Phi(\bar{b})=\alpha$. We can solve equations (2) and (3) for $\Phi(b)$ as a function of $\phi(b)$ and b only:

$$\Phi(b)=\frac{\phi(b)\big((\alpha+b)\phi(b)-2b(1+\alpha)\big)}{2\big(1-\phi(b)\big)\big(\phi(b)-b\big)} \tag{4}$$

We need $\Phi(\bar{b})=\alpha$; then (4) implies $\bar{b}=\frac{\alpha}{2+2\alpha}$. Substituting this back into (2) or (3), we arrive at a single differential equation

$$\phi'(b)=\frac{\big(\phi(b)-b\big)\big(2-\phi(b)\big)\phi(b)}{\big(\alpha-b\big)\big(\phi(b)^2+2b\phi(b)\big)-2b^2}. \tag{5}$$

Unfortunately, (5) does not admit a (clean) analytical solution but its numeric solution is simple to generate.

A.2.3. *XYY* Environment

For any set of bids, the seller will allocate two items to the X type bidder and three items to the highest Y type bidder. Therefore, $b(w)\equiv 0$ and a Y type bidder wins only if she out bids the other Y type bidder. Supposing her rivals play according to their equilibrium strategies, let $\pi_Y(b,W)$ denote the expected payoff of the type Y bidder with valuation W when she bids b. Payoffs are

$$\pi_Y(b,W)=(W-b)\Phi(b)$$

Equilibrium requires that $\frac{\partial}{\partial b}\pi_Y(b,w)=0$ whenever $b>0$ evaluated at the equilibrium strategies. This gives us the differential equation

$$-\Phi(b)+(W-b)\Phi'(b)=-W+(W-B(W))/B'(W)=0 \tag{6}$$

together with the initial condition $B(\alpha)=\bar{b}$. This has solution $B(W)=\frac{W}{2}$.

A.2.4. *YYY* Environment

The seller will allocated three items to the bidder submitting the highest bid. Therefore, a type Y bidder wins if she out bids both of her rivals. Supposing her rivals play according to their equilibrium strategies, let $\pi_Y(b,W)$ denote the expected payoff of the type Y bidder with valuation W when she bids b. Payoffs are

$$\pi_Y(b,W)=(W-b)\frac{\Phi(b)^2}{\alpha^2}$$

Equilibrium requires that $\frac{\partial}{\partial b}\pi_Y(b,w) = 0$ whenever $b > 0$ when evaluated at the equilibrium strategies. After multiplying by $\frac{\alpha^2}{W}$, this gives us the differential equation

$$-\Phi(b)^2 + 2(W-b)\Phi(b)\Phi'(b) = -W + 2\big(W - B(W)\big)/B'(W) = 0 \tag{7}$$

together with the terminal conditions $B(\alpha) = \bar{b}$. This has solution $B(W) = \frac{2W}{3}$.

A.3. The Simultaneous Multiple-Round Auction

Since the items within a package are substitutes for the bidders and they can freely switch demand between items throughout the auction, the price clocks will always display the same price. A bid function specifies the price level at which the bidder drops out of the auction; it will depend on the number and types of bidders still bidding in the auction. Beliefs are updated via Bayes rule and according to the equilibrium bid functions when a bidder observes a rival drop out of an auction.

A.3.1. *XXX* environment

Once any bidder stops bidding the auction ends; therefore, bidding functions depend only on the price level and the bidder's draw. A bidder wins if she outbids the lowest bid of her rivals.

Let $b : [0,1] \to \mathbb{R}_+$ denote a bidder's equilibrium bidding function and let $\phi(b) = b^{-1}(b)$ be its inverse for $b \in [0,\bar{b}]$ with the upper bound $\bar{b}$ to be determined. Supposing her rivals play according to their equilibrium strategies, let $\pi_X(b,w)$ denote her expected payoff when she bids b and her draw is $w \in [0,1]$. Equilibrium payoffs are

$$\hat{\pi}_X(b,w) = 2\int_0^{\phi(b)}\int_y^1 \Big(W - 2b(y)\Big)dzdy - b(1-\phi(b))^2. \tag{8}$$

The last term arises when the bidder drops out first at $p = b$ and is forced to purchase one good. Equilibrium requires that $\frac{\partial}{\partial b}\hat{\pi}_X(b,w) = 0$ whenever $b > 0$ when evaluated at the equilibrium strategies. This gives us the differential equation

$$2\phi'(b)(1-\phi(b))\big(w-2b\big) - (1-\phi(b))^2 + 2b(1-\phi(b)) = \frac{(1-w)}{b'(w)}(2(w-b(w)) - b'(w)(1-w)) = 0$$

together with the terminal conditions $b(0) = 0$. This gives $b(w) = w^2$.

A.3.2. *XXY* environment

Once any bidder stops bidding the auction ends; therefore, bidding functions depend only on the price level and the bidder's draw.

For a type X bidder with draw w, it is a dominant strategy to bid on two items if $p \leq \frac{w}{2}$ and otherwise to stop bidding on any items.[21]

Let B denote the Y type's equilibrium bidding function and let $\pi_Y(b,w)$ denote her expected payoff when she bids B and her draw is $w \in [0,\alpha]$. Given the X-types' strategy

$$\hat{\pi}_Y(b,W) = 2\int_0^{2b}\int_w^1 \Big(W - 3\frac{w}{2}\Big)dzdw - b(1-2b)^2. \tag{9}$$

[21] The auction for a type X bidder is mathematically identical to a second price sealed bid auction; a type X bidder's dominant strategy is to bid her valuation.

The last term arises when the Y type drops out at $p = b$ and is forced to purchase one item. Equilibrium requires that $\frac{\partial}{\partial b}\hat{\pi}_Y(b, w) = 0$ when evaluated at $b = B(W)$ whenever $B(W) > 0$ and $\frac{\partial}{\partial b}\pi_Y(b, w) \leq 0$ when evaluated at $b = B(W)$ whenever $B(W) = 0$. Since

$$\frac{\partial}{\partial b}\pi_Y\big(B(W), W\big) = \Big(4\big(W-2B(W)\big)-\big(1-2B(W)\big)\Big)\big(1-2B(W)\big) = \big(4W-1-6B(W)\big)\big(1-2B(W)\big) \geq 0$$

if and only if $W \geq \frac{1}{2}$, we have

$$B(W) = \begin{cases} 0 & \text{if } 0 \leq W < \frac{1}{4} \\ \frac{1}{3}\big(2W - \frac{1}{2}\big) & \text{if } \frac{1}{4} \leq W \leq \frac{3}{4} \\ 1 & \text{if } \frac{3}{4} \leq W \leq \alpha \end{cases} .$$

The second panel of the left hand side of Figure **??** plots this bid function and the type X bid function.

A.3.3. *XYY* environment

For a type X bidder with draw w, it is a dominant strategy to bid on two items if $p \leq \frac{w}{2}$ and otherwise to stop bidding on any items.

The auction ends only after a Y type drops out; therefore, a bidding functions for the Y type bidder will one her draw, the price level, and who remains in the auction – i.e. whether or not the X type bidder had dropped out. A Y can win if the type X bidder drops out *then* the rival type Y bidder drops out, or if the rival type Y bidder drops out while the type X type is still actively bidding.

Proceeding by backward induction, let $B^Y(W, p)$ denote the price level in equilibrium at which they type Y bidder drops out when her draw is W and the X type bidder has dropped out at the price level p and define $\Phi^Y(b, p)$ such that $B^Y(\Phi^Y(b, p), p) = b$. Supposing her rivals play according to their equilibrium strategies, let $\pi_Y^Y(b, W)$ denote a Y type bidder's expected payoff when she bids drops out at price level b and her draw is $W \in [0, \alpha]$. Equilibrium payoffs are

$$\pi_Y^Y(b, p, W) = \int_0^{\Phi^Y(b,p)} \Big(W - 3B^Y(V, p)\Big)\frac{dV}{\alpha} - 2b\Big(1 - \frac{\Phi(b, p)}{\alpha}\Big) \tag{10}$$

The last term arises when the bidder drops out at $p = b$ and is forced to purchase two items. Equilibrium requires that $\frac{\partial}{\partial b}\pi_Y(b, p, W) = 0$ whenever $b > 0$ when evaluated at the equilibrium strategies. This gives us the differential equation

$$\frac{\partial\Phi^Y(b, p)}{\partial b}(W - 3b) - 2\Big(1 - \frac{\Phi(b, p)}{\alpha}\Big) + \frac{2b}{\alpha}\frac{\partial\Phi^Y(b, p)}{\partial b} = \frac{1}{\frac{\partial B^Y(W,p)}{\partial W}}\Big(W - B^Y(W, p)\Big) - 2\Big(1 - \frac{W}{\alpha}\Big)$$

together with the terminal conditions $B(\alpha) = \bar{b}$. This gives

$$B^Y(W, p) = W - 2\sqrt{\alpha - W}\Big(\sqrt{\alpha - p} - \sqrt{\alpha - W}\Big).$$

Expected equilibrium profits for at Y type bidder with a draw of W in this stage – i.e. supposing that the X type bidder dropped out at p – are

$$\pi_Y^Y(p, W) = \pi_Y^Y(B^Y(W, p), p, W) = \frac{(W - p)^2}{2(\alpha - p)} - 2p$$

Let $B^{XY}(W)$ denote the price level in equilibrium at which they type Y bidder drops out when her draw is W and neither rival has dropped out and define $\Phi^{XY}(b)$ such that $B^{Y}(\Phi^{XY}(b)) = b$. Supposing her rivals play according to their equilibrium strategies, let $\pi_Y^{XY}(b, w)$ denote a Y type bidder's expected payoff when she bids drops out at price level b, neither rival has dropped out and her draw is $W \in [0, \alpha]$. Payoffs are

$$\pi_Y^Y(b, p, W) = \int_0^{\Phi^Y(b)} \int_{2b}^{1} \Big(W - 3B^{XY}(V)\Big) dy \frac{dV}{\alpha} - \int_{\Phi^Y(b, \frac{v}{2})}^{\alpha} \int_{2b}^{1} \pi_Y^Y\Big(\Phi^{XY}\big(b, \frac{y}{2}\big), \frac{y}{2}, W\Big) dv \frac{dV}{\alpha} \quad (11)$$

Equilibrium requires that $\frac{\partial}{\partial b}\pi_Y^{XY}(b, p, W) = 0$ whenever $b > 0$ when evaluated at the equilibrium strategies. After some manipulation, this gives us the differential equation

$$\big(W - 3B^{XY}(W)\big)\big(1 - 2B^{XY}(W)\big) - 4\frac{\partial B^{XY}(W)}{\partial W} B^{XY}(W)\big(\alpha - W\big) = 0$$

together with the terminal conditions $B(\alpha) = \bar{b}$. This equation has no simple analytical solution. Its numeric solution is display in the fourth panel of the left-hand side of Figure **??** for the case where the X type bidder drops out at price $\hat{p}$.

A.3.4. *YYY* environment

The auction ends only after two Y types drop out; therefore, a bidding functions for a Y type bidder will depend both on her draw, and how many bidders remains in the auction.

Proceeding by backward induction, let $B^Y(W)$ denote the price level in equilibrium at which they type Y bidder drops out when her draw is W and only one Y type bidder remains active in the auction. Define $\Phi^Y(b)$ such that $B^Y(\Phi^Y(b)) = b$. This is strategically identical to the stage in the *XYY* environment after the X type has dropped out. Therefore, as derived above,

$$B^Y(W, p) = W - 2\sqrt{\alpha - W}\Big(\sqrt{\alpha - p} - \sqrt{\alpha - W}\Big).$$

and expected equilibrium profits for a Y type bidder with a draw of W in this stage – i.e. supposing that first bidder dropped out at price p – are

$$\pi_Y^Y(p, W) = \pi_Y^Y(B^Y(W), p, W) = \frac{(W-p)^2}{2(\alpha - p)} - 2p$$

Let $B^{YY}(W, p)$ denote the price level in equilibrium at which the type Y bidder drops out when her draw is W and neither rival has dropped out and define $\Phi^{YY}(b)$ such that $B^{YY}(\Phi^{YY}(b)) = b$. Supposing her rivals play according to their equilibrium strategies, let $\pi_Y^{XY}(b, W)$ denote a Y type bidder's expected payoff when she bids drops out at price level b, neither rival has dropped out and her draw is $W \in [0, \alpha]$. Payoffs are

$$\pi_Y^Y(b, p, W) = \int_0^{\Phi^Y(b,p)} \int_V^W \pi_Y^Y(B^{YY}(V), W) \frac{dZ}{\alpha}\frac{dV}{\alpha} \quad (12)$$

Equilibrium requires that $\frac{\partial}{\partial b}\pi_Y^{YY}(b, p, W) = 0$ whenever $b > 0$ when evaluated at the equilibrium strategies. After some manipulation, this gives us the equation

$$-2(\alpha - W)B(W) = 0.$$

But this is negative whenever $B(W) > 0$. Thus, there is no symmetric equilibrium (in pure strategies) wherein all three Y type bidders bid above zero in the auction. Instead, we assume one bidder randomly drops out at any price $p \geq 0$. The remaining two bidders play the equilibrium strategy $B^Y(W, p)$ defined above.

B. Regressions and statistical test results (Online Appendix)

	FPSB	SMRA	FPSB-U	SMRA-U	FPSB-2
SMRA	.008	-	-	-	-
FPSB-U	.312	.008	-	-	-
SMRA-U	.008	.109	.008	-	-
FPSB-2	.023	.250	.016	.195	-
SMRA-2	.008	.383	.008	.312	.250

Table 5: p-values for the Wilcoxon Signed-Rank test where H_0: mean efficiency$_i$ = mean efficiency$_j$ for $i, j \in$ {FPSB,SMRA, FPSB-U , SMRA-U, FPSB-2 SMRA-2}. For each treatment we have eight independent observations, one for each group average. For efficiency, the VCG mechanism achieves the theoretical maximum and therefore non-parametric statistical tests will always reject the null-hypothesis.

	FPSB	SMRA	FPSB-U	SMRA-U	FPSB-2	SMRA-2
SMRA	.109	-	-	-	-	-
FPSB-U	.312	.016	-	-	-	-
SMRA-U	.016	.945	.023	-	-	-
FPSB-2	.195	.148	.078	.312	-	-
SMRA-2	.312	.078	.742	.008	.148	-
VCG	.312	.109	.055	.078	.844	.312

Table 6: p-values for the Wilcoxon Signed-Rank test where H_0: mean revenue$_i$ = mean revenue$_j$ for $i, j \in$ {FPSB,SMRA, FPSB-U , SMRA-U, FPSB-2 SMRA-2, VCG}. For each treatment we have eight independent observations, one for each group average.

	FPSB	SMRA	FPSB-U	SMRA-U	FPSB-2	SMRA-2
SMRA	.945	-	-	-	-	-
FPSB-U	.250	.641	-	-	-	-
SMRA-U	.383	.641	.383	-	-	-
FPSB-2	.742	.742	.742	.547	-	-
SMRA-2	.055	.195	.148	.008	.055	-
VCG	.008	.250	.008	.945	.023	.039

Table 7: p-values for the Wilcoxon Signed-Rank test where H_0: mean earnings$_i$ = mean earnings$_j$ for $i, j \in$ {FPSB,SMRA, FPSB-U , SMRA-U, FPSB-2 SMRA-2, VCG}. For each treatment we have eight independent observations, one for each group average.

	FPSB	SMRA	FPSB-U	SMRA-U	FPSB-2
SMRA	.000	-	-	-	-
FPSB-U	.878	.000	-	-	-
SMRA-U	.000	.161	.000	-	-
FPSB-2	.002	.105	.003	.195	-
SMRA-2	.000	.442	.000	.234	.105

Table 8: p-values for the Mann-Whitney U test where H_0: mean efficiency$_i$ = mean efficiency$_j$ for $i, j \in$ {FPSB,SMRA, FPSB-U , SMRA-U, FPSB-2 SMRA-2}. For each treatment we have eight independent observations, one for each group average. For efficiency, the VCG mechanism achieves the theoretical maximum and therefore non-parametric statistical tests will always reject the null-hypothesis.

	FPSB	SMRA	FPSB-U	SMRA-U	FPSB-2	SMRA-2
SMRA	.028	-	-	-	-	-
FPSB-U	.505	.038	-	-	-	-
SMRA-U	.003	.367	.027	-	-	-
FPSB-2	.574	.137	.382	.185	-	-
SMRA-2	.442	.038	.721	.078	.234	-
VCG	.279	.065	.234	.099	1.00	.246

Table 9: p-values for the Mann-Whitney U test where H_0: mean revenue$_i$ = mean revenue$_j$ for $i, j \in$ {FPSB,SMRA, FPSB-U , SMRA-U, FPSB-2 SMRA-2, VCG}. For each treatment we have eight independent observations, one for each group average.

	FPSB	SMRA	FPSB-U	SMRA-U	FPSB-2	SMRA-2
SMRA	.442	-	-	-	-	-
FPSB-U	.382	.505	-	-	-	-
SMRA-U	.279	.959	.234	-	-	-
FPSB-2	.505	.382	.878	.130	-	-
SMRA-2	.382	.083	.279	.130	.279	-
VCG	.078	.959	.065	.798	.069	.130

Table 10: p-values for the Mann-Whitney U test where H_0: mean earnings$_i$ = mean earnings$_j$ for $i, j \in$ {FPSB,SMRA, FPSB-U , SMRA-U, FPSB-2 SMRA-2, VCG}. For each treatment we have eight independent observations, one for each group average.

Dept. Variable: ***Efficiency***

	Informed		Uninformed		1-stage Pooled		2-stage	
	all rnds	*rnds 6-15*	*all rnds*	*rnds 6-15*	*all rnds*	*rnds 6-15*	*all rnds*	*rnds 6-15*
SMRA=1	-0.301***	-0.254***	-0.205***	-0.222***	-0.253***	-0.238***	-0.066	-0.025
	(0.010)	(0.046)	(0.053)	(0.051)	(0.036)	(0.034)	(0.057)	(0.044)
XXY	-0.030**	-0.007	0.045*	0.063***	0.008	0.028	-0.280	-0.253
	(0.014)	(0.019)	(0.022)	(0.011)	(0.023)	(0.017)	(0.229)	(0.226)
XYY	-0.073	-0.041	-0.046*	-0.022	-0.059**	-0.032	-0.017	0.039
	(0.050)	(0.030)	(0.023)	(0.034)	(0.028)	(0.023)	(0.042)	(0.043)
YYY	0.022	0.022	0.011	0.012	0.017	0.017	-0.080	-0.028
	(0.013)	(0.022)	(0.033)	(0.027)	(0.017)	(0.020)	(0.049)	(0.067)
SMRA=1 × XXY	0.005	-0.034	0.012	0.078	0.009	0.022	0.196	0.214
	(0.126)	(0.158)	(0.074)	(0.052)	(0.090)	(0.095)	(0.237)	(0.234)
SMRA=1 × XYY	-0.099	-0.259***	-0.014	0.067	-0.056	-0.096	-0.262***	-0.242***
	(0.080)	(0.064)	(0.065)	(0.077)	(0.077)	(0.103)	(0.072)	(0.065)
SMRA=1 × YYY	0.046	-0.005	-0.113	0.077	-0.033	0.036	-0.099	-0.142*
	(0.038)	(0.109)	(0.074)	(0.057)	(0.051)	(0.064)	(0.080)	(0.080)
Constant	0.936***	0.958***	0.936***	0.932***	0.936***	0.945***	0.865***	0.838***
	(0.002)	(0.019)	(0.022)	(0.011)	(0.011)	(0.012)	(0.004)	(0.011)
Observations	240	160	240	160	480	320	240	160
R^2	0.226	0.266	0.192	0.180	0.192	0.197	0.132	0.114

Robust standard errors, clustered at the group level, in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 11: Regression comparing the effect of using an SMRA format on efficiency, controlling for the value type composition of groups.

Dept. Variable: ***Revenue***

	Informed		Uninformed		1-stage Pooled		2-stage	
	all rnds	*rnds 6-15*	*all rnds*	*rnds 6-15*	*all rnds*	*rnds 6-15*	*all rnds*	*rnds 6-15*
SMRA=1	-43.267**	-58.000***	-26.333***	-25.000***	-34.800***	-41.500***	-16.133	-19.600
	(17.217)	(17.695)	(5.836)	(7.331)	(9.865)	(12.225)	(10.345)	(12.734)
XXY	-3.367	1.750	12.133	16.100*	4.383	8.925*	-27.767	-27.550
	(4.282)	(3.438)	(7.101)	(7.895)	(5.649)	(5.247)	(21.449)	(26.751)
XYY	-8.633*	-16.050***	-15.833	-18.200	-12.233	-17.125**	-17.600	-23.850
	(4.611)	(3.775)	(14.448)	(15.602)	(7.636)	(7.909)	(14.119)	(13.772)
YYY	-12.900*	-12.950**	-7.500	-8.600	-10.200**	-10.775*	-21.867**	-17.750*
	(6.098)	(5.805)	(6.976)	(9.068)	(4.722)	(5.295)	(9.872)	(8.977)
SMRA=1 × XXY	53.200**	58.000***	-16.967	-20.600*	18.117	18.700	55.367**	72.250**
	(18.378)	(19.214)	(14.144)	(11.185)	(15.999)	(16.226)	(24.393)	(28.673)
SMRA=1 × XYY	17.467	21.800	14.500	27.200	15.983	24.500	21.100	3.900
	(26.644)	(25.509)	(16.968)	(20.626)	(16.210)	(19.868)	(22.454)	(30.369)
SMRA=1 × YYY	17.400	12.950	10.333	3.100	13.867	8.025	71.167***	80.150**
	(17.773)	(18.523)	(14.297)	(9.503)	(12.628)	(14.407)	(19.720)	(33.574)
Constant	200.767***	203.750***	200.667***	201.500***	200.717***	202.625***	201.100***	205.100***
	(4.274)	(3.399)	(5.831)	(7.245)	(3.530)	(3.934)	(9.809)	(8.739)
Observations	240	160	240	160	480	320	240	160
R^2	0.128	0.276	0.112	0.131	0.088	0.160	0.112	0.197

Robust standard errors, clustered at the group level, in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 12: Regression comparing the effect of using an SMRA format on seller's revenue, controlling for the value type composition of groups.

Dept. Variable: ***Profits***

	Informed		Uninformed		1-stage Pooled		2-stage	
	all rnds	*rnds 6-15*	*all rnds*	*rnds 6-15*	*all rnds*	*rnds 6-15*	*all rnds*	*rnds 6-15*
SMRA=1	24.983	42.425**	13.483**	11.000	19.233**	26.713**	12.650	18.675***
	(17.462)	(18.076)	(5.356)	(8.212)	(9.398)	(12.490)	(8.636)	(6.326)
XXY	3.983	0.625	-5.617	-8.725	-0.817	-4.050	8.683	9.675
	(5.746)	(2.687)	(7.941)	(5.838)	(5.391)	(3.856)	(9.720)	(10.532)
XYY	-1.617	5.150***	7.283	8.350	2.833	6.750	10.117	16.875*
	(5.366)	(1.189)	(11.466)	(11.315)	(6.578)	(5.619)	(9.961)	(8.303)
YYY	-9.050*	-10.350***	-15.183**	-15.675**	-12.117***	-13.012***	-8.017	-9.950
	(4.252)	(2.282)	(5.892)	(6.486)	(3.890)	(3.562)	(9.209)	(6.484)
SMRA=1 × XXY	-56.483***	-63.175***	15.167	23.525*	-20.658	-19.825	-41.333**	-56.725***
	(18.860)	(18.857)	(10.373)	(11.264)	(17.089)	(18.017)	(18.369)	(14.290)
SMRA=1 × XYY	-33.550	-49.250**	-18.967	-25.275	-26.258*	-37.263**	-45.950**	-24.375
	(22.166)	(23.078)	(18.221)	(16.777)	(14.811)	(16.035)	(20.760)	(30.060)
SMRA=1 × YYY	-17.817	-16.250	-21.200	0.175	-19.508	-8.038	-79.800***	-90.925**
	(17.630)	(18.354)	(16.938)	(10.809)	(13.528)	(14.047)	(20.466)	(31.217)
Constant	18.383***	17.850***	18.283***	18.425***	18.333***	18.137***	13.433	8.975*
	(3.546)	(0.822)	(3.719)	(3.455)	(2.508)	(1.733)	(8.598)	(4.874)
Observations	240	160	240	160	480	320	240	160
R^2	0.070	0.148	0.088	0.083	0.035	0.060	0.196	0.262

Robust standard errors, clustered at the group level, in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 13: Regression comparing the effect of using an SMRA format on beddiers' profits, controlling for the value type composition of groups.

C. Istructions (Online Appendix)

C.1. Instructions for SMRA

Welcome to the UTS Behavioural Laboratory

Welcome and thank you for participating in today's experiment.

Place all of your personal belongings away, so we can have your complete attention. In particular, please turn off your phone and put it away.

Please sit at the computer you have been assigned to and log on using your usual UTS username and password. Click once on the grey screen and await further instructions.

The Experiment

The experiment you will be participating in today will involve a series of auctions. At the end of the experiment you will be paid in cash for your participation. Each of you may earn different amounts. The amount you earn depends on your decisions, chance, and on the decisions of others.

You will be using the computer for the entire experiment, and all interaction between you and others will be through computer terminals. Please DO NOT socialize or talk during the experiment.

If you have any questions, raise your hand and your question will be answered so everyone can hear.

The Auction

The experiment consists of a series of **15 periods.** In each period, there will be an auction.

In the auction, you will be in a group of **3 bidders** (you and 2 other bidders). You will remain in the same group for all 15 periods.

In each auction, there will be **5 items** for sale, labeled A through E.

A B C D E

Each bidder can win a **maximum of 3 items.**

We will explain the details of the auction later. We first explain the items' values to you.

Bidder Values

Each bidder has values for winning a single item, two items or three items. These values depend on the following:

- Your type: **X** or **Y**. Your type will remain the same throughout the experiment.
- Whether item A is among the items you won. Item A has a lower value than the other items.
- Whether winning items are consecutive, e.g. AB or CDE (but not AC or ACE). The value for winning consecutive items is higher than the sum of individual item values.
- A random number **R** between 25 and 35, with all numbers in this range being equally likely. In each period, each bidder will get their own random number, so the random number will likely differ from bidder to bidder. Also, each bidder will get a new draw when a new period starts, so your random number will likely differ from period to period.

Bidder Values

The value of winning **consecutive** items, e.g. AB or CDE (but not AC or ACE), is higher than the sum of individual item values.

For type X:

# of items	Value **WITH** item A	Value **WITHOUT** item A
1 item	5	10
2 **consecutive** items	10 + 1.5 **R**	10 + 3 **R**
3 **consecutive** items	10 + 3.5 **R**	10 + 4 **R**

For type Y:

# of items	Value **WITH** item A	Value **WITHOUT** item A
1 item	5	10
2 **consecutive** items	10 + 0.5 **R**	10 + **R**
3 **consecutive** items	10 + 3 **R**	10 + 5 **R**

Bidder Values

Example: **If R = 30, the tables become**

Type X:

# of items	Value **WITH** item A	Value **WITHOUT** item A
1 item	5	10
2 **consecutive** items	55	100
3 **consecutive** items	115	130

Type Y:

# of items	Value **WITH** item A	Value **WITHOUT** item A
1 item	5	10
2 **consecutive** items	25	40
3 **consecutive** items	100	160

Bidder Values

Note that:

- The increase in value from winning a 2nd item is higher for type **X** than for type **Y**.
- The increase in value from winning a 3rd item is higher for type **Y** than for type **X**.

In each period, you will be shown a table with your values like the one shown before. You will not be shown the R you draw.

You will know your type and the type of the other bidders in your group.

You will not know the exact values of the other bidders.

Bidding

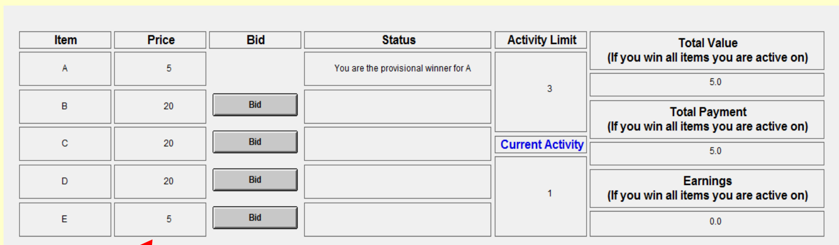
Each auction proceeds in a series of rounds. In each round of the auction, you will see a **price for each item**.

You can then **bid for the items** you want at the given prices by clicking a button.

After submitting your bids, the computer assigns a **provisional winner** for each item, chosen randomly among the bidders that bid for it. If the auction ends, provisional winners become actual winners for the items.

In the next round you are informed about the items for which you are the provisional winner, **prices are increased by 15 points** and you can place bids for the other items.

Bidding



Prices are increased by 15 points every round

Activity

Your **activity** is the number of items you are provisionally winning plus the number of other items you bid for.

Your activity cannot exceed your **activity limit.** Your initial activity limit is **3.**

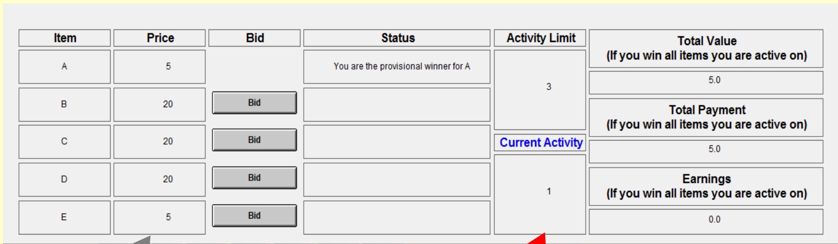
In each round, your activity limit is reset to your previous round activity. Therefore, if you do not use all your available activity in a given round, your activity limit is reduced in the next round.

<u>Example 1:</u> Suppose your **activity limit is 3** and you are the provisional winner on 1 item. So you have 2 units of spare activity.

- If you bid on 2 more items, your next-round activity limit will again be 3
- If you bid on 1 more item, your next-round activity limit will decrease to 2
- If you do not place any bid, your next-round activity limit will decrease to 1

<u>Example 2:</u> Suppose your **activity limit is 1** and you are the provisional winner on 1 item. In this case, you have no spare activity and cannot place bids on additional items.

Bidding



Prices are increased by 15 points every round

If you do not use all your available activity in a given round, your activity limit is reduced in the next round.

Auction end and payments

Depending on the bids submitted in the group, each auction will proceed in multiple rounds. The auction ends if no bidder places a new bid, or if no bidder has any spare activity left to bid (i.e. if all bidders are provisional winners for as many items as their activity limits)

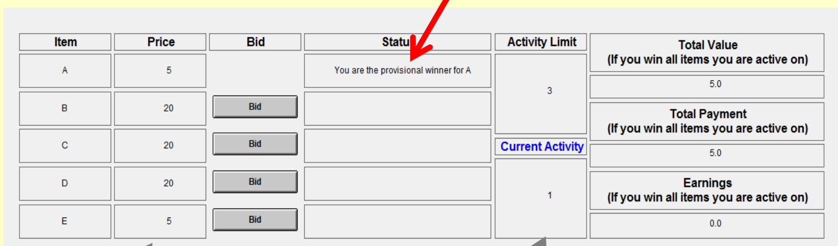
When the auction ends, you will be informed about the items you win.

Your payment will equal the sum of the prices at which you won each item.

Your activity limit will be reset to 3 when a new auction starts.

Bidding

Provisional winner ≠ Final winner



Prices are increased by 15 points every round

If you do not use all your available activity in a given round, your activity limit is reduced in the next round.

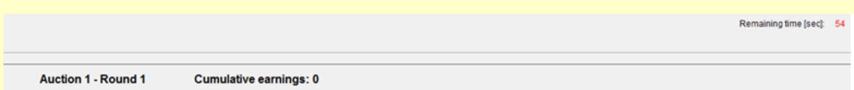
Rounds and Timer

Each auction consists of **multiple rounds. Round 1** will last for **at most 60 seconds**. Any further round will last for **at most 30 seconds**.

If you don't need the full 30 or 60 seconds then you can speed up the auction: select the items you want to bid for and click "**Done**". If you do not use this option the software will automatically move to the next round after 30 or 60 seconds with whatever items you have selected at that point. **Your next-round activity limit will be reduced** if you did not use all available activity.

If you don't have spare activity left and cannot bid on new items then you will automatically be moved on to the next stage after **10 seconds**.

On the decision screen, you will see the timer counting down (top right corner) as well as the auction, round and the cumulative earnings.



Earnings

Your earnings from each auction equal the value of the items you win minus your payment.

Your Earnings = Your Value – Your Payment

NOTE: if your Total Payment exceeds your Value for the items you won then your earnings will be negative and will be subtracted from your cumulative earnings so far. If you finish the experiment with negative earnings you will only be paid the show-up fee.

Results

Item	Final Price	Winner
A	35	Bidder 1
B	35	**You**
C	5	Bidder 3
D	0	
E	0	

Total Value	Auction Earnings
10.0	-25.0
Total Payment	**Cumulative Earnings**
35.0	-25.0

OK

Final Prices

Final Winner

Earnings are negative when total payment exceeds total value

Summary

The experiment consists of a series of **15 auctions** preceded by 1 **practice auction** that does not affect earnings.

You will be either a **type X** or a **type Y** bidder. Your type will remain the same throughout the experiment. Your type and that of others in your group will be shown on your screen.

In each auction, each bidder receives a **new** random number **R** that determines the values for winning 1, 2, or 3 items.

The value of winning **consecutive** items is **higher** than the sum of individual item values.

Each auction consists of multiple rounds:

- Your activity (items you are provisional winner for and items you bid for) cannot exceed your activity limit.
- Your current activity will be your next round's activity limit.
- Prices increase by **15** every round.

Your earnings are equal to the value of the items you win minus your payment.

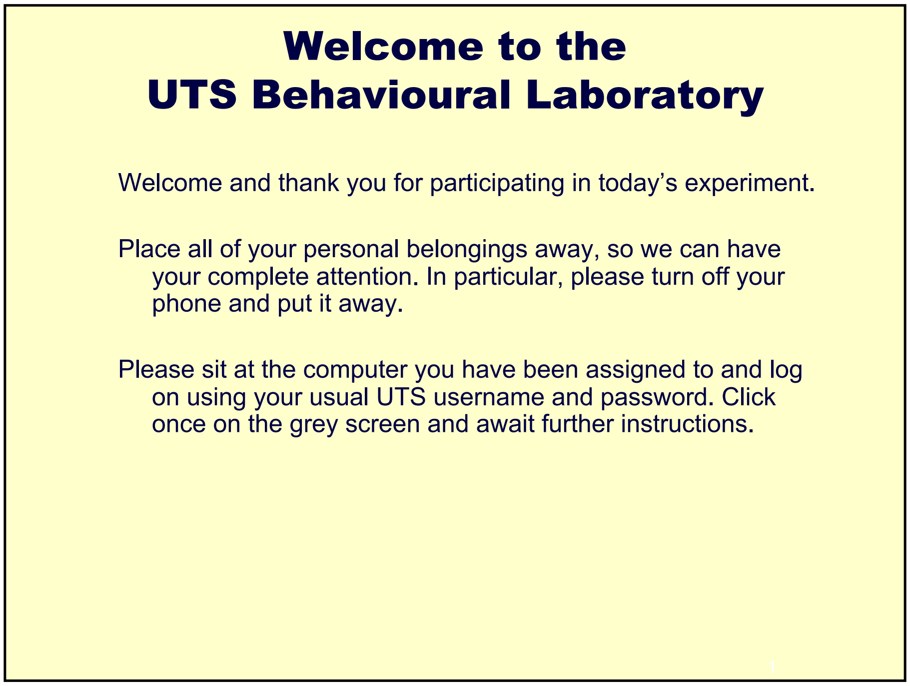
Concluding Remarks

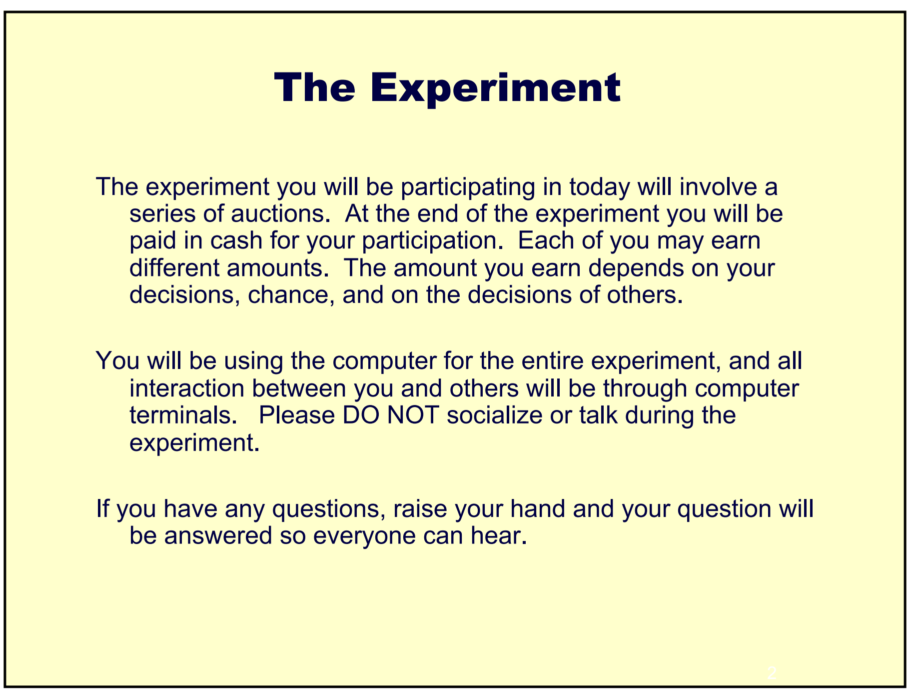
The exchange rate used in the experiment is **1 dollar for every 4 points**.

You also receive a **$10 participation fee**.

You will be paid at the end of the experiment the total amount you have earned in all of the periods. You need not tell any other participant how much you earned.

C.2. Instructions for FPSB-U





The Auction

The experiment consists of a series of **15 periods.** In each period, there will be an auction.

In the auction, you will be in a group of **3 bidders** (you and 2 other bidders). You will remain in the same group for all 15 periods.

In each auction, there will be **5 items** for sale, labeled A through E.

Each bidder can win a **maximum of 3 items.**

We will explain the details of the auction later. We first explain the items' values to you.

Bidder Values

Each bidder has values for winning a single item, two items or three items. These values depend on the following:

- Whether item A is among the items you won. Item A has a lower value than the other items.
- In each period, each bidder will get their own values, and the values will likely differ from bidder to bidder. Also, each bidder will get new values when a new period starts, so your values will likely differ from period to period.

Bidder Values

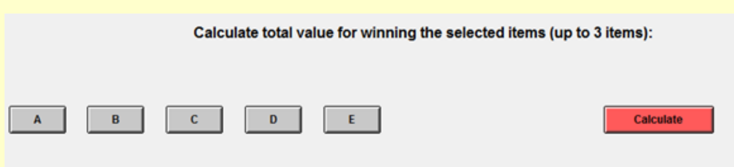
In each period, you will be shown a table with your values like the one shown below. The numbers used in the experiment will be quite different from the ones below, which are shown for illustrative purposes only.

You will not know the values of the other bidders.

# of items	Value **WITH** item A	Value **WITHOUT** item A
1 item	1	2
2 items	4	7
3 items	8	9

Example of values

A calculator is available on your screen to calculate the value of any possible combination of items you can win.



Bidding

In each auction, you are asked to submit bids for different quantities of items **WITH** or **WITHOUT** **Item A**.

# of Items	value WITH Item A	value WITHOUT Item A
1 Item		
2 Items		
3 Items		

You place 6 bids in total: for 1, 2, and 3 items with or without item A.

But **at most one** of these bids can be winning. The computer assigns the 5 items such that the sum of the winners' payments is maximized.

If one of your bids is winning then you pay that bid (you pay nothing if none of your bids are winning).

Earnings

Your earnings from each auction equal the value of the items you win minus your payment.

Your Earnings = Your Value – Your Payment

NOTE: if your Payment exceeds your Value for the items you won then your earnings will be negative and will be subtracted from your cumulative earnings so far. If you finish the experiment with negative earnings you will only be paid the show-up fee.

Summary

The experiment consists of a series of **15 auctions** preceded by 1 **practice auction** that does not affect earnings.

In each auction, each bidder receives **new** values for winning 1, 2, or 3 items **with** or **without** **item A**

You will know your values but not the ones of other bidders

Item A has a **lower** value than the other items.

You bid for the number of items you want to win **with** or **without** **item A**

Your earnings are equal to the value of the items you win **minus** your payment.

Concluding Remarks

The exchange rate used in the experiment is **1 dollar for every 4 points**.

You also receive a **$10 participation fee**.

You will be paid at the end of the experiment the total amount you have earned in all of the periods. You need not tell any other participant how much you earned.

C.3. Instructions for SMRA-2

Welcome to the UTS Behavioural Laboratory

Welcome and thank you for participating in today's experiment.

Place all of your personal belongings away, so we can have your complete attention. In particular, please turn off your phone and put it away.

Please sit at the computer you have been assigned to and log on using your usual UTS username and password. Click once on the grey screen and await further instructions.

The Experiment

The experiment you will be participating in today will involve a series of auctions. At the end of the experiment you will be paid in cash for your participation. Each of you may earn different amounts. The amount you earn depends on your decisions, chance, and on the decisions of others.

You will be using the computer for the entire experiment, and all interaction between you and others will be through computer terminals. Please DO NOT socialize or talk during the experiment.

If you have any questions, raise your hand and your question will be answered so everyone can hear.

The Auction

The experiment consists of a series of **15 periods.** In each period, there will be an auction.

In the auction, you will be in a group of **3 bidders** (you and 2 other bidders). You will remain in the same group for all 15 periods.

In each auction, there will be **5 items** for sale, labeled A through E.

A B C D E

Each bidder can win a **maximum of 3 items.**

We will explain the details of the auction later. We first explain the items' values to you.

Bidder Values

Each bidder has values for winning a single item, two items or three items. These values depend on the following:

- Your type: **X** or **Y**. Your type will remain the same throughout the experiment.
- Whether item A is among the items you won. Item A has a lower value than the other items.
- A random number **R** between 25 and 35, with all numbers in this range being equally likely. In each period, each bidder will get their own random number, so the random number will likely differ from bidder to bidder. Also, each bidder will get a new draw when a new period starts, so your random number will likely differ from period to period.

Bidder Values

For type X:

# of items	Value **WITH** item A	Value **WITHOUT** item A
1 item	5	10
2 items	10 + 1.5 **R**	10 + 3 **R**
3 items	10 + 3.5 **R**	10 + 4 **R**

For type Y:

# of items	Value **WITH** item A	Value **WITHOUT** item A
1 item	5	10
2 items	10 + 0.5 **R**	10 + **R**
3 items	10 + 3 **R**	10 + 5 **R**

Bidder Values

Example: **If R = 30, the tables become**

Type X:

# of items	Value **WITH** item A	Value **WITHOUT** item A
1 item	5	10
2 items	55	100
3 items	115	130

Type Y:

# of items	Value **WITH** item A	Value **WITHOUT** item A
1 item	5	10
2 items	25	40
3 items	100	160

Bidder Values

Note that:

- The increase in value from winning a 2nd item is higher for type **X** than for type **Y**.
- The increase in value from winning a 3rd item is higher for type **Y** than for type **X**.

In each period, you will be shown a table with your values like the one shown before. You will not be shown the R you draw.

You will know your type and the type of the other bidders in your group.

You will not know the exact values of the other bidders.

First Stage Bidding

Each auction proceeds in a series of rounds. In each round, you will see a **price**. You can then **demand items** at that price

After all bidders submit their demands, the computer **provisionally assigns** the items:

- If only you submitted a demand at this round's price then you will be provisionally assigned your demand
- If more than one bidder submitted a demand at this round's price then they will be provisionally assigned their demand in random order

Example:

- Only you bid for 3 items at a price of 20, then you get all 3 items.
- All three bidders bid for 3 items at a price of 20. Then one bidder is randomly chosen to get 3 items, a next bidder is randomly chosen to get 2 items, and the final bidder gets 0 items.

In a new round of the auction the price is **increased by 10 points** and the bidders can then place their demands at that new price.

Bidding

Activity

Your activity in a round is determined as follows:

- If you **DO NOT** or **CAN NOT** bid this round: your activity is equal to the number of items you were provisionally assigned in the previous round
- If you **DO** bid this round: your activity equals the number of items you bid for

Your activity cannot exceed your **activity limit.** Your initial activity limit is **3.**

In each new round, your activity limit is reset to your previous round activity. Therefore, if you do not use all your available activity in a given round, your activity limit is reduced in the next round.

You cannot place new bids if you have **no spare activity**, i.e. when the number of items you provisionally win equals your activity limit. If you **have spare activity** then you can bid on **more items** than you are provisionally winning (but not more than your activity limit):

- If your activity limit is 3 and you provisionally win
  - - 0 items then you can bid for 1, 2 or 3 items
  - - 1 item then you can bid for 2 or 3 items
  - - 2 items then you can bid for 3 items
- If your activity limit is 2 and you provisionally win
  - - 0 items then you can bid for 1 or 2 items
  - - 1 item then you can bid for 2 items
- If your activity limit is 1 and you provisionally win 0, you can bid for 1 item