

# MW24.2 Experimental Economics (SS2021)

## Coordination Games

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⇒ unlike in *cooperation* games (e.g., Prisoner's Dilemma), the interests of the players in *coordination* games are *not* conflicted by socially and privately optimal choices/outcomes

⇒ coordinating on the *same* action ( $\sim$  equilibrium strategy):

\* [individual coordination] each player would prefer to choose an action that supports an equilibrium (i.e., best response)

\* [collective coordination] all players would prefer to end up in a payoff dominant equilibrium

### Coordination Games ( $2 \times 2$ )

#### Pure Coordination Game

	L	R
L	*2, 2*	-1, -1
R	-1, -1	*1, 1*

\* 2 N.E.: {L; L} and {R; R}

\* {L; L} payoff dominates {R; R}

#### Traffic Game

$\sim$  choice of a *new* technological standard

	L	R
L	*1, 1*	-1, -1
R	-1, -1	*1, 1*

\* 2 N.E.: {L; L} and {R; R}

\* neither equilibrium payoff dominates the other

#### Battle of Sexes

$\sim$  coordination with a payoff (i.e., interest) conflict

$\sim$  universal adoption of an *existing* standard

	O	F
O	*2, 1*	0, 0
F	0, 0	*1, 2*

\* 2 N.E.: {O; O} and {F; F}

\* The players *disagree* on which equilibrium is desirable

## Stag Hunt

~ coordination with a tension between safe and risky outcomes

	S	H
S	*8, 8*	6, 7
H	7, 6	*7, 7*

\* 2 N.E.: {S; S} and {H; H}

\* {S; S} is payoff dominant while {H; H} is risk dominant

## Minimum Effort Game

\* more general than, e.g., Stag Hunt

\* models processes subject to bottlenecking (i.e., “weakest link”)

$$\Rightarrow \pi(e_i, e_{-i}) = a \cdot \min\{e_i, e_{-i}\} - b \cdot e_i + c$$

s.t.  $a > b > 0$  and  $e_i \in [0, \bar{e}]$ ,

where  $\pi$  is own payoff,  $e_i$  is own effort level,  $e_{-i}$  are opponent effort levels,  $a$  is return to coordination,  $b$  is marginal cost of effort, and  $c$  is base payoff

$\Rightarrow$  any *common* effort level  $e_i = e_{-i}$  is a N.E.

exa) Stag Hunt  $\leftarrow \pi = 20 \cdot \min\{e_i, e_{-i}\} - 10 \cdot e_i + 60$  s.t.  $e_i \in \{1, 2\}$

	(2)	(1)
(2)	80, 80	60, 70
(1)	70, 60	70, 70

\* two types of coordination failure:

- incorrectly predict  $\min\{e_{-i}\}$  and choose  $e_i \neq \min\{e_{-i}\}$  (i.e., not b.r.)
- coordinate on  $e_i = e_{-i} \neq \bar{e}$  (i.e., not socially desirable)

$\Rightarrow$  according to Harsanyi and Selten [1988]<sup>1</sup>, *payoff dominance* should resolve both issues

<sup>1</sup>John C Harsanyi and Reinhard Selten. *A general theory of equilibrium selection in games*. The MIT Press, 1988

## Huyck et al. [1990]

- \* testing payoff dominance as an equilibrium selection device
- \* repeated minimum effort game (treatment A: 10 repetitions) [Table A]
- \* minimum effort level revealed; prediction about future play occasionally
- \* group size: 14–16 (partner) or 2 (partner/stranger)

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Treatments: [Table 1]

- A)  $\sim$  as above
- B)  $\sim e_i = 7$  is (weakly) dominant ( $b = 0$ ); no coordination problem [Table B]
- A')  $\sim$  A after B again
- C)  $\sim$  A played in pairs
- A\*)  $\sim$  A with monitoring  $\Leftrightarrow$  entire distribution of effort levels known

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\* payoff function:

$$\pi(e_i, e_{-i}) = 0.2 \cdot \min\{e_i, e_{-i}\} - 0.1 \cdot e_i + 0.6 \text{ s.t. } e_i \in \{1, 2, 3, 4, 5, 6, 7\}$$

\* predictors:

- payoff (Pareto) dominance
- risk dominance (i.e., maximin)
- adaptive learning (i.e., b.r. to the minimum observed)

\* major manipulations:

- (i) cost to benefit ratio of effort
- (ii) number of players

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(i) Compare the previous Stag Hunt parametrization to one with the following payoff function:

$$\pi' = 20 \cdot \min\{e_i, e_{-i}\} - 19 \cdot e_i + 60 \text{ s.t. } e_i \in \{1, 2\}$$

	(2)	(1)
(2)	62, 62	42, 61
(1)	61, 42	61, 61

(ii)  $E(\pi|e_i = 1) = 0.2 \cdot E[\min\{1, e_{-i}\}] - 0.1 + 0.6 = 0.2 - 0.1 + 0.6$  (i.e., no risk)<sup>2</sup>

$$E(\pi|e_i = 7) = 0.2 \cdot E[\min\{7, e_{-i}\}] - 0.7 + 0.6,$$

where  $E[\min\{7, e_{-i}\}]$  is *negatively* related to the number of players

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## Results:

⇒ Subject predictions:

- heterogeneous expectations
- match actual behavior better than payoff or risk dominance
- relatively reasonable fit between beliefs and actions albeit most choose  $e_i > E_i[\min\{\cdot\}] \mid E_i[\min\{\cdot\}] < 7$

⇒ Period one: [Table 2]

- (7) ~ 31%; (1) ~ 2%; (4) ~ 17%; (5) ~ 32%;
- $\max[\min\{\cdot\}] \leq 4$
- if  $e_i > \min\{\cdot\} \rightarrow$  lower effort in period 2 (some ‘overshoot’  $\min\{\cdot\}$ !)
- if  $e_i = \min\{\cdot\} \rightarrow$  adjust upward or repeat same effort level
- only 14 out 107 subjects b.r. in period 2, some go below the  $\min\{\cdot\}$

⇒ Repeated: [Table 2]

- convergence to the “secure” inefficient equilibrium
- convergence to the payoff dominant equilibrium in B, which does *not* persist through A’ [Table 3]

⇒ Paired: [Tables 4–5]

- partner matching  $\rightarrow$  most pairs coordinate on (7)
- random matching  $\rightarrow$  most are above (1) but below (7)

⇒ Monitoring: [Table 6]

- initial distribution of actions and time dynamics quite similar (albeit faster)
- *individual* coordination (b.r.) appears easier to achieve

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<sup>2</sup>All expectations are conditional on the probability distributions over effort choice of the individual opponents, e.g.,  $E(\pi|e_i) \equiv E(\pi|e_i; e_{-i}) \equiv E(\pi|e_i; f_{e_a}(\cdot), \dots, f_{e_h}(\cdot), f_{e_j}(\cdot), \dots, f_{e_n}(\cdot))$ , where  $f_e(\cdot)$  is a probability density function over said effort.

## Suggested Literature

- Charles A Holt. *Markets, games, & strategic behavior*. Boston Pearson Addison Wesley, 2007 [Chapters 3.3, 12]
- John B. Van Huyck, Raymond C. Battalio, and Richard O. Beil. Tacit coordination games, strategic uncertainty, and coordination failure. *The American Economic Review*, 80(1):234–248, 1990
- \* Russell W. Cooper, Douglas V. DeJong, Robert Forsythe, and Thomas W. Ross. Selection criteria in coordination games: Some experimental results. *The American Economic Review*, 80(1):218–233, 1990