Let’s look at a short series of experiments by one group of experimenters.

Van Huyck, Battalio and Beil "Asset Markets as an Equilibrium Selection Mechanism: coordination failure, game form auctions, and forward induction." Games and Economic Behavior, 5(3), July 1993, 485-504.

_____"Strategic Uncertainty, Equilibrium Selection, and Coordination Failure in Average Opinion Games,” The Quarterly Journal of Economics, 106(3), August 1991, 885-911.

_____"Tacit Coordination Games, Strategic Uncertainty, and Coordination Failure," American Economic Review, March 1990, 234-248.

Smallest Value of X

		7	6	5	4	3	2	1
	7	1.30	1.10	0.90	0.70	0.50	0.30	0.10
	6	-	1.20	1.00	0.80	0.60	0.40	0.20
Your	5	-	-	1.10	0.90	0.70	0.50	0.30
Choice	4	-	-	-	1.00	0.80	0.60	0.40
of	3	-	-	-	-	0.90	0.70	0.50
X	2	-	-	-	-	-	0.80	0.60
	1	-	-	-	-	-	-	0.70

Sources: Van Huyck, Battalio, and Beil 1990.

Procedures

Series of games, after which one will be randomly chosen to be the payoff period.* Today in class, everyone will keep their own accounts. Choices will be collected and reported on the board.

- In repeated game experiments, one design decision is whether to pay subjects the sum of their earnings in each period, or choose one period at random to be the payoff period. What are some reasons you might want to do one or the other? (How about other options, like paying only for the last period??)

- How much information to provide to participants across rounds. The whole distribution? Only the minimum?

Let’s take a look at Van Huyck et al. experimental design.

It is a complex (and atypical) design, that involves having the experimental subjects each experience a sequence of related environments.

TABLE 1—EXPERIMENTAL DESIGN

Experiment No.	Date	Size	*A* Payoff *A* Fullsize	*B* Payoff *B* Fullsize	*A'* Payoff *A* Fullsize	*C* Payoff *A* Size Two[b]
1	June	16	$1^P,2,\ldots,10$	–	–	–
2	June	16	$1^P,2,\ldots,10^P$	$11,\ldots,15$	$16^P,\ldots,20$	–
3	June	14	$1^P,2,\ldots,10^P$	$11,\ldots,15$	$16^P,\ldots,20$	–
4	Sept	15	$1^P,2^P,\ldots,10^P$	$11^P,\ldots,15$	$16,\ldots,20$	$21,\ldots,27$
5	Sept	16	$1^P,2^P,\ldots,10^P$	$11^P,\ldots,15$	$16,\ldots,20$	$21,\ldots,27$
6	Sept	16	$1^P,2^P,\ldots,10^P$	$11^P,\ldots,15$	$16,\ldots,20$	$21,\ldots,25$
7	Sept	14	$1^P,2^P,\ldots,10^P$	$11^P,\ldots,15$	$16,\ldots,22$	$23,\ldots,25$

[P] ~ Denotes a period in which subjects made predictions.

[a] ~ In experiment 4 and 5 pairings were fixed, while in experiments 6 and 7 pairings were random.

PAYOFF TABLE *A*

		Smallest Value of *X* Chosen						
		7	6	5	4	3	2	1
Your	7	1.30	1.10	0.90	0.70	0.50	0.30	0.10
Choice	6	–	1.20	1.00	0.80	0.60	0.40	0.20
of	5	–	–	1.10	0.90	0.70	0.50	0.30
X	4	–	–	–	1.00	0.80	0.60	0.40
	3	–	–	–	–	0.90	0.70	0.50
	2	–	–	–	–	–	0.80	0.60
	1	–	–	–	–	–	–	0.70

PAYOFF TABLE *B*

		Smallest Value of *X* Chosen						
		7	6	5	4	3	2	1
Your	7	1.30	1.20	1.10	1.00	0.90	0.80	0.70
Choice	6	–	1.20	1.10	1.00	0.90	0.80	0.70
of	5	–	–	1.10	1.00	0.90	0.80	0.70
X	4	–	–	–	1.00	0.90	0.80	0.70
X	3	–	–	–	–	0.90	0.80	0.70
	2	–	–	–	–	–	0.80	0.70
	1	–	–	–	–	–	–	0.70

TABLE 2—EXPERIMENTAL RESULTS FOR TREATMENT *A*

	Period									
	1	2	3	4	5	6	7	8	9	10
Experiment 1										
No. of 7's	8	1	1	0	0	0	0	0	0	1
No. of 6's	3	2	1	0	0	0	0	0	0	0
No. of 5's	2	3	2	1	0	0	1	0	0	0
No. of 4's	1	6	5	4	1	1	1	0	0	0
No. of 3's	1	2	5	5	4	1	1	1	0	1
No. of 2's	1	2	2	4	8	7	8	6	4	1
No. of 1's	0	0	0	2	3	7	5	9	12	13
Minimum	2	2	2	1	1	1	1	1	1	1
Experiment 2										
No. of 7's	4	0	1	0	0	0	0	0	0	1
No. of 6's	1	0	1	0	0	1	0	0	0	0
No. of 5's	3	3	2	1	0	0	1	1	0	1
No. of 4's	4	6	2	3	3	0	0	0	0	0
No. of 3's	1	4	2	5	0	1	1	0	1	0
No. of 2's	3	2	6	5	5	9	3	4	3	1
No. of 1's	0	1	2	2	8	5	11	11	12	13
Minimum	2	1	1	1	1	1	1	1	1	1
Experiment 3										
No. of 7's	4	4	1	0	1	1	1	0	0	2
No. of 6's	2	0	2	0	0	0	0	0	0	0
No. of 5's	5	6	1	1	1	0	0	0	0	0
No. of 4's	3	3	2	1	2	1	0	0	0	1
No. of 3's	0	0	7	6	0	2	3	0	0	0
No. of 2's	0	1	1	4	5	3	6	3	2	2
No. of 1's	0	0	0	2	5	7	4	11	12	9
Minimum	4	2	2	1	1	1	1	1	1	1
Experiment 4										
No. of 7's	6	0	1	1	0	0	1	0	0	0
No. of 6's	0	6	2	0	0	1	0	0	0	0
No. of 5's	8	5	5	5	0	1	0	0	0	0
No. of 4's	1	1	4	6	7	1	2	1	1	0
No. of 3's	0	2	3	2	4	3	2	2	1	0
No. of 2's	0	1	0	0	2	3	7	4	2	2
No. of 1's	0	0	0	1	2	6	3	8	11	13
Minimum	4	2	3	1	1	1	1	1	1	1

TABLE 2—EXPERIMENTAL RESULTS FOR TREATMENT *A*, Continued

	Period									
	1	2	3	4	5	6	7	8	9	10
Experiment 5										
No. of 7's	2	2	3	1	1	1	1	0	0	0
No. of 6's	1	3	1	0	0	0	0	0	0	0
No. of 5's	9	3	0	4	1	0	2	0	0	0
No. of 4's	3	4	6	2	1	2	0	2	1	1
No. of 3's	1	2	2	4	6	0	0	0	0	1
No. of 2's	0	2	2	3	4	6	5	2	5	3
No. of 1's	0	0	2	2	3	7	8	12	10	11
Minimum	3	2	1	1	1	1	1	1	1	1
Experiment 6										
No. of 7's	5	3	1	1	1	1	2	2	2	3
No. of 6's	2	0	0	0	1	0	0	0	0	0
No. of 5's	5	1	0	0	0	1	0	0	0	0
No. of 4's	2	3	4	0	0	0	0	0	0	0
No. of 3's	1	5	4	2	2	2	1	0	2	0
No. of 2's	0	2	4	5	3	3	6	4	5	5
No. of 1's	1	2	3	8	9	9	7	10	7	8
Minimum	1	1	1	1	1	1	1	1	1	1
Experiment 7										
No. of 7's	4	3	1	1	1	1	1	1	1	1
No. of 6's	1	0	0	0	0	0	0	0	0	0
No. of 5's	2	3	0	0	0	0	0	0	0	0
No. of 4's	4	0	1	2	1	0	0	0	0	0
No. of 3's	1	3	2	1	1	0	0	0	0	0
No. of 2's	1	3	2	2	4	4	4	4	5	3
No. of 1's	1	2	8	8	7	9	9	9	8	10
Minimum	1	1	1	1	1	1	1	1	1	1

TABLE 3—EXPERIMENTAL RESULTS FOR TREATMENT *B* AND TREATMENT *A'*

	Treatment *B*					Treatment *A'*				
	11	12	13	14	15	16	17	18	19	20
Experiment 2										
No. of 7's	13	15	16	16	16	8	2	0	0	0
No. of 6's	1	0	0	0	0	0	0	0	0	0
No. of 5's	0	1	0	0	0	1	0	0	0	0
No. of 4's	1	0	0	0	0	1	2	0	0	0
No. of 3's	1	0	0	0	0	1	1	1	1	0
No. of 2's	0	0	0	0	0	3	3	4	2	0
No. of 1's	0	0	0	0	0	2	8	11	13	16
Minimum	3	5	7*	7*	7*	1	1	1	1	1*
Experiment 3										
No. of 7's	13	13	12	13	14	6	2	2	1	1
No. of 6's	0	0	1	1	0	1	0	0	0	0
No. of 5's	0	0	1	0	0	0	2	1	0	0
No. of 4's	1	0	0	0	0	1	0	0	0	1
No. of 3's	0	1	0	0	0	0	0	0	0	0
No. of 2's	0	0	0	0	0	2	4	2	3	0
No. of 1's	0	0	0	0	0	4	6	9	10	12
Minimum	4	3	5	6	7*	1	1	1	1	1
Experiment 4										
No. of 7's	12	13	14	14	15	3	1	0	0	0
No. of 6's	0	0	0	0	0	0	0	0	0	0
No. of 5's	1	0	0	1	0	0	0	0	0	0
No. of 4's	0	1	1	0	0	2	0	0	0	0
No. of 3's	0	1	0	0	0	2	0	0	0	0
No. of 2's	0	0	0	0	0	2	1	2	0	0
No. of 1's	2	0	0	0	0	6	13	13	15	15
Minimum	1	3	4	5	7*	1	1	1	1*	1*
Experiment 5										
No. of 7's	13	13	15	15	15	1	0	0	0	0
No. of 6's	0	0	0	0	0	0	0	0	0	0
No. of 5's	1	1	0	0	0	0	0	0	0	0
No. of 4's	1	1	0	0	0	0	0	0	0	0
No. of 3's	0	0	0	0	0	1	1	0	0	0
No. of 2's	0	0	0	0	0	3	4	2	2	3
No. of 1's	1	1	1	1	1	11	11	14	14	13
Minimum	1	1	1	1	1	1	1	1	1	1
Experiment 6										
No. of 7's	13	13	12	12	13	2	2	2	2	2
No. of 6's	0	1	1	1	0	0	0	0	0	0
No. of 5's	0	1	1	0	1	0	0	0	0	0
No. of 4's	1	0	1	1	0	1	0	0	0	0
No. of 3's	0	1	0	1	0	1	0	0	0	0
No. of 2's	1	0	0	0	1	5	6	7	6	5
No. of 1's	1	0	1	1	1	7	8	7	8	9
Minimum	1	3	1	1	1	1	1	1	1	1
Experiment 7										
No. of 7's	12	14	13	13	14	3	4	2	2	2
No. of 6's	0	0	1	0	0	0	0	0	0	0
No. of 5's	0	0	0	0	0	1	0	0	0	0
No. of 4's	1	0	0	0	0	2	0	0	0	0
No. of 3's	0	0	0	1	0	2	0	0	0	0
No. of 2's	0	0	0	0	0	2	4	2	2	1
No. of 1's	1	0	0	0	0	4	6	10	10	11
Minimum	1	7*	6	3	7*	1	1	1	1	1

TABLE 4—EXPERIMENTAL RESULTS FOR TREATMENT C: FIXED PAIRINGS

	Period						
	21	22	23	24	25	26	27
Experiment 5							
Pair 1							
Subject 1	7	7	7	7	7	7	7
Subject 16	7	7	7	7	7	7	7
Minimum	7*	7*	7*	7*	7*	7*	7*
Pair 2							
Subject 2	7	2	7	7	7	7	7
Subject 15	1	7	3	6	7	7	7
Minimum	1	2	7	7	7	7	7
Pair 3							
Subject 3	1	1	1	1	1	1	1
Subject 14	1	1	7	1	1	1	7
Minimum	1*	1*	1	1*	1*	1*	1
Pair 4							
Subject 4	1	7	7	7	7	7	7
Subject 13	7	2	5	7	7	7	7
Minimum	1	2	5	7*	7*	7*	7*
Pair 5							
Subject 5	1	7	4	7	7	7	7
Subject 12	1	4	7	7	7	7	7
Minimum	1	4	4	7*	7*	7*	7*
Pair 6							
Subject 6	5	7	7	7	7	7	7
Subject 11	7	7	7	7	7	7	7
Minimum	5	7*	7*	7*	7*	7*	7*
Pair 7							
Subject 7	1	7	6	7	7	7	7
Subject 10	5	3	6	7	7	7	7
Minimum	1	3	6*	7*	7*	7*	7*
Pair 8							
Subject 8	7	6	6	7	7	7	7
Subject 9	3	5	7	7	7	7	7
Minimum	3	5	6	7*	7*	7*	7*
Experiment 6							
Pair 1							
Subject 2	7	7	4	5	6	6	7
Subject 15	2	3	6	6	7	7	7
Minimum	2	3	4	5	6	6	7*
Pair 2							
Subject 3	5	7	7	7	7	7	7
Subject 14	7	7	7	7	7	7	7
Minimum	5	7*	7*	7*	7*	7*	7*
Pair 3							
Subject 4	1	1	1	1	4	4	1
Subject 13	7	1	1	3	1	1	2
Minimum	1	1*	1*	1	1	1	1
Pair 4							
Subject 5	5	7	7	7	7	7	7
Subject 12	7	7	7	7	7	7	7
Minimum	5	7*	7*	7*	7*	7*	7*

TABLE 4—FIXED PAIRINGS, Continued

	Period						
	21	22	23	24	25	26	27
Pair 5							
Subject 6	4	5	7	7	7	7	7
Subject 11	4	5	7	7	7	7	7
Minimum	4*	5*	7*	7*	7*	7*	7*
Pair 6							
Subject 7	5	7	7	7	7	7	7
Subject 10	5	7	7	7	7	7	7
Minimum	5*	7*	7*	7*	7*	7*	7*

* ~ Denotes a mutual best-response outcome.

TABLE 5—DISTRIBUTION OF ACTIONS FOR TREATMENT *C*: RANDOM PAIRINGS

	Period				
	21	22	23	24	25
Experiment 6					
No. of 7's	5	5	4	10	8
No. of 6's	0	1	3	0	0
No. of 5's	2	5	3	3	4
No. of 4's	3	1	1	1	1
No. of 3's	1	1	1	0	0
No. of 2's	1	1	2	2	2
No. of 1's	4	2	2	0	1
Experiment 7					
No. of 7's	–	–	6	5	5
No. of 6's	–	–	1	0	1
No. of 5's	–	–	0	3	0
No. of 4's	–	–	2	1	4
No. of 3's	–	–	2	0	0
No. of 2's	–	–	0	0	1
No. of 1's	–	–	3	5	3

After the experiment was completed, a referee noted that the information passed to each player in the original experiment was simply the minimum choice in each period. He asked whether the results would be different if subjects saw the whole distribution (as we did in class…)

TABLE 6—DISTRIBUTION OF ACTIONS FOR TREATMENT *A* WITH MONITORING

[A picture of the page.]

	Period							
	1[P]	2[P]	3	4	5	6	7	8
Experiment 8								
No. of 7's	4	0	0	0	2	0	0	1
No. of 6's	1	1	0	0	0	0	0	0
No. of 5's	4	0	1	0	0	1	0	0
No. of 4's	5	4	2	1	0	0	1	0
No. of 3's	1	4	1	0	0	2	0	0
No. of 2's	0	2	1	2	3	2	1	1
No. of 1's	1	5	11	13	11	11	14	14
Minimum	1	1	1	1	1	1	1	1
Experiment 9								
No. of 7's	6	2	0	1	0	0	0	0
No. of 6's	1	2	0	0	0	0	0	0
No. of 5's	2	2	1	0	0	0	0	1
No. of 4's	4	2	3	1	0	0	0	0
No. of 3's	1	5	3	1	0	0	0	0
No. of 2's	0	1	0	5	4	1	0	0
No. of 1's	2	2	9	8	12	15	16	15
Minimum	1	1	1	1	1	1	1*	1

[P] ~ Denotes a period in which subjects made predictions.
* ~ Denotes a mutual best-response outcome.

Van Huyck and his colleagues have conducted a number of variations of their original experiment.

Median games (payoff is maximized if you choose the median of the numbers chosen)

Bidding for positions in the minimum game: (Earnings if one of these games is the payoff game will be zero for unsuccessful bidders, and earnings minus bids for successful bidders.

Median Value of *x* Chosen

		7	6	5	4	3	2	1
	7	0.70	0.65	0.50	0.25	-0.10	-0.55	-1.10
	6	0.65	0.70	0.65	0.50	0.25	-0.10	-0.55
Your	5	0.50	0.65	0.70	0.65	0.50	0.25	-0.10
Choice	4	0.25	0.60	0.65	0.70	0.65	0.50	0.25
of	3	-0.10	0.25	0.50	0.65	0.70	0.65	0.50
X	2	-0.55	-0.10	0.25	0.50	0.65	0.70	0.65
	1	-1.10	-0.55	-0.10	0.25	0.50	0.65	0.70

Source: Van Huyck, Battalio, and Beil1, 1991.

What can we learn from these experiments? What new conjectures do they suggest?

The Minimum game shows that we don't always get Pareto optimality; that it takes time to converge to an equilibrium; that size and repetition interact (2 player repeated gets to Pareto optimal equilibrium, other conditions do not).

The Median game shows that the rules matter in a way they wouldn't if only the equilibrium structure was important—games with the same equilibria can be very different. And history can be important. These two observations go together—if players don't reach equilibrium immediately, then games with the same equilibria may be different because they are different out of equilibrium, and players learn from and react to their out of equilibrium experiences. (Another way to think about this is that we may need to consider rational behavior not just in the face of rational behavior by others, but also in the face of boundedly rational or irrational behavior by some members of the population.)

The Auction version of the Minimum game shows that history can matter in a different way: forward induction, or selection, or perhaps a combination.