

COORDINATION GAMES

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COORDINATION GAMES

- A game consists of a set of players, a set of actions and a set of payoffs that depend on the actions of the players.
- Consider an assembly line. A step of the production process cannot be started until the previous one has been completed. Production can therefore progress no faster than the slowest worker on the assembly line.
- Coordination is great. Can workers achieve coordination?
Most likely no!

How can a manager overcome a history of coordination failure?

THE SETUP

- We use an experimental setting which involves repeated play of a game between a group of 4 experimental subjects (employees) that are part of a fictitious entity (firm).
- Employees choose effort levels $\{0, 10, 20, 30, 40\}$ hours to devote to Activity A. [▶ Return](#)
- Earnings depend on:
 - ① the base wage,
 - ② the cost of the effort, and
 - ③ the bonus.

EXAMPLE

▶ Return

$$Payoff_i = BsWg - (Cost \times Effort_i) + (BnFct \times \min_{j \in Firm} (ActvA))$$

- In this example, the base wage is set at 300, the cost is set at 5 per hour, and the bonus factor is set at 6.

		Minimum Effort Hours by Employees of the Firm				
		0	10	20	30	40
Employee i	Effort	0	300	-	-	-
	by	10	250	310	-	-
		20	200	260	320	-
		30	150	210	270	330
		40	100	160	220	280

DESIGN CHARACTERISTICS

- There are 2 blocks of 10-rounds of game-play.
- The experimental set-up within each block has fixed-pairings amongst the employees of a firm.
- At each round, the employees receive full informational feedback.
- The effort-cost per hour is fixed throughout the experimental session.

BLOCK 1

- In Block 1, the bonus factor is set at 6, the cost per hour is set at 5, and the base wage at 300.
- There is coordination failure in Block 1.

		Minimum Effort Hours by Employees of the Firm				
		0	10	20	30	40
Effort by Employee i	0	300	-	-	-	-
	10	250	310	-	-	-
	20	200	260	320	-	-
	30	150	210	270	330	-
	40	100	160	220	280	340

TREATMENT (BLOCK 2)

$$\text{Payoff}_i = \text{BsWg} - (\text{Cost} \times \text{Effort}_i) + (\text{BnFct} \times \text{Min}_{j \in \text{Firm}}(\text{Actv}A))$$

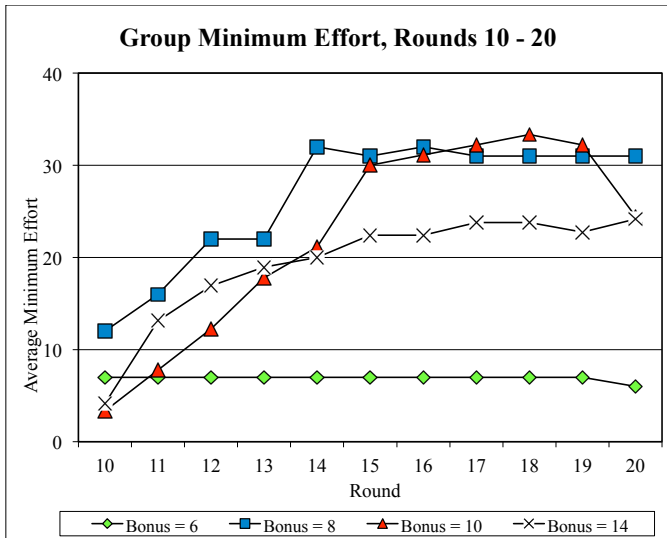
- In Block 2, the base wage remains at 300, the cost remains at 5 per hour, but the bonus factor is **increased to 10**.

▶ Return1

▶ Return2

		Minimum Effort Hours by Employees of the Firm				
		0	10	20	30	40
Effort by Employee i	0	300	-	-	-	-
	10	250	350	-	-	-
	20	200	300	400	-	-
	30	150	250	350	450	-
	40	100	200	300	400	500

BRANDS AND COOPER (2006)



FINDINGS

- ① Lower attractiveness of the secure action relative to the risky action is efficiency-enhancing. [▶ Table 1](#)
- ② Lower costs of exerting effort is efficiency-enhancing. [▶ Payoff Function](#)
- ③ Less stringent coordination requirements (i.e. smaller group size) is efficiency-enhancing.
- ④ Fixed matching protocols are efficiency-enhancing.
- ⑤ Providing full informational feedback seems efficiency enhancing (in small groups).

FINDINGS

- ⑥ Slowly growing groups that have managed to establish efficient precedents is efficiency enhancing.
- ⑦ Costly pre-play communication is efficiency enhancing.
- ⑧ Costless pre-play communication is efficiency enhancing.
- ⑨ Loss avoidance is efficiency enhancing. [▶ Table 2](#)
- ⑩ Lower costs of experimentation (increasing the number of rounds or refining the action space) is efficiency enhancing. [▶ Set-Up](#)

WHAT WE DON'T KNOW!

- We know quite a lot about structural determinants.
- We don't know anything about cognitive or behavioral determinants.
- Risk attitudes have been hardly studied even though everybody acknowledges their importance in coordination games.
- The impact of group composition along dimensions such as cultural homogeneity remains also a blind spot.

COOPER, IOANNOU AND QI (2018)

Would an endogenous change do better?

- Are we missing part of the impact of incentive contracts by assigning them to subjects randomly?
- There is ample evidence in non-interactive settings (i.e. piece rates) that much of the effect of contracts is due to selection (sorting).
 - Lazear (2000)
 - Dohmen and Falk (2011)
- What about a game, where productivity isn't determined by hard work or ability, but rather the ability to coordinate?
- Is high performance pay more effective when incentive contracts are endogenously selected through a market mechanism rather than being exogenously imposed?

THE TURNAROUND GAME

- All experiments consist of 20 rounds, split into two 10-round blocks.
- Throughout a block, the groups are fixed with 4 persons each.
- Two parameters are varied over time: the fixed wage (W) and the bonus rate (B).
- Employees choose effort levels $\{0, 10, 20, 30, 40\}$ hours.

$$Payoff_i = W - (5 \times Effort_i) + (B \times MinEffort_{j \in Firm})$$

CONTRACT 1

		Minimum Effort Hours by Employees of the Firm				
		0	10	20	30	40
Effort by Employee i	0	300	-	-	-	-
	10	250	310	-	-	-
	20	200	260	320	-	-
	30	150	210	270	330	-
	40	100	160	220	280	340

- $W = 300$
- $B = 6$

CONTRACT 2

		Minimum Effort Hours by Employees of the Firm				
		0	10	20	30	40
Effort by Employee i	0	W	-	-	-	-
	10	W-50	W+50	-	-	-
	20	W-100	W	W+100	-	-
	30	W-150	W-50	W+50	W+150	-
	40	W-200	W-100	W	W+100	W+200

- W ? W is a treatment variable.
- $B = 10$

AUCTION TREATMENT

- Subjects bid on the level of W they are willing to accept in exchange for the higher value of B in Contract 2.
- Clock auction with falling values of W .
 - Starts at $W = 400$ and falls by 5 ECUs every 5 seconds.
 - At any point, a subject can press a button to drop out, taking Contract 1 for certain.
 - Once $\frac{N}{2}$ subjects have dropped out, the remaining individuals all get Contract 2 with W determined by the value at the last dropout.
 - New four-person groups are randomly formed consisting of subjects who selected into the same contract.
- Subjects receive extensive training on the auction.
 - A movie shows the auction interface in action.
 - The subjects practice auction against robots.

AUCTION SCREENSHOT

Period: 1 out of 10

Contract 1

		Minimum Hours by Employees of Firm Devoted on Activity A				
		0 hrs	10 hrs	20 hrs	30 hrs	40 hrs
My Hours Devoted on Activity A	0 hrs	300				
	10 hrs	250	310			
	20 hrs	200	260	320		
	30 hrs	150	210	270	330	
	40 hrs	100	160	220	280	340

Contract 2

		Minimum Hours by Employees of Firm Devoted on Activity A				
		0 hrs	10 hrs	20 hrs	30 hrs	40 hrs
My Hours Devoted on Activity A	0 hrs	400				
	10 hrs	350	450			
	20 hrs	300	400	500		
	30 hrs	250	350	450	550	
	40 hrs	200	300	400	500	600

Remaining Seconds: 400

Contract 1
Bonus Factor: 6 & Base Wage (in ECUs): 300

Contract 2
Bonus Factor: 10 & Base Wage (in ECUs): 400

To choose Contract 1, please press "Contract 1." Otherwise, please wait for the procedure to end.

Contract 1

RANDOM TREATMENT

- Session sizes and values of W for Contract 2 are matched to sessions from the Auction treatment.
- Subjects are randomly assigned to new four-person groups for Block 2. Groups are randomly assigned a contract.
 - Subjects are told they will be assigned to a new group and (possibly) a new contract.
 - They are given no information about how they are being assigned to groups or contracts.

You will be assigned to a new contract for Block 2. This may be a different contract than the one you had in Block 1. The base wage and the bonus factor, along with the payoff table of your new contract will be shown next.

SORT AND REVERSE SORT TREATMENTS

- We use data from the Auction treatments to predict dropout values.
- We sort subjects by predicted dropout values and form four-person groups (i.e. the four highest predicted dropouts form a group, then the predicted dropouts five to eight form a group etc.).
 - Sort treatment: Groups with the highest predicted dropout values ($\frac{N}{2}$ subjects) get Contract 1 and the remaining groups get Contract 2.
 - Reverse Sort treatment: Groups with the lowest predicted dropout values ($\frac{N}{2}$ subjects) get Contract 1 and the remaining groups get Contract 2.

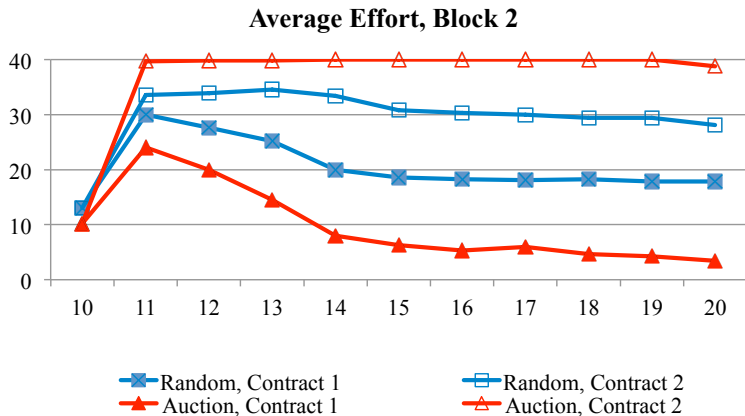
PREDICTING DROPOUTS FOR SORT AND REVERSE SORT TREATMENTS

- Tobit is used to predict dropout times for the Auction treatment.
 - Censoring when auction ends before subject drops out.
 - Best predictor is Round 1 choice; that is, higher effort is negatively correlated with lower dropout value (more willing to take Contract 2).

HYPOTHESES

- ① Average effort in Block 2 will be higher for Contract 2 than Contract 1 in the Random Assignment, Sort, and Auction treatments.
- ② Average effort in Block 2 for Contract 2 will be increasing in the following order across treatments: Reverse Sort, Random Assignment, Sort, and Auction.
- ③ Average effort in Block 2 for Contract 1 will be decreasing in the following order across treatments: Reverse Sort, Random Assignment, Sort, and Auction.

EXOGENOUS VERSUS ENDOGENOUS CONTRACTS

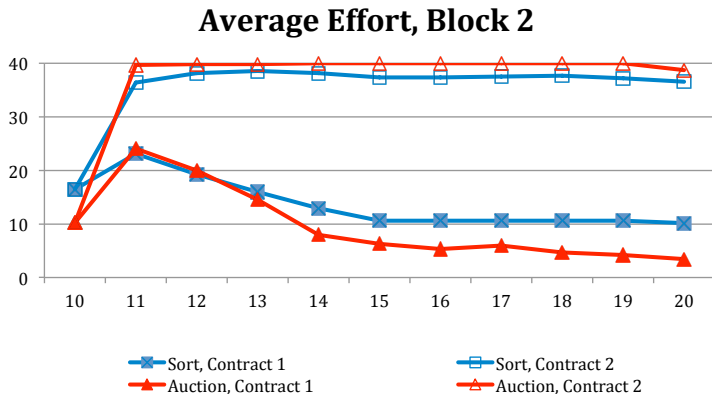


EXOGENOUS VERSUS ENDOGENOUS CONTRACTS (CONT.)

- The difference between Contracts 1 and 2 is significant for the Random Assignment.
- Effort is significantly higher in the Auction treatment for Contract 2, and significantly lower in Contract 1.
- The positive effect for groups with high performance pay is matched by a negative effect for groups with low performance pay.

Conclusion 1: The positive effect of high performance pay is larger with endogenous assignment to contracts. This is offset by an increased negative effect for groups assigned to low performance pay, so that the overall effect of endogenous assignment to incentive contracts is neutral.

AUCTION VERSUS SORT



- The difference between Sort and Auction treatments is weakly significant for Contract 2, but not for Contract 1.

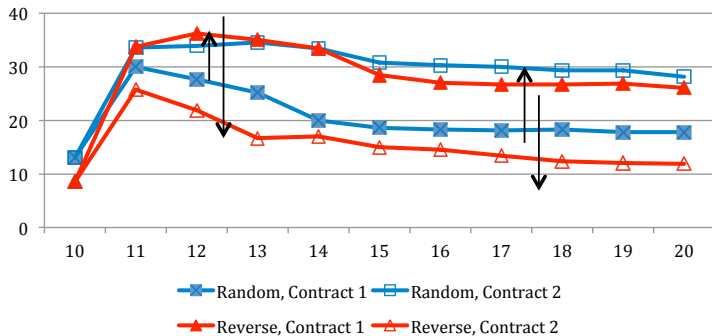
INCENTIVES, SELECTION OR STRATEGIC ANTICIPATION?

- We can decompose the effect of endogenous assignment to Contract 2 into two components.
 - Selection: This is the difference between the Sort and Random Assignment treatments for Contract 2.
 - Strategic Anticipation: This is the difference between the Auction and Sort treatments for Contract 2.
- Taking the ratio of the selection effect to the sum of these two effects, 73% of the effect of making high performance pay endogenous is due to selection.

Conclusion 2: Roughly three quarters of the effect of making high performance pay endogenous is due to selection.

REVERSE SORT TREATMENT

Average Effort, Block 2



REVERSE SORT

- The effect of sorting is sufficiently strong to overcome the direct effect of incentives.
 - Effort is significantly lower with Contract 2 versus Contract 1 in the Reserve Sort treatment, rather than significantly higher as in the other treatments.

Conclusion 3: The direct effect of increased incentives to coordinate with Contract 2 is reversed in the Reverse Sort treatment by assigning subjects to the contract they were **not** predicted to get in the Auction treatment.

CONCLUDING REMARKS

- We study the effect of making assignment to incentive contracts endogenous rather than exogenous.
- Most of the effect of having an endogenous contract assignment is due to selection.
- The total effect of endogenous contract assignment is virtually zero.