

Supplemental Material

(to accompany Crouter, "A Water Bank Game with Fishy Externalities," Review of Agricultural Economics 25(1) (June 2003))

- 1) Instructions for the Water Bank Game
- 2) Worksheets
- 3) Value Slips

Note: Before class I staple a matching value slip to each work sheet and fold each worksheet with its enclosed value slip into quarters. The folded worksheets are placed in a hat. In class I work through the instructions together with the students and then pass the hat with an appropriate number of work sheets for utilities, farmers, and fly-fishers. Each student is assigned their role in the game by drawing their worksheet and attached value slip from the hat.

INSTRUCTIONS FOR THE WATER BANK GAME

- 1) This is a hypothetical market for water diversion rights. Some of you are hydroelectric utilities who buy water rights in order to supplement instream flows in the main stem of the river. Some of you are irrigators who are potential sellers of water diversion rights. Irrigators who sell a diversion right will refrain from diverting water from the tributary on which their farm is located. Finally, some of you are fly-fishers who benefit from the sale of water diversion rights because water that isn't diverted by farmers contributes to instream flows in the tributaries where you fish. Initially, the fly-fishers will play the role of interested bystanders, but they will become active players in the later part of the game. All of you have received a slip of paper, which contains important information about your valuation of a right to divert 100 acre-feet during a year's irrigation season. Do not share this information with others.
- 2) The game consists of several trading periods which represent irrigation seasons. During a period, each utility may purchase at most one diversion right and each irrigator may sell at most one diversion right.
- 3) Utilities: If you buy a diversion right in a period, you earn a surplus which is the difference between your value for the diversion right and the price you pay. If you cannot find an irrigator willing to sell at a price lower than your value, you should not buy. For example, if you agree to purchase a diversion right for \$10 and you value the diversion right at \$16, your surplus is \$6. If you do not purchase a diversion right, your surplus is zero. In each period, keep track of your transactions and your surpluses.
- 4) Irrigators: If you sell a diversion right in a period, you earn a surplus which is the difference between the price at which you sell the right and the value of the right in your farming operation. If you cannot find a utility willing to pay a price higher than this value, you should not sell. For example, if you sell a diversion right to a utility for \$14 and you value the diversion right for \$12, then your surplus is \$2. If you do not sell a diversion right, your surplus is zero. In each period, keep track of your transactions, and your surplus.
- 5) Fly-fishers: You all fish all of the tributaries in the area and you gain from each diversion right that irrigators sell because this reduces the amount of water removed from the tributaries. Your individual surplus is the difference between your value from the units of reduced diversions and the payment you make to prevent farmers from diverting water. In the initial periods when you are an interested bystander your surplus is simply your water value per diversion right times the number of diversion rights sold because you do not participate in the market in the early periods. For example, if seven water diversion rights are sold and you value each water diversion right at \$2, your surplus is \$14. In later periods when you are a participant, your surplus will be calculated as your water value per diversion times the number of diversion rights sold MINUS any payments you make to aid in the sale of diversion rights. Keep track of your surpluses, even if you are not a market participant in a period.
- 6) The market institution is a double-oral auction. Buyers may call out bids by saying "Buy at XX." Any seller may accept a buyer's bid. Sellers may call out offers by saying "Sell at YY," and any buyer may accept a seller's offer. You may not buy or sell just a part of a diversion right, and you must buy or sell at whole dollars.
- 7) When a buyer and seller (there must be one of each for the first part of the game!) have agreed on a transaction, they must both come to me and report the buyer number, seller letter (and fly-fisher designation, if relevant in the latter part of the game) and the price. Then move out of the trading area until the next period.
- 8) Prices of each transaction will be posted.
- 9) Each period will end when trading activity ceases. After a brief pause, I will announce the beginning of the next period.

(Adapted from Jeffrey Parker, "Double Oral Auction Experiment," Chap. 2 in Economics 201 Instructor's Laboratory Manual, Reed College, November 1993 and from Denise Hazlett, "An Experimental Education Market with Positive Externalities," Journal of Economic Education 31(1)(Winter 2000): 44-51.

WORKSHEET FOR AN IRRIGATOR

---Water Bank Game, Phase One, Irrigator---

Period One

My value for a diversion right is: $V = \underline{\hspace{2cm}}$.

The price I received for a diversion right is: $P = \underline{\hspace{2cm}}$.

My surplus in period 1 is: $P - V = \underline{\hspace{2cm}}$ --or-- $= 0$
(if I sold a diversion right) (if no sale)

Period Two

My value for a diversion right is: $V = \underline{\hspace{2cm}}$.

The price I received for a diversion right is: $P = \underline{\hspace{2cm}}$.

My surplus in period 2 is: $P - V = \underline{\hspace{2cm}}$ --or-- $= 0$
(if I sold a diversion right) (if no sale)

Period Three

My value for a diversion right is: $V = \underline{\hspace{2cm}}$.

The price I received for a diversion right is: $P = \underline{\hspace{2cm}}$.

My surplus in period 3 is: $P - V = \underline{\hspace{2cm}}$ --or-- $= 0$
(if I sold a diversion right) (if no sale)

Period Four

My value for a diversion right is: $V = \underline{\hspace{2cm}}$.

The price I received for a diversion right is: $P = \underline{\hspace{2cm}}$.

My surplus in period 4 is: $P - V = \underline{\hspace{2cm}}$ --or-- $= 0$
(if I sold a diversion right) (if no sale)

---Water Bank Game, Phase Two, Irrigator---

Period One

My value for a diversion right is: $V = \underline{\hspace{2cm}}$.

The price I received a diversion right is: $P = \underline{\hspace{2cm}}$.

Other receipts ($X > 0$) or payments ($X < 0$): $X = \underline{\hspace{2cm}}$.

My surplus in period 1 is: $P - V + X = \underline{\hspace{2cm}}$ --or-- $= 0$
(if I sold a diversion right) (if no sale)

Period Two

My value for a diversion right is: $V = \underline{\hspace{2cm}}$.

The price I received for a diversion right is: $P = \underline{\hspace{2cm}}$.

Other receipts ($X > 0$) or payments ($X < 0$): $X = \underline{\hspace{2cm}}$.

My surplus in period 2 is: $P - V + X = \underline{\hspace{2cm}}$ --or-- $= 0$
(if I sold a diversion right) (if no sale)

Period Three

My value for a diversion right is: $V = \underline{\hspace{2cm}}$.

The price I received for a diversion right is: $P = \underline{\hspace{2cm}}$.

Other receipts ($X > 0$) or payments ($X < 0$): $X = \underline{\hspace{2cm}}$.

My surplus in period 3 is: $P - V + X = \underline{\hspace{2cm}}$ --or-- $= 0$
(if I sold a diversion right) (if no sale)

WORKSHEET FOR A UTILITY

---Water Bank Game, Phase One, Utility---

Period One

My value for a diversion right is: $V = \underline{\hspace{2cm}}$.

The price I paid for a diversion right is: $P = \underline{\hspace{2cm}}$.

My surplus in period 1 is: $V - P = \underline{\hspace{2cm}}$ --or-- $= 0$
(if I purchased a diversion right) (if no purchase)

Period Two

My value for a diversion right is: $V = \underline{\hspace{2cm}}$.

The price I paid for a diversion right is: $P = \underline{\hspace{2cm}}$.

My surplus in period 2 is: $V - P = \underline{\hspace{2cm}}$ --or-- $= 0$
(if I purchased a diversion right) (if no purchase)

Period Three

My value for a diversion right is: $V = \underline{\hspace{2cm}}$.

The price I paid for a diversion right is: $P = \underline{\hspace{2cm}}$.

My surplus in period 3 is: $V - P = \underline{\hspace{2cm}}$ --or-- $= 0$
(if I purchased a diversion right) (if no purchase)

Period Four

My value for a diversion right is: $V = \underline{\hspace{2cm}}$.

The price I paid for a diversion right is: $P = \underline{\hspace{2cm}}$.

My surplus in period 4 is: $V - P = \underline{\hspace{2cm}}$ -or-- $= 0$
(if I purchased a diversion right) (if no purchase)

---Water Bank Game, Phase Two, Utility---

Period One

My value for a diversion right is: $V = \underline{\hspace{2cm}}$.

The price I paid for a diversion right is: $P = \underline{\hspace{2cm}}$.

Other receipts ($X > 0$) or payments ($X < 0$): $X = \underline{\hspace{2cm}}$.

My surplus in period 1 is: $V - P + X = \underline{\hspace{2cm}}$ --or-- $= 0$
(if I purchased a diversion right) (if no purchase)

Period Two

My value for a diversion right is: $V = \underline{\hspace{2cm}}$.

The price I paid for a diversion right is: $P = \underline{\hspace{2cm}}$.

Other receipts ($X > 0$) or payments ($X < 0$): $X = \underline{\hspace{2cm}}$.

My surplus in period 2 is: $V - P + X = \underline{\hspace{2cm}}$ --or-- $= 0$
(if I purchased a diversion right) (if no purchase)

Period Three

My value for a diversion right is: $V = \underline{\hspace{2cm}}$.

The price I paid for a diversion right is: $P = \underline{\hspace{2cm}}$.

Other receipts ($X > 0$) or payments ($X < 0$): $X = \underline{\hspace{2cm}}$.

My surplus in period 3 is: $V - P + X = \underline{\hspace{2cm}}$ --or-- $= 0$
(if I purchased a diversion right) (if no purchase)

WORKSHEET FOR A FLY-FISHER

---Water Bank Game, Phase One, Fly-Fisher---

Period One

My value for a single diversion right is: $v = \underline{\hspace{2cm}}$.

The number of diversion rights sold is: $n = \underline{\hspace{2cm}}$.

The value I derive from these sales is: $V = n * v = \underline{\hspace{2cm}}$.

My payments/contributions for the purchase of diversion rights is: $Y = 0$.

My surplus in period 1 is: $V - Y = \underline{\hspace{2cm}}$.

Period Two

My value for a single diversion right is: $v = \underline{\hspace{2cm}}$.

The number of diversion rights sold is: $n = \underline{\hspace{2cm}}$.

The value I derive from these sales is: $V = n * v = \underline{\hspace{2cm}}$.

My payments/contributions for the purchase of diversion rights is: $Y = 0$.

My surplus in period 2 is: $V - Y = \underline{\hspace{2cm}}$.

Period Three

My value for a single diversion right is: $v = \underline{\hspace{2cm}}$.

The number of diversion rights sold is: $n = \underline{\hspace{2cm}}$.

The value I derive from these sales is: $V = n * v = \underline{\hspace{2cm}}$.

My payments/contributions for the purchase of diversion rights is: $Y = 0$.

My surplus in period 3 is: $V - Y = \underline{\hspace{2cm}}$.

Period Four

My value for a single diversion right is: $v = \underline{\hspace{2cm}}$.

The number of diversion rights sold is: $n = \underline{\hspace{2cm}}$.

The value I derive from these sales is: $V = n * v = \underline{\hspace{2cm}}$.

My payments/contributions for the purchase of diversion rights is: $Y = 0$.

My surplus in period 4 is: $V - Y = \underline{\hspace{2cm}}$.

---Water Bank Game, Phase Two, Fly-Fisher---

Period One

My value for a single diversion right is:

$$v = \underline{\hspace{2cm}}.$$

The number of diversion rights sold is:

$$n = \underline{\hspace{2cm}}.$$

The value I derive from these sales is:

$$V = n * v = \underline{\hspace{2cm}}.$$

My payments/contributions for the purchase of diversion rights is:

$$Y = \underline{\hspace{2cm}}.$$

My surplus in period 1 is:

$$V - Y = \underline{\hspace{2cm}}.$$

Period Two

My value for a single diversion right is:

$$v = \underline{\hspace{2cm}}.$$

The number of diversion rights sold is:

$$n = \underline{\hspace{2cm}}.$$

The value I derive from these sales is:

$$V = n * v = \underline{\hspace{2cm}}.$$

My payments/contributions for the purchase of diversion rights is:

$$Y = \underline{\hspace{2cm}}.$$

My surplus in period 2 is:

$$V - Y = \underline{\hspace{2cm}}.$$

Period Three

My value for a single diversion right is:

$$v = \underline{\hspace{2cm}}.$$

The number of diversion rights sold is:

$$n = \underline{\hspace{2cm}}.$$

The value I derive from these sales is:

$$V = n * v = \underline{\hspace{2cm}}.$$

My payments/contributions for the purchase of diversion rights is:

$$Y = \underline{\hspace{2cm}}.$$

My surplus in period 3 is:

$$V - Y = \underline{\hspace{2cm}}.$$

VALUE SLIPS FOR PARTICIPANTS

Note: Value slips may for each player may be cut off from these pages and attached to appropriate work sheets in advance.

You are Farmer A. Your value for a diversion right is: 680.

You are Farmer B. Your value for a diversion right is: 730.

You are Farmer C. Your value for a diversion right is: 560.

You are Farmer D. Your value for a diversion right is: 710.

You are Farmer E. Your value for a diversion right is: 780.

You are Farmer F. Your value for a diversion right is: 620.

You are Farmer G. Your value for a diversion right is: 800.

You are Farmer H. Your value for a diversion right is: 840.

You are Flyfisher Brook. Your value for each diversion right purchased from a farmer is: 60.

You are Flyfisher Cutthroat. Your value for each diversion right purchased from a farmer is: 40.

You are Flyfisher Rainbow. Your value for each diversion right purchased from a farmer is: 20.

You are Utility 1. Your value for a diversion right is: 710.

You are Utility 2. Your value for a diversion right is: 620.

You are Utility 3. Your value for a diversion right is: 720.

You are Utility 4. Your value for a diversion right is: 690.

You are Utility 5. Your value for a diversion right is: 750.

You are Utility 6. Your value for a diversion right is: 660.

You are Utility 7. Your value for a diversion right is: 580.

You are Utility 8. Your value for a diversion right is: 600.