A Appendix

A.1 Solution to the case of one informed buyer (standard preferences)

Suppose there are $m \geq 2$ sellers and $n \geq 2$ buyers, with exactly 1 informed buyer and the remaining $n-1$ buyers uninformed. Let $\bar{U}$ be buyers' common valuation for the good (in the experiment, $\bar{U} = 20$).

Proposition 3 *Define*

$$p^* = \bar{U}\left[1 - \left(1 - \frac{1}{m}\right)^{n-1}\right]. \quad (4)$$

Then there exists a unique symmetric subgame perfect equilibrium. In this equilibrium, each seller's price is drawn from a distribution with support $[p^*, \bar{U}]$ and no mass points. For p in this interval, the cumulative distribution function (c.d.f.) F is given by

$$F(p) = 1 - \left[\frac{p^*(\bar{U} - p)}{p(\bar{U} - p^*)}\right]^{\frac{1}{m-1}}. \quad (5)$$

Proof: Buyer behavior is straightforward: each of the u uninformed buyers mixes uniformly over sellers, and the one informed buyer chooses the lowest–priced seller with certainty, or mixes among them if there is more than one lowest–priced seller. So, a seller choosing price $p \leq \bar{U}$ will sell for sure if it is the lowest price (since the informed buyer visits); while if another seller has a strictly lower price, she will sell with probability $1 - \left(1 - \frac{1}{m}\right)^{n-1}$, the probability of at least one uninformed buyer visiting. Finally, if she is one of exactly k lowest–priced sellers, she will sell with probability $1 - \left(1 - \frac{1}{k}\right)\left(1 - \frac{1}{m}\right)^{n-1}$; note that this is strictly larger than $1 - \left(1 - \frac{1}{m}\right)^{n-1}$ for any $k \in \{1, 2, ..., n\}$, and strictly smaller than one as long as $k > 1$ (i.e., the seller is tied with at least one other seller).

Let F be the common c.d.f. of the sellers. F cannot have a mass point at any price $p \in [p^*, \bar{U}]$, since then a seller could improve her profit by shifting some mass from p slightly to the left (removing the chance of a tie and hence discontinuously raising the probability of selling, with only a second–order decrease in the selling price).[20] Also, F cannot have a "gap" – an interval (p_0, p_1) with zero density throughout but positive density below and above – since then choosing price p_1 would earn a strictly higher profit than prices just below p_0, as it would increase the selling price with only a second–order decrease in the probability of selling.

Let $\hat{p} = sup\{p|F(p) = 0\}$ and $\tilde{p} = min\{p|F(p) = 1\}$ (the latter exists because of right–continuity of c.d.f.'s). Then choosing $\tilde{p}$ yields profit $\pi(\tilde{p}) = \tilde{p}\left[1 - \left(1 - \frac{1}{m}\right)^{n-1}\right]$. But choosing price $\bar{U}$ yields profit $\pi(\bar{U}) = \bar{U}\left[1 - \left(1 - \frac{1}{m}\right)^{n-1}\right]$, so we cannot have $\tilde{p} < \bar{U}$. Also, any price above $\bar{U}$ yields zero profit, so we cannot have $\tilde{p} > \bar{U}$. Hence we must have $\tilde{p} = \bar{U}$.

Then, choosing $\hat{p}$ yields profit $\pi(\hat{p}) = \hat{p}$, which must be equal to $\pi(\bar{U})$; that is, $\hat{p} = p^*$ as defined in (4). So, p^* and $\bar{U}$ are the left and right endpoints of the smallest closed interval containing the support of

[20] The arguments for this "no mass point" assertion and the upcoming "no gap" assertion are based on arguments used by Varian (1980, pp. 653–654) in his model of temporal price dispersion.

the price distribution. Since we have already noted there are no "gaps" in this support, this means that the support of F is exactly $[p^*, \bar{U}]$.

Finally, let $p \in [p^*, \bar{U}]$. Since F has no mass points, the probability of another seller choosing exactly p is zero, so we can ignore the possibility of ties for the lowest price. Then p is the lowest price with probability $[1 - F(p)]^{m-1}$, in which case it sells for sure; otherwise, another seller's price is strictly lower, in which case it sells with probability $1 - \left(1 - \frac{1}{m}\right)^{n-1} = p^*/\bar{U}$. So, the resulting expected profit is given by

$$\pi(p) = p \cdot [1 - F(p)]^{m-1} + p \cdot \frac{p^*}{\bar{U}} \left\{1 - [1 - F(p)]^{m-1}\right\}$$

Since there is positive density at p, it must yield profit equal to that of p^*, so

$$p^* = p \cdot [1 - F(p)]^{m-1} + p \cdot \frac{p^*}{\bar{U}} \left\{1 - [1 - F(p)]^{m-1}\right\}.$$

Solving for $F(p)$ yields (5). □

Note that for the special case of the 2x2–1 market, (5) simplifies to $F(p) = 2 - 20/p$, so the corresponding probability density function (p.d.f.) is $f(p) = 20/p^2$ with support [10, 20] and expected value $E(p) = 20 \cdot ln(2) \approx 13.86$.

A.2 Proofs of Propositions 1 and 2 (2x2–0 case)

Proposition 1

Let $\bar{U}$ be buyers' common valuation for the good (in the experiment, $\bar{U} = 20$). Suppose the sellers post prices p_1 and p_2, not both equal to $\bar{U}$, and with $p_1 \leq p_2$ without loss of generality. Define $c_i = c(p_i - p^*)$.

(i) Then in the symmetric equilibrium of the game played between buyers, the probability a given buyer visits Seller 1 is given by

$$q^* = \frac{\bar{U} - 2p_1 + p_2 - 2c_1 + 2c_2}{2\bar{U} - p_1 - p_2}, \tag{6}$$

when this is between 0 and 1.[21] Note that when $c_1 = c_2 = 0$, this expression reduces to (2) in Section 4.3.

Now,

$$\frac{\partial q^*}{\partial p^*} = \frac{2}{2\bar{U} - p_1 - p_2} \left(\frac{\partial c_2}{\partial p^*} - \frac{\partial c_1}{\partial p^*}\right),$$

and note that the expression outside the parentheses is positive, so that $\frac{\partial q^*}{\partial p^*}$ has the same sign as $\left(\frac{\partial c_2}{\partial p^*} - \frac{\partial c_1}{\partial p^*}\right)$. Since $p_1 \leq p_2$, this means that $\frac{\partial q^*}{\partial p^*} < 0$ if $c(\cdot)$ is convex (which is true by assumption), and also that q^* is the probability of visiting the lower–priced seller. Thus, as p^* increases, the equilibrium probability of visiting the lower–price seller decreases. □

[21] Since at least one price is less than $\bar{U}$, q^* exists. If the right–hand side of (6) is less than zero (more than one), buyers visit Seller 2 (Seller 1) with certainty.

(ii) Suppose now that p^* varies across buyers, with a distribution over $[0, \bar{U}]$ that is common knowledge. Suppose that each buyer's value of p^* is his private information. Then a given buyer's expected utility from visiting Seller 1 and Seller 2 are

$$q\left[\frac{\bar{U}-p_1}{2}\right]+(1-q)[\bar{U}-p_1]-c(p_1-p^*)=\left(1-\frac{q}{2}\right)[\bar{U}-p_1]-c(p_1-p^*)$$

and

$$q[\bar{U}-p_2]+(1-q)\left[\frac{\bar{U}-p_2}{2}\right]-c(p_2-p^*)=\frac{1+q}{2}[\bar{U}-p_2]-c(p_2-p^*)$$

respectively, where q is the probability that the rival buyer (who from this buyer's standpoint is randomly chosen from the population) visits Seller 1. So the buyer prefers to visit Seller 1 if

$$c_2-c_1>\frac{1+q}{2}[\bar{U}-p_2]-\left(1-\frac{q}{2}\right)[\bar{U}-p_1], \tag{7}$$

where $c_i = c(p_i - p^*)$. She prefers to visit Seller 2 if the inequality in (7) is reversed, and is indifferent if the inequality sign is replaced by an equal sign. (In particular, if $c_1 = c_2 = 0$, equality yields the equilibrium mixed–strategy under standard preferences.) So, other things equal, the larger is c_2 relative to c_1, the more likely she is to prefer Seller 1.

Now, suppose $p_1 < p_2$. Then as p^* decreases, c_2 increases relative to c_1 due to the convexity of c, so the buyer will be more likely to visit Seller 1 – who is the lower-price seller – meaning the buyer is more price–responsive. Similarly, if $p_1 > p_2$, then as p^* decreases, c_2 decreases relative to c_1, so the buyer will be more likely to visit Seller 2 (who is now the lower-price seller), so again the buyer is more price–responsive. □

Proposition 2

A seller's utility is given by

$$\Pi_i = \Phi_i \cdot p_i - c(p_i - p^*),$$

where Φ_i is the probability that at least one buyer visits the seller (which is a function of p_i and other sellers' prices, but not p^*). We assume that $\frac{\partial \Phi_i}{\partial p_i}$ and $\frac{\partial^2 \Phi_i}{\partial p_i^2}$ are negative for any rival seller price, as is true when buyers have standard preferences or weak fairness preferences, and for prices sufficiently near p^* under strong fairness preferences. We also assume that $\frac{\partial^2 \Phi_i}{\partial p_i \partial p_j} = 0$; this will be exactly true in equilibrium when buyers have standard preferences, or more generally when they have the same fairness preferences.

(i) Then a given seller's utility is maximized when

$$0 = \Phi_i + \frac{\partial \Phi_i}{\partial p_i} - \frac{\partial c}{\partial p_i},$$

and the equilibrium condition is that this holds when $p_1 = p_2 = p$, in which case $\Phi_i = 0.75$. Implicit differentiation yields

$$0=\left[\frac{\partial \Phi_i}{\partial p_i}+p_i\frac{\partial^2 \Phi_i}{\partial p_i^2}+p_i\frac{\partial^2 \Phi_i}{\partial p_i \partial p_j}-\frac{\partial^2 c}{\partial p_i^2}\right]\cdot dp_i-\frac{\partial^2 c}{\partial p_i \partial p^*}\cdot dp^*,$$

or

$$\frac{dp}{dp^*} = \frac{-\frac{\partial^2 c}{\partial p_i \partial p^*}}{\frac{\partial^2 c}{\partial p_i^2} - \frac{\partial \Phi_i}{\partial p_i} - p\frac{\partial^2 \Phi_i}{\partial p_i^2} - p\frac{\partial^2 \Phi_i}{\partial p_i \partial p_j}} = \frac{\frac{\partial^2 c}{\partial p_i^2}}{\frac{\partial^2 c}{\partial p_i^2} - \frac{\partial \Phi_i}{\partial p_i} - p\frac{\partial^2 \Phi_i}{\partial p_i^2} - p\frac{\partial^2 \Phi_i}{\partial p_i \partial p_j}}.$$

By convexity of c, the numerator and the first term of the denominator of the last expression are positive, and by assumption, $\frac{\partial \Phi_i}{\partial p_i}$ and $\frac{\partial^2 \Phi_i}{\partial p_i^2}$ are negative and $\frac{\partial^2 \Phi_i}{\partial p_i \partial p_j}$ is zero, so that the entire denominator and thus $\frac{dp}{dp^*}$ is positive. $\square$

(ii) Suppose now that p^* varies across sellers, with a distribution over $[0, \bar{U}]$ that is common knowledge, and that each seller's value of p^* is his private information. Then sellers' posted prices may depend on their own value of p^*.

So, a seller's expected utility is given by

$$E\Pi_i = E\Phi_i \cdot p_i - c(p_i - p^*)$$

(where the expectation is over the distribution of rival–seller prices). This is maximised when

$$0 = E\Phi_i + \frac{\partial E\Phi_i}{\partial p_i} - \frac{\partial c}{\partial p_i}.$$

Implicit differentiation yields

$$0 = \left[2\frac{\partial E\Phi_i}{\partial p_i} + p_i\frac{\partial^2 E\Phi_i}{\partial p_i^2} - \frac{\partial^2 c}{\partial p_i^2}\right] \cdot dp_i - \frac{\partial^2 c}{\partial p_i \partial p^*} \cdot dp^*,$$

or

$$\frac{dp_i}{dp^*} = \frac{-\frac{\partial^2 c}{\partial p_i \partial p^*}}{\frac{\partial^2 c}{\partial p_i^2} - 2\frac{\partial E\Phi_i}{\partial p_i} - p_i\frac{\partial^2 E\Phi_i}{\partial p^2}} = \frac{\frac{\partial^2 c}{\partial p_i^2}}{\frac{\partial^2 c}{\partial p_i^2} - 2\frac{\partial E\Phi_i}{\partial p_i} - p\frac{\partial^2 E\Phi_i}{\partial p_i^2}}.$$

By convexity of c, the numerator and the first term of the denominator of the last expression are positive, and by assumption, $\frac{\partial \Phi_i}{\partial p_i}$ and $\frac{\partial^2 \Phi_i}{\partial p_i^2}$ are negative for any rival price, so that $\frac{\partial E\Phi_i}{\partial p_i}$ and $\frac{\partial^2 E\Phi_i}{\partial p^2}$ are also negative. This means that the entire denominator and thus $\frac{dp_i}{dp^*}$ is positive. $\square$

A.3 Solution of the 2x3–0 and 2x3–1 cases with identical risk–averse agents

We allow both sellers and buyers to have any twice–differentiable weakly risk–averse utility function such that the utility of not trading is equal to zero. The only additional assumptions we make are (a) all buyers have the same utility function and all sellers have the same (possibly different from buyers') utility function, and (b) utility functions are common knowledge amongst the agents.[22]

The 2x3–1 case

Let u be the common utility function of buyers, and v that of sellers. As noted above, the utility of not trading is zero; otherwise we express u and v as functions of p, the price at which the agent trades. Since

[22] A weaker version of (b) also works, since it is not necessary that buyers know sellers' utility functions. See Appendix A.4 for a relaxation of (a).

prices are restricted to be between zero and buyers' valuation, we have $u, v \geq 0$. Also, $v'(p) > 0 > u'(p)$ (the latter since buyer's monetary surplus is $\bar{U} - p$), and $u''(p), v''(p) \leq 0$ (from weak risk aversion). Note that the conditions on first derivatives imply that $v > 0$ when $p > 0$ and $u > 0$ when $p < \bar{U}$.

Figure 11: Buyer 1 payoffs in the 2x3–1 cell, given seller prices p_1, p_2 (symmetric game)

		Buyer 2	
		Visit Seller 1	Visit Seller 2
Buyer 1	Visit Seller 1	$\frac{5}{12}u_1$	$\frac{3}{4}u_1$
	Visit Seller 2	$\frac{3}{4}u_2$	$\frac{5}{12}u_2$

Given sellers' prices, the two informed buyers play the game shown in Figure 11, where $u_1 = u(p_1)$ and $u_2 = u(p_2)$ are the utilities from buying from Seller 1 and Seller 2. (As always, the uninformed buyer, randomizes uniformly between sellers irrespective of risk attitude.) Note that each payoff is the product of the utility from buying (u_1 or u_2) and the probability of being able to buy. (For example, if Buyer 1 and Buyer 2 visit the same seller, each is equally likely to buy with probability 1/2 or 1/3, depending on the realization of the uninformed buyer's seller visit choice.) In the symmetric equilibrium of this game, each buyer visits Seller 1 with probability

$$q(p_1, p_2) = \frac{9u_1 - 5u_2}{4u_1 + 4u_2}$$

(as long as p_1 and p_2 are not too far apart), so

$$\frac{\partial q}{\partial p_1} = \frac{7u_2}{2(u_1 + u_2)^2} \cdot u'(p_1). \tag{8}$$

Given q, the probability of Seller 1 being able to sell is

$$\Phi_1(p_1, p_2) = 1 - \frac{1}{2}(1 - q)^2,$$

and Seller 1's expected utility is

$$\Pi_1(p_1, p_2) = \Phi_1(p_1, p_2) \cdot v(p_1).$$

Expected utility is maximized when

$$\begin{aligned} 0 = \frac{\partial \Pi_1}{\partial p_1} &= \Phi_1 \cdot v'(p_1) + v(p_1)\frac{\partial \Phi_1}{\partial p_1} \\ &= \Phi_1 \cdot v'(p_1) + v(p_1) \cdot (1 - q)\frac{\partial q}{\partial p_1}. \end{aligned}$$

In a symmetric equilibrium in prices, $p_1 = p_2$, so that $q = 1/2$ and thus $\Phi_1 = \Phi_2 = 7/8$. Let p be the common value of p_1 and p_2. Then p solves

$$0 = \frac{7}{8}v'(p) + v(p)\frac{7u'(p)}{16u(p)}. \tag{9}$$

Figure 12: Buyer 1 payoffs in the 2x3–0 cell, given seller prices p_1, p_2 (symmetric game)

Buyer 3: Visit Seller 1

		Buyer 2: Visit Seller 1	Buyer 2: Visit Seller 2
Buyer 1	Visit Seller 1	$\frac{1}{3}u_1$	$\frac{1}{2}u_1$
	Visit Seller 2	u_2	$\frac{1}{2}u_2$

Buyer 3: Visit Seller 2

		Buyer 2: Visit Seller 1	Buyer 2: Visit Seller 2
Buyer 1	Visit Seller 1	$\frac{1}{2}u_1$	u_1
	Visit Seller 2	$\frac{1}{2}u_2$	$\frac{1}{3}u_2$

The 2x3–0 case

Solving this case follows a similar process to the 2x3–1 case, with two important differences. First, all three buyers are informed, so they play a 2x2x2 game given sellers' prices (see Figure 12). In a symmetric equilibrium, each buyer visits Seller 1 with probability q that solves

$$(u_1 - u_2)q^2 - (3u_1 + u_2)q + (3u_1 - u_2) = 0,$$

so that $\frac{\partial q}{\partial p_1}$ can be computed by differentiating implicitly:

$$\frac{\partial q}{\partial p_1} = -\frac{q^2 - 3q + 3}{2q(u_1 - u_2) - 3u_1 - u_2} \cdot u'(p_1).$$

The second difference is that sellers' visit probabilities reflect the fact that all three buyers play the symmetric equilibrium strategy (rather than one of them randomizing uniformly). So, given q, we have

$$\Phi_1(p_1, p_2) = 1 - (1 - q)^3,$$

so that

$$\frac{\partial \Phi_1}{\partial p_1} = 3(1 - q)^2 \cdot \frac{\partial q}{\partial p_1}.$$

Then Seller 1's expected utility ($\Pi_1 = \Phi_1 \cdot v(p_1)$) is maximized when

$$0 = \Phi_1 \cdot v'(p_1) + v(p_1) \cdot 3(1 - q)^2 \frac{\partial q}{\partial p_1}.$$

In a symmetric equilibrium in prices, as before we have $p_1 = p_2$, $q = 1/2$ and $\Phi_1 = \Phi_2 = 7/8$, so that p (the common value of p_1 and p_2) solves

$$0 = \frac{7}{8}v'(p) + v(p)\frac{21u'(p)}{64u(p)}. \tag{10}$$

Comparison of the two cases

Let p_0 and p^* solve (10) and (9) respectively; that is, they are the subgame perfect equilibrium prices in the 2x3–0 and 2x3–1 cases given utility functions u and v. (Note that since the left–hand sides of (10) and (9) are neither zero nor infinite, it must be that u and v are strictly positive; i.e., $p_0, p^* \in (0, \bar{U})$.) Then we have

$$-2 = \frac{v(p^*)}{v'(p^*)} \cdot \frac{u'(p^*)}{u(p^*)} \quad \text{and} \quad -\frac{8}{3} = \frac{v(p_0)}{v'(p_0)} \cdot \frac{u'(p_0)}{u(p_0)},$$

so that

$$\frac{v(p^*)}{v'(p^*)} \cdot \frac{u'(p^*)}{u(p^*)} > \frac{v(p_0)}{v'(p_0)} \cdot \frac{u'(p_0)}{u(p_0)}.$$

Define

$$g(p) = \frac{u'(p)v(p)}{u(p)v'(p)}.$$

Then

$$\begin{aligned} g'(p) &= \frac{uv'(u'v' + u''v) - u'v(uv'' + u'v')}{(uv')^2} \\ &= \frac{vv'\left[uu'' - (u')^2\right] - uu'\left[vv'' - (v')^2\right]}{(uv')^2}. \end{aligned} \tag{11}$$

Since u and v are strictly positive, u'' and v'' are weakly negative, and $v' > 0 > u'$, the first term of the numerator is negative while the second is positive, making the entire numerator negative. Since the denominator is clearly positive, we therefore have $g' > 0$, so that g is increasing in p and hence $p_0 > p^*$. Thus the equilibrium price in the 2x3–0 case is higher than that in the 2x3–1 case, not only for risk–neutral agents, but also for risk–averse ones.

A.4 Solution of the 2x3–0 and 2x3–1 cases with heterogeneous risk–averse agents

Here, we extend the analysis in the previous section to allow a distribution of risk attitudes amongst buyers, with each having private knowledge of his risk attitude. To keep the analysis simple, we assume sellers are risk neutral. Uninformed buyers will continue visiting each seller with equal probability, so we focus here on informed buyers.

As in the previous section, we assume that informed buyers' utility functions are twice–differentiable and that the utility of not trading is zero. But rather than all having the same utility function, there is a one–parameter continuum of risk–averse buyer types indexed by θ, such that a buyer of type θ_1 is more risk averse than a buyer of type θ_2 if and only if $\theta_1 > \theta_2$. The utility function for a buyer of type θ will be called $u(\theta, p)$ or $u_\theta(p)$. As before, $u_\theta(p) \geq 0$, $u'_\theta(p) < 0$ and $u''_\theta(p) < 0$ for $p \in [0, \bar{U}]$ (and thus $u_\theta(p) > 0$ when $p < \bar{U}$). Suppose the population distribution of θ is given by some c.d.f. F with p.d.f. f. We assume F and f are common knowledge, but the type of any given buyer is his private information.

Suppose the sellers choose prices p_1 and p_2, where $p_1 \leq p_2$. Then visiting Seller 1 entails a smaller probability of trading but a higher surplus conditional on trading, while visiting Seller 2 entails a larger probability of trading but a lower surplus conditional on trading. This means that if buyers believe that the probability of a given buyer visiting Seller 1 is $q \geq 0.5$, and some buyer type θ is indifferent between visiting the two sellers given q, then buyers who are more risk averse (to the right of θ in the population distribution) will visit Seller 2 and those who are less risk averse (to the left of θ) will visit Seller 1, so that the fraction of buyers visiting Seller 1 will be $F(\theta)$. So, an equilibrium of the game played amongst the informed buyers will be characterized by $q^* = F(\theta^*)$, where type θ^* is indifferent between visiting the two sellers given q^*.

The 2x3–1 case

Given q, a buyer of type θ gets utility from visiting Seller 1 of $u_\theta(p_1)$ with probability $\frac{9-4q}{12}$, and gets utility from visiting Seller 2 of $u_\theta(p_2)$ with probability $\frac{5+4q}{12}$. Then, the equilibrium condition is

$$\frac{9-4q}{12} \cdot u_\theta(p_1) = \frac{5+4q}{12} \cdot u_\theta(p_2),$$

along with $q = F(\theta)$. That is,

$$[9 - 4F(\theta)] \cdot u(\theta, p_1) = [5 + 4F(\theta)] \cdot u(\theta, p_2). \tag{12}$$

To find $\frac{\partial q}{\partial p_1}$, we first note that $\frac{\partial q}{\partial p_1} = f(\theta) \cdot \frac{\partial \theta}{\partial p_1}$. Next, we use implicit differentiation on (12):

$$\begin{aligned} -4f(\theta)u(\theta, p_1)\frac{\partial \theta}{\partial p_1} \quad + \quad & [9 - 4F(\theta)]\left[u_1(\theta, p_1)\frac{\partial \theta}{\partial p_1} + u_2(\theta, p_1)\right] \\ & = 4f(\theta)u(\theta, p_2)\frac{\partial \theta}{\partial p_1} + [5 + 4F(\theta)]u_1(\theta, p_2)\frac{\partial \theta}{\partial p_1}, \end{aligned} \tag{13}$$

where u_1 and u_2 are the partial derivatives of u with respect to the first and second argument respectively.

When sellers are choosing their equilibrium prices, $p_1 = p_2$; call their common value p. Also, $q = 0.5$, which means $F(\theta) = 0.5$. So (13) simplifies to

$$-4f(\theta)u(\theta, p)\frac{\partial \theta}{\partial p_1} + 7u_2(\theta, p) = 4f(\theta)u(\theta, p)\frac{\partial \theta}{\partial p_1},$$

and solving for $\frac{\partial \theta}{\partial p_1}$ yields

$$\frac{\partial \theta}{\partial p_1} = \frac{7u_\theta'(p)}{8f(\theta)u_\theta(p)},$$

so

$$\frac{\partial q}{\partial p_1} = \frac{7u_\theta'(p)}{8u_\theta(p)}$$

when sellers are in equilibrium.

Turning to sellers, Seller 1's profit is given by $p_1 \cdot \left[1 - \frac{1}{2}(1-q)^2\right]$, which is maximized when

$$0 = \left[1 - \frac{1}{2}(1-q)^2\right] + p(1-q)\frac{\partial q}{\partial p_1}.$$

In equilibrium, $p_1 = p_2 = p$ and $q = 0.5$, so we have

$$\begin{aligned} 0 &= \frac{7}{8} + \frac{p}{2} \cdot \frac{\partial q}{\partial p_1} \\ &= \frac{7}{8} + \frac{p}{2} \cdot \frac{7u_\theta'(p)}{8u_\theta(p)}, \end{aligned}$$

and therefore

$$-2 = p \cdot \frac{u_\theta'(p)}{u_\theta(p)},$$

which implicitly solves for the equilibrium price. (Note the similarity to the corresponding result from the previous section.)

The 2x3–0 case

Given q, a buyer of type θ gets utility $u_\theta(p_1)$ with probability $\frac{3-3q+q^2}{3}$ from visiting Seller 1, and $u_\theta(p_2)$ with probability $\frac{1+q+q^2}{3}$ from visiting Seller 2. Then the equilibrium condition is

$$[3 - 3F(\theta) + F(\theta)^2] \cdot u(\theta, p_1) = [1 + F(\theta) + F(\theta)^2] \cdot u(\theta, p_2).$$

Using implicit differentiation,

$$\begin{aligned}
[-3f(\theta) + 2F(\theta)f(\theta)]u(\theta, p_1)\frac{\partial\theta}{\partial p_1} \quad &+ \quad [3 - 3F(\theta) + F(\theta)^2]\left[u_1(\theta, p_1)\frac{\partial\theta}{\partial p_1} + u_2(\theta, p_1)\right] \\
= [f(\theta) + 2F(\theta)f(\theta)]u(\theta, p_2)\frac{\partial\theta}{\partial p_1} \quad &+ \quad [1 + F(\theta) + F(\theta)^2]u_1(\theta, p_2)\frac{\partial\theta}{\partial p_1},
\end{aligned}$$

and substituting the equilibrium conditions $p_1 = p_2 = p$ and $F(\theta) = 0.5$ yields

$$-2f(\theta)u(\theta, p)\frac{\partial\theta}{\partial p_1} + \frac{7}{4}u_2(\theta, p) = 2f(\theta)u(\theta, p)\frac{\partial\theta}{\partial p_1},$$

or equivalently

$$\frac{\partial\theta}{\partial p_1} = \frac{7u'_\theta(p)}{16f(\theta)u_\theta(p)},$$

so that

$$\frac{\partial q}{\partial p_1} = \frac{7u'_\theta(p)}{16u_\theta(p)}$$

when sellers are in equilibrium.

Turning to sellers, Seller 1's profit is given by $p_1 \cdot \left[1 - (1-q)^3\right]$, which is maximized when

$$0 = \left[1 - (1-q)^3\right] + 3p(1-q)^2\frac{\partial q}{\partial p_1}.$$

In equilibrium,

$$\begin{aligned}
0 \quad &= \quad \frac{7}{8} + \frac{3p}{4} \cdot \frac{\partial q}{\partial p_1} \\
&= \quad \frac{7}{8} + \frac{3p}{4} \cdot \frac{7u'_\theta(p)}{16u_\theta(p)},
\end{aligned}$$

and therefore

$$-\frac{8}{3} = p \cdot \frac{u'_\theta(p)}{u_\theta(p)}.$$

Note that the marginal buyer (the one indifferent between sellers) is the same here as in the 2x3–1 case as long as the population distribution is the same in both cases; it is the "median buyer" with type $\theta^* = F^{-1}(0.5)$.

Comparison of the two cases

To show that the equilibrium price must be higher in 2x3–0 than in 2x3–1, we follow a process very much like that at the end of Appendix A.3 for the homogeneous case. Define $h(p) = p \cdot \frac{u'_\theta(p)}{u_\theta(p)}$; then as before, it suffices to show that $h'(p) < 0$. But

$$\begin{aligned} h'(p) &= \frac{u_\theta(p)[p \cdot u''_\theta(p) + u'_\theta(p)] - p[u'_\theta(p)]^2}{[u_\theta(p)]^2} \\ &= \frac{pu_\theta(p)u''_\theta(p) + u_\theta(p)u'_\theta(p) - p[u'_\theta(p)]^2}{[u_\theta(p)]^2}. \end{aligned} \tag{14}$$

The denominator of (14) is positive, while the three terms of the numerator are negative, negative and positive respectively, so that the entire fraction is negative. Thus even under heterogeneous and privately–known risk attitudes, the predicted treatment effect remains the same.

A.5 Effect of price responsiveness on equilibrium prices

As in Section 4.4, suppose that buyers are β times as price–responsive as they are predicted to be under the assumption of standard preferences (i.e., suppose that price responsiveness is given by (3) in that section), while sellers have standard preferences. In this section, we compute the implied Nash equilibrium in seller prices, as a function of β, for the 2x2–0 case. The 2x3–0 and 2x3–1 cases follow a nearly identical process (and indeed can be obtained from Appendix A.3, substituting in the CRRA utility function $u(x) = x^\beta$ but with $v(x) = x$), while the 2x2–1 case is analogous to what was done in Appendix A.1.[23]

A seller's expected profit is equal to her price multiplied by the probability that she is visited by at least one buyer. For Seller 1 in the 2x2–0 case, this is $\pi_1 = p_1 \cdot \Phi$, where

$$\Phi = 1 - (1 - \hat{q})^2, \tag{15}$$

$\hat{q}$ is given by (3), and $q(p_1, p_2)$ is given by (2) in Section 4.3. Then

$$\begin{aligned} \frac{\partial \pi_1}{\partial p_1} &= 1 - (1-\hat{q})^2 + 2p_1(1-\hat{q})\frac{\partial \hat{q}}{\partial p_1} \\ &= 1 - (1-\hat{q})^2 + 2p_1(1-\hat{q})\beta\frac{\partial q}{\partial p_1} \\ &= 1 - (1-\hat{q})^2 + 2p_1(1-\hat{q})\beta\left[-\frac{60-3p_2}{(40-p_1-p_2)^2}\right]. \end{aligned} \tag{16}$$

In a symmetric Nash equilibrium, π_1 is maximized when $p_1 = p_2$, so that q and hence $\hat{q}$ are equal to one–half. So (16) simplifies to $0 = \frac{3}{4} - \frac{3\beta p}{4(20-p)}$ (where p is the common value of p_1 and p_2), whence $p = \frac{20}{1+\beta}$.

[23]The associated equilibrium prices are $\frac{160}{8+3\beta}$ in the 2x3–0 case and $\frac{40}{2+\beta}$ in the 2x3–1 case, while in the 2x2–1 case, sellers play continuous mixed strategies with expectation $\frac{30-10\beta}{\beta} \cdot ln\left(\frac{3+\beta}{3-\beta}\right)$, based on the density function $f(p) = \frac{30-10\beta}{\beta p^2}$ for $p \in \left[20\left(\frac{3-\beta}{3+\beta}\right), 20\right]$.

A.6 Sample instructions from original experiment

The instructions below are from the 2x3 market, with no uninformed buyers in rounds 1-20 and one uninformed buyer in rounds 21-40. Parts 1, 2 and 3 were given to subjects before round 1, between rounds 20 and 21, and after round 40 respectively. The instructions from the other treatments were very similar, and available from the corresponding author upon request.

Instructions (Part 1)

You are about to participate in a decision making experiment. Please read these instructions carefully, as the money you earn may depend on how well you understand them. If you have a question at any time, please feel free to ask the experimenter. We ask that you not talk with the other participants during the experiment, and that you put away your mobile phones and other devices at this time.

This experiment has three parts. These instructions are for Part 1; you will receive new instructions after this part has finished. Part 1 is made up of 20 rounds, each consisting of a simple computerised market game. Before the first round, you are assigned a role: buyer or seller. ***You will remain in the same role throughout the experiment.***

In each round, the participants in this session are divided into "markets": groups of five containing a total of ***three buyers*** and ***two sellers***. ***The other people in your market will be randomly assigned in each round.*** You will not be told the identity of the people in your market, nor will they be told yours – even after the session ends.

The market game: In each round, a seller can produce ***one*** unit of a hypothetical good, at a cost of ***$0***. A buyer can buy up to ***one*** unit of the good, which is ***resold to the experimenter*** at the end of the round for ***$20***. It is not possible to buy or sell more than one unit in a round. Sellers begin by choosing their prices, which are entered as ***multiples of 0.05, between 0 and 20*** inclusive (without the dollar sign).

After all sellers have chosen prices, ***all buyers can observe the prices*** of each of the sellers in their market, then each chooses which seller to visit. If ***only one buyer*** visits a particular seller, then that buyer pays the seller's price for the seller's item. If ***more than one buyer*** visits the ***same*** seller, then since the seller only has one unit, ***one of the buyers is randomly selected*** by the computer to purchase it at that seller's price, and the other buyers are ***unable to buy***. Any seller visited by no buyers is ***unable to sell***.

Profits: Your profit for the round depends on the round's result.
- If you are a ***seller*** and you are ***able to sell***, your profit is the price you chose.
- If you are a ***seller*** and you are ***unable to sell***, your profit is zero.
- If you are a ***buyer*** and you are ***able to buy***, your profit is $20.00 minus the price you paid.
- If you are a ***buyer*** and you are ***unable to buy***, your profit is zero.

Sequence of play in a round:
(1) The computer randomly forms markets made up of ***three buyers*** and ***two sellers*** each.
(2) Sellers choose their prices.
(3) All buyers observe the sellers' prices, then each buyer chooses which seller to visit.
(4) The round ends. If you are a seller, you are informed of: each seller's price, how many buyers visited

you, quantity sold and profit for the round. If you are a buyer, you are informed of: each seller's price, how many buyers visited the same seller as you, your quantity bought and profit for the round. After this, you go on to the next round.

Payments: Your payment depends on the results of the experiment. At the end of the experiment, ***two*** rounds from Part 1 will be chosen randomly for each participant. ***You will be paid the total of your profits from those two rounds***, plus whatever you earn in the other parts of the experiment. Payments are made privately and in cash at the end of the session.

Instructions (Part 2)

The procedure in this part is nearly the same as before. You will play a similar market game for 20 additional rounds. Your role (buyer or seller) will remain the same as before, and the participants in your market – a total of 3 buyers and 2 sellers – will still be randomly re-assigned in each round.

The difference from the first part of the experiment is that now, in each round ***only two of the three buyers will be able to observe the sellers' prices*** before choosing which seller to visit. The remaining buyer will still choose a seller to visit, but ***without having seen any prices***.

As before, if only one buyer visits a particular seller, then that buyer buys the seller's item, and if more than one buyer visits the same seller, then one of them is randomly selected by the computer to buy. Profits are determined in the same way as in Part 1.

Payments: At the end of the experiment, ***two*** rounds from Part 2 will be chosen randomly for each participant. ***You will be paid the total of your profits from those two rounds***. Your payment from this part will be added to what you got from Part 1, and additional earnings are possible in Part 3.

Instructions (Part 3)

This part begins with a Gamble Selection Task. You will be shown five gambles, and will be asked to choose the one you prefer. Each gamble has two possible outcomes, with equal (50%) chance of occurring. Your earnings from this task will depend on which gamble you choose, and which outcome occurs.

The gambles are as follows:

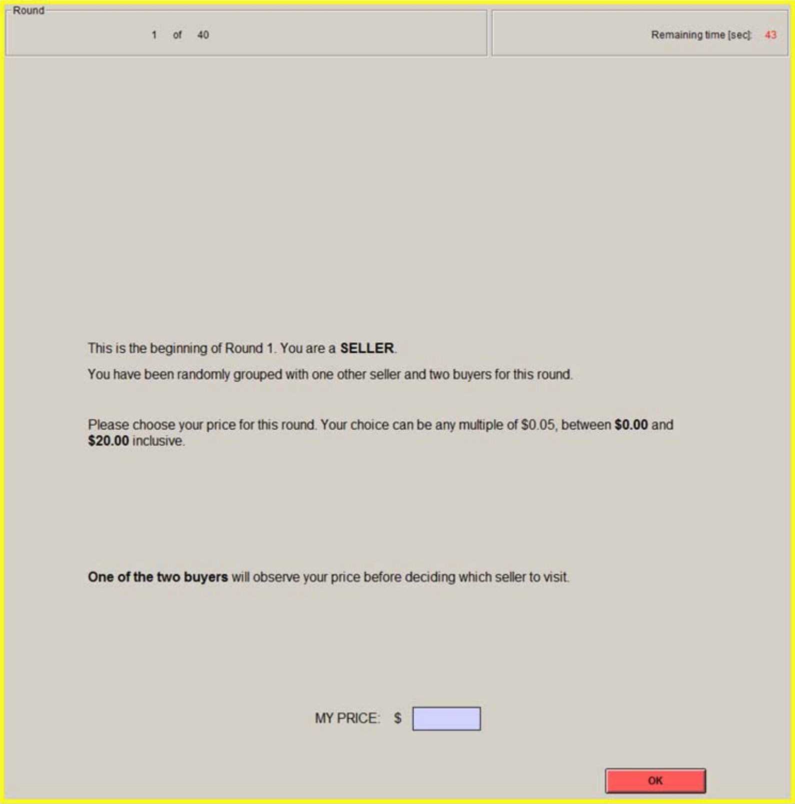
Gamble	Random numbers 1-50 (50% chance)	Random numbers 51-100 (50% chance)
1	You earn $4	You earn $4
2	You earn $6	You earn $3
3	You earn $8	You earn $2
4	You earn $10	You earn $1
5	You earn $12	You earn $0

After you have chosen one of these gambles, the computer will randomly draw a whole number between 1 and 100 (inclusive). If the random number is 50 or less, your earnings from this task are as shown in the middle column of the table. If the random number is 51 or more, your earnings from this task are as shown in the right column. The random number drawn for you may be different from the ones drawn for other participants.

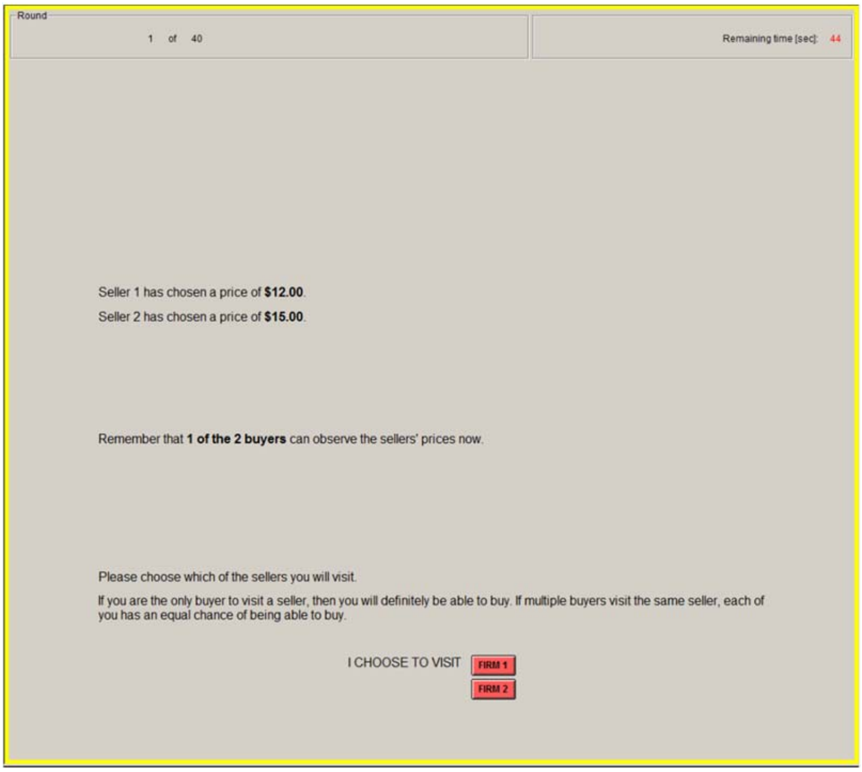
Once you have chosen a gamble, you will be shown another screen containing a questionnaire. You will receive $5 for answering all of the questions if you were a seller in Parts 1 and 2, or $15 if you were a buyer. Once everyone has finished the questionnaire, you will be shown the results of all three parts of the experiment.

A.7 Sample screen-shots

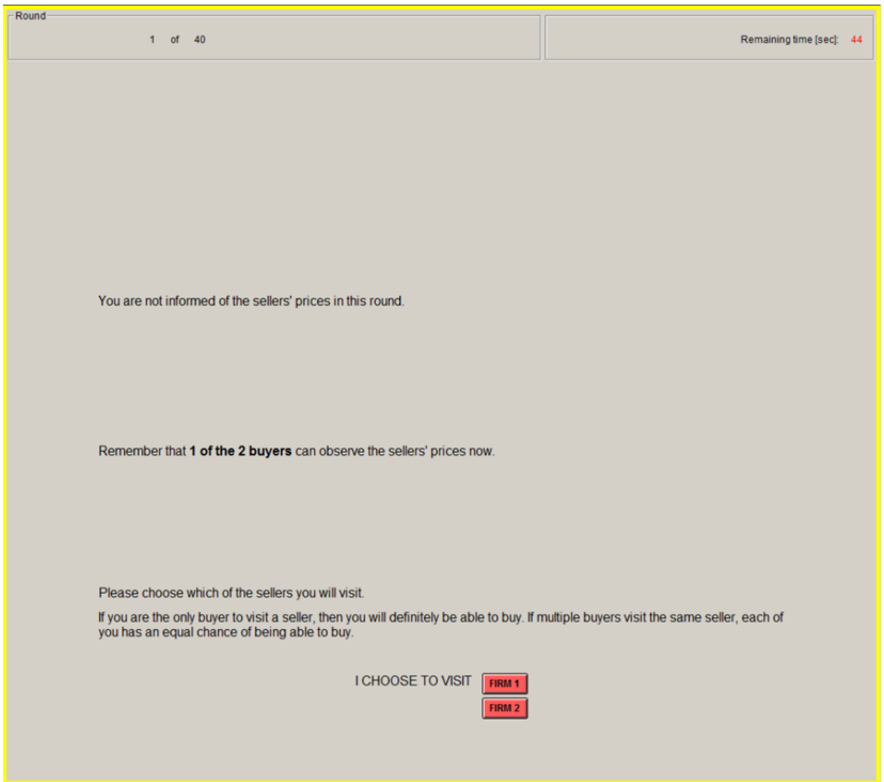
Seller decision screen:



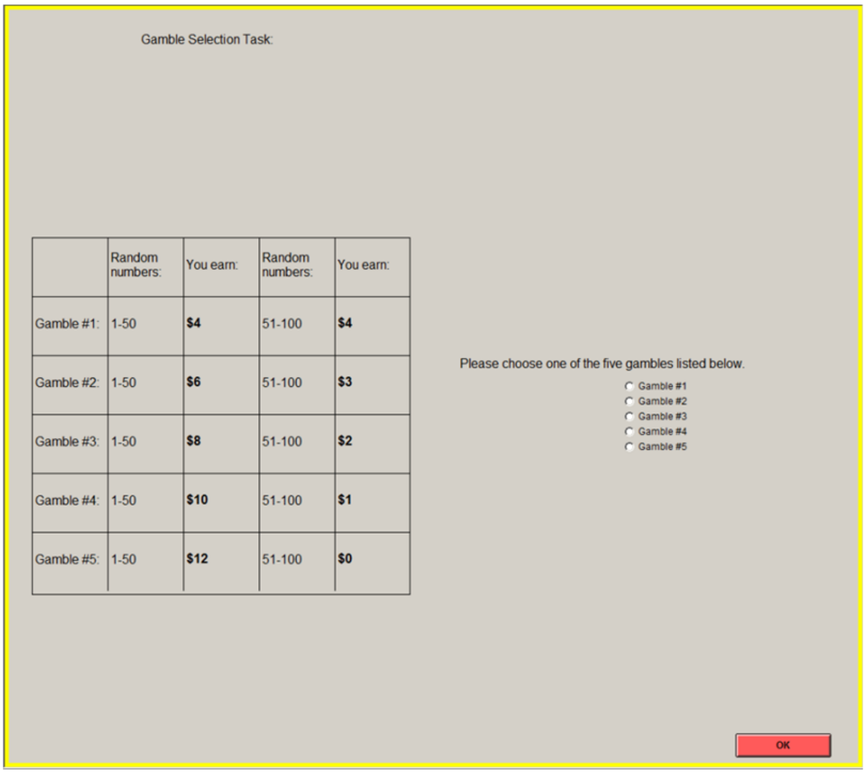
Informed buyer decision screen:



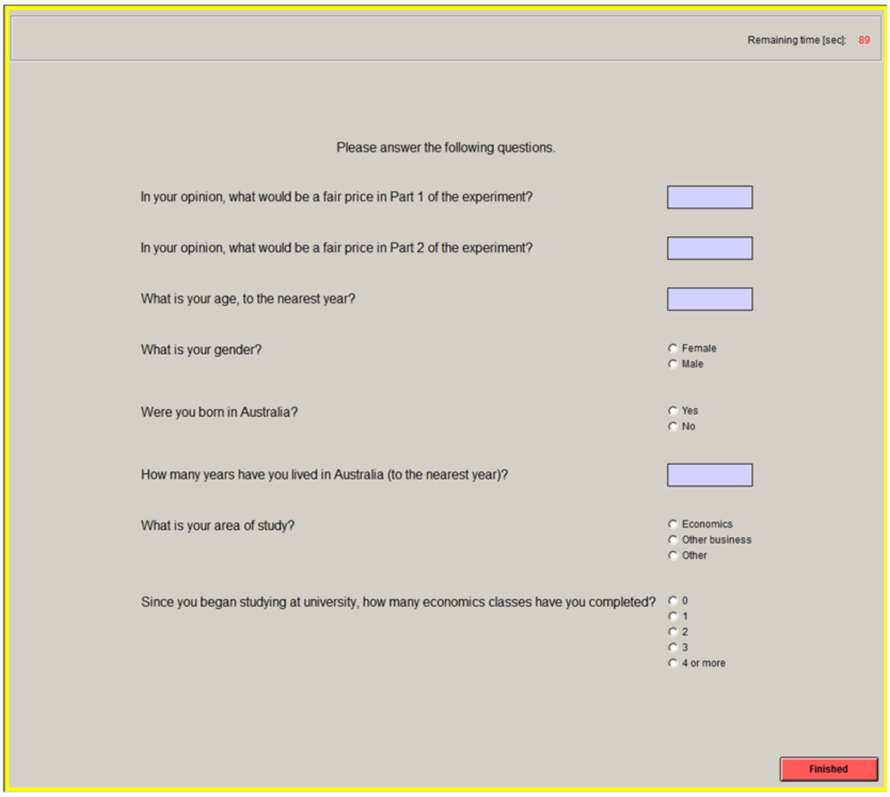
Uninformed buyer decision screen:



Lottery choice screen:



Questionnaire screen:



A.8 Sample instructions from follow-up experiment

The instructions below are from the 2x3 market with one uninformed buyer in all rounds (1-50). Parts 1 and 2 were given to subjects before round 1 and after round 50 respectively. The instructions from the other treatment were very similar, and available from the corresponding author upon request.

Instructions (Part 1)

You are about to participate in a decision making experiment. Please read these instructions carefully, as the money you earn may depend on how well you understand them. If you have a question at any time, please feel free to ask the experimenter. We ask that you not talk with the other participants during the experiment, and that you put away your mobile phones and other devices at this time.

This experiment has two parts. These instructions are for Part 1; you will receive new instructions after this part has finished. Part 1 is made up of 50 rounds, each consisting of a simple computerised market game. Before the first round, you are assigned a role: buyer or seller. ***You will remain in the same role throughout the experiment.***

In each round, the participants in this session are divided into "markets": groups of five containing a total of ***three buyers*** and ***two sellers***. ***The other people in your market will be randomly assigned in each round.*** You will not be told the identity of the people in your market, nor will they be told yours – even after the session ends.

The market game: In each round, a seller can produce ***one*** unit of a hypothetical good, at a cost of ***$0***. A buyer can buy up to ***one*** unit of the good, which is ***resold to the experimenter*** at the end of the round for ***$20***. It is not possible to buy or sell more than one unit in a round. Sellers begin by choosing their prices, which are entered as ***multiples of 0.05, between 0 and 20*** inclusive (without the dollar sign).

After all sellers have chosen prices, ***two of the three buyers can observe the prices*** of each of the sellers in their market, while the remaining buyer does not. Then each buyer chooses which seller to visit. If ***only one buyer*** visits a particular seller, then that buyer pays the seller's price for the seller's item. If ***more than one buyer*** visits the ***same*** seller, then since the seller only has one unit, ***one of the buyers is randomly selected*** by the computer to purchase it at that seller's price, and the other buyers are ***unable to buy***. Any seller visited by no buyers is ***unable to sell***.

Profits: Your profit for the round depends on the round's result.
- If you are a ***seller*** and you are ***able to sell***, your profit is the price you chose.
- If you are a ***seller*** and you are ***unable to sell***, your profit is zero.
- If you are a ***buyer*** and you are ***able to buy***, your profit is $20.00 minus the price you paid.
- If you are a ***buyer*** and you are ***unable to buy***, your profit is zero.

Sequence of play in a round:
(1) The computer randomly forms markets made up of ***three buyers*** and ***two sellers*** each.
(2) Sellers choose their prices.
(3) Two of the three buyers observe the sellers' prices, then each buyer chooses which seller to visit.
(4) The round ends. If you are a seller, you are informed of: each seller's price, how many buyers visited you, quantity sold and profit for the round. If you are a buyer, you are informed of: each seller's price, how many buyers visited the same seller as you, your quantity bought and profit for the round.

After this, you go on to the next round.

Payments: Your payment depends on the results of the experiment. At the end of the session, ***five*** rounds from Part 1 will be chosen randomly for each participant. ***You will be paid the total of your profits from those five rounds***, plus whatever you earn in Part 2 of the experiment. Payments are made privately and in cash at the end of the session.

Instructions (Part 2)

This part begins with a Gamble Selection Task. You will be shown five gambles, and will be asked to choose the one you prefer. Each gamble has two possible outcomes, with equal (50%) chance of occurring. Your earnings from this task will depend on which gamble you choose, and which outcome occurs.

The gambles are as follows:

Gamble	Random numbers 1-50 (50% chance)	Random numbers 51-100 (50% chance)
1	You earn $4	You earn $4
2	You earn $6	You earn $3
3	You earn $8	You earn $2
4	You earn $10	You earn $1
5	You earn $12	You earn $0

After you have chosen one of these gambles, the computer will randomly draw a whole number between 1 and 100 (inclusive). If the random number is 50 or less, your earnings from this task are as shown in the middle column of the table. If the random number is 51 or more, your earnings from this task are as shown in the right column. The random number drawn for you may be different from the ones drawn for other participants.

Once you have chosen a gamble, you will be shown another screen containing a questionnaire. You will receive $5 for answering all of the questions if you were a seller in Part 1, or $15 if you were a buyer. Once everyone has finished the questionnaire, you will be shown the results of both parts of the experiment.