Motivation and Coordination Games: Experiencing Organizational Dynamics

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Introduction

The motivation and coordination games covered here are used in the Managerial Economics class that is taught at UC Santa Cruz. Both games provide students with a hands on way to experience the differences between problems of motivation and coordination, a distinction which many under-graduates do not immediately understand.

Both games are conducted in class and they have a short follow-up assignment that is announced after the game is finished. This assignment is meant to help the students understand what they have been doing and why the two games are different.

In the coordination game, the students have a common interest (the equilibria are Pareto ranked, and one is efficient). The problem is aligning expectations (and actions). Generally, the students initially settle on an inefficient equilibrium. Direct communication between students allows students to achieve efficiency and move to the Pareto efficient equilibrium without the need for binding commitments.

In contrast, in the motivation game, the players have a personal interest diametrically opposed to the common interest (a sort of multilateral prisoner's dilemma). By playing the game, students come to realize how difficult it can be to achieve cooperation when the benefits to defection are great. Even in the classroom, it seems impossible to get the Pareto optimal equilibrium without some kind of binding agreement.

Motivation and Coordination in Economics

Following Milgrom and Roberts' text, Economics, Organization, and Management, the firm's problems fall into two distinct categories: motivation and coordination. Problems such as getting all of the parts of a firm to work together, and economy wide resource allocation, are illustrations of the coordination problems faced by the firm. Some of these problems, like resource allocation, are easily solved by using price mechanisms. In other situations, however, prices are inappropriate or just do not work. How does a firm set up and make work a just-in-time manufacturing system? Relative prices may work but they may not be the most appropriate way to coordinate all of the elements that need to work together to get such a system to work. In all of these problems, there is an equilibrium that is best for all the actors involved, but how does the firm get there? Are there not ways for firms to get better outcomes?

Motivation problems are slightly different. These deal with the problems of making people or firms do what they otherwise would not want to. This issue is critically important to issues

involving contracts. It also illustrates why it is so difficult to get others to do what is in the group's best interest and how group and personal interests can be diametrically opposed.

Firms constantly face motivation problems from both inside and outside. How does one ensure that employees consistently act in the best interest of the company and not in a self interested fashion? How, in inter-firm agreements, do the firms work for the best interest of the partnership? The key to solving motivation problems is to align the interests of the individual (or other company) with the interest of the firm.

A hands-on experience with some of these problems seems to help students understand the concepts as well as appreciate the difficulty, in some situations, of reaching the optimum.

The Coordination Game

The coordination game is very simple in its structure. The students are playing for points (ideally linked to a prize or in our case, bonus points) and receive an instruction/reporting sheet. Two to four class monitors are needed. All the other students in the class participate. The students are split into groups A, B, of between 5 and 15 players each.* Each period, the students are asked to choose a number between 1 and 10 (inclusive) based on the following earnings rule that is on their instruction sheets (see Appendix A): let LG be the smallest number chosen in team G, let xi > LG be the choice of individual i in that team. Student i earns LG less his deviation di = xi - LG from the team's choice. So, Pi = LG - di (= 2LG - xi) are i's earnings that period.

The students make their choice and record it on their reporting sheets. The monitors then go around and announce the values of LG for all of the teams and the students calculate their earnings that period (and record the LGs for each group).

We use two different treatment variables: communication and group size. The initial periods can have no communication between students. In subsequent periods, communication is allowed. They generally achieve the optimal outcome without incentive schemes so long as there is communication allowed. Varying group size by combining and splitting up groups also adds some additional dynamics to the exercise and keeps the students' interest up by changing the people with whom they must interact. It is however crucial to make sure that each change in treatment be noted on the students' record sheets.

The efficient equilibrium is to have all members of the group choosing xi = 10 (see Table 1). Contrary to what will happen in the other game, there is no incentive here to defect. A student who chooses to defect would get earnings of 9 instead of the 10 they could get by not defecting (it is interesting to note that the other members of the group lose even more from the defection--they now get earnings of 8 points instead of the 10).

Table 1. Coordination Game PayoffsThe individual player's earnings are dependent on the smallest number chosen in team G (LG) as well as the choice of xi.

	LG=1	LG=2	LG=3	LG=4	LG=5	LG=6	LG=7	LG=8	LG=9	LG=10
xi=1	1	.	.	.	.	.	.	.	.	.
xi=2	0	2	.	.	.	.	.	.	.	.
xi=3	-1	1	3	.	.	.	.	.	.	.
xi=4	-2	0	2	4	.	.	.	.	.	.
xi=5	-3	-1	1	3	5	.	.	.	.	.
xi=6	-4	-2	0	2	4	6	.	.	.	.
xi=7	-5	-3	-1	1	3	5	7	.	.	.
xi=8	-6	-4	-2	0	2	4	6	8	.	.
xi=9	-7	-5	-3	-1	1	3	5	7	9	.
xi=10	-8	-6	-4	-2	0	2	4	6	8	10

The Motivation Game

The motivation game appears very similar to the coordination game. The class setup is the same and the instructions are similar. This is done so that the students focus on the structure of the game rather than on the differences in notation. The primary difference is in the earnings rules that are given. The group and individual benefits are now diametrically opposed, not complementary.

Each period, each student is asked to choose either 0 or 1 based on payoff rules that are provided on their instruction sheets (see Appendix B). Letting MG = SUM(xi) be the total number chosen in group G, player i earns MG less her effort cost 5xi, so player i's individual earnings are Pi = MG - 5xi. The students make their choice and write it on their reporting sheet. The student monitors go around checking the sheets and announce the values of MG for each group. The students fill in the values for MG and calculate their earnings on their reporting sheets.

Once again, the first four periods are done with no communication between students. In periods four through eight the students are allowed to communicate. In the final periods the students are allowed to agree on contingent transfer (or incentive) schemes. Group size and composition are also changed periodically.

As can be seen from Tables 2 and 3, the players have an interest diametrically opposed to the group interest. Assuming a group of seven students, table 2 shows how a myopic individual player perceives the game. The myopic player will have a tendency to play xi = 0. In contrast, Table 3 shows the group average earnings for different MGs. Here the average earnings clearly increase as MG increases so there is a definite benefit to everyone in the group choosing xi = 1 over xi = 0.

Table 2. The Individual's Motivation Game

MG	Pilxi=0	Pilxi=1
0	0	n/a
1	1	-4
2	2	-3
3	3	-2
4	4	-1
5	5	0
6	6	1
7	n/a	2

Table 3 also illustrates the advantages defection from the optimal policy can have for a player. If all other players are going to play xi = 1, the last player has the option of playing xi = 1 earning 2, or xi = 0 earning 6. The player's interests are diametrically opposed to the group's interest.

Table 3. Motivation Game Payoffs: Motivation game payoffs with a group of 7 students

#of xi=1	# of xi=0	Pi for xi=1	Pi for xi=0	Total Group Earnings	Average Earnings
0	7	n/a	0	0	0
1	6	-4	1	2	0.2857
2	5	-3	2	4	0.5714
3	4	-2	3	6	0.8571
4	3	-1	4	8	1.1428
5	2	0	5	10	1.4286
6	1	1	6	12	1.7143
7	0	2	n/a	14	2

In class, the students are usually incapable of reaching the Pareto optimal outcome without binding agreements. It is interesting to let the students decide on their own what kind of agreement they think will work (although they do occasionally need a few suggestions on how binding agreements can be set up). The instructor is often used to enforce the binding agreement but this is only allowed when their group's agreement is unanimous.

Post Game Exercises

After the games have been conducted in the classroom, the students are required to turn in follow-up exercises in the next class. This usually requires graphing the results, computing the mean, the standard deviation, the deviations from the Pareto optimal outcome, etc., across the different treatments. These reports are usually separate assignments since the two games are usually conducted on different days. The results of the game and the students' write-ups are then

discussed in class (or in section). This is a time for the students to compare their experiences and results, get questions answered, and discuss the differences between the two games.

Because the students will be basing all of their analysis on the data they recorded on their record sheets, it is crucial that they fill these out completely. It is also important to have the follow-up analysis announced after the students have completed the exercise so that it does not influence their actions.

Variations and Other Applications

Both of these games can be varied in several different ways. In either game the earnings could be changed from individual earnings to average group earnings. This would substantially change the actions of the individuals in the motivation game and not have a substantial effect on the coordination game. Another possible variation is making slight changes in the earnings rules. Changing the effort cost in the motivation game will affect the gains to defection and should change the ease of reaching the Pareto optimal outcome. Making the earning rule in the coordination game be dependent on two times the deviation from the team's choice is another possi- bility. The variants are endless and could lead to interesting post game exercises for the students.

There are also other possible uses of these games. Although incorporated in a series of games, these games could just as easily be used as stand alone games in other classes such as environmental, introductory, or intermediate economics courses. The motivation game is particularly suited to explaining the difficulties in organizing a cartel (although the game does not model the social costs of the cartel).

References

Milgrom, Paul and John Roberts, Economics, Organization, and Management, Englewood Cliffs, New Jersey: Prentice Hall, 1992.

**The examples given in this paper are for a class of approximately 50 students. A few minor adjustments may have to be made for classes that are substantially larger or smaller.*

Appendix A: Coordination Game Instructions and Reporting Sheet

Economics 101 Name:
UCSC Term, 199X

Coordination Game Instructions

Purpose: To experience a basic coordination problem and how it may be overcome.

Rules: Two to four student volunteers to monitor. The others form teams. Each period each person chooses a number 1–10 so as to maximize earnings.

Earnings: Let LG be the smallest number chosen in team G, and let xi > LG be the choice of individual i in that team. Then, i earns LG less his deviation di = xi – LG from the team's choice, i.e., Pi = LG – di (= 2 LG – xi) are i's earnings that period.

Each period, every player records his or her own choice, xi, each team's choice LA, LB, ... , and his or her deviation di and earnings each period on the record sheet.

Players receive .05 of the total earnings as bonus points. Monitors receive the class average bonus points.

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Name:
Term, 199X

Record Sheet: Coordination Game

	Choices						Your outcome
Period	Your xi	LA	LB	LC	LD	di = xi – LG	Pi = LG – di
0	7	4	.	.	.	3	1
1							
2							

Total earnings _____

Appendix B: Motivation Game Instructions and Reporting Sheet

Economics 101 Name:
UCSC Term, 199X

Motivation Game Instructions

Purpose: To understand how group efficiency can be affected by motivational problems.

Rules: Two to four student volunteers to monitor. The others form teams. Each period each person i chooses a number xi = 0 or 1 so as to maximize earnings.

Earnings: Let MG = SUM(xi) be the total number chosen in team G. Then player i earns MG less her effort cost 5xi, so Pi = MG - 5xi are her earnings that period.

Each period, every player records his or her own choice xi, each team's choice MA, MB, and his or her earnings each period on the record sheet.

Players receive .05 of the total earnings as bonus points. Monitors receive the class average bonus points.

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Name:
Term, 199X

Record Sheet: Motivation Game

	Choices					Your outcome
Period	Your xi	MA	MB	MC	MD	Pi = MG - 5xi
0	1	6	.	.	.	1
1						
2						

Total Earnings _____