

Suggested solutions to the 6th seminar, ECON4260

Problem 1

- a) *What is a public good game?*
See, for example, Camerer (2003), Fehr and Schmidt (1999) p.836, and/or lecture notes, lecture 1 of Topic 3.
- b) *Assume that each player in a one-shot public good game has preferences for his own material payoff only. Which outcome of the game would you expect? Why?*

Each keeps his entire endowment for himself. See lecture notes, lecture 1 of Topic 3.

- c) *Discuss to what extent your predictions from Question 3b seems to accord with public good game findings reported in the experimental economics literature.*

Poorly. Usual findings: Average contributions typically 40-60 percent of initial endowment (depending on the specific aspects of the game setup such as group size and multiplication factor). Substantial heterogeneity: Many 0's and many high contributions. (Another interesting finding: many players seem to prefer giving about the same amount as others, whatever that is.)

- d) *Could inequity aversion provide a possible explanation to the typical findings in experimental one-shot public good games? Why? (An intuitive explanation is sufficient.)*

Yes – at least to some extent.

You are asked only for an intuitive explanation, and the n-player model is a bit complex, but some intuition can be seen from the following (for a formal treatment, see p.839 (Prop. 4) and 840 in Fehr and Schmidt (1999)):

What happens when your contribution increases?

When i gives 1 kr extra to the group, she gets M/N kr extra back (where M is the multiplication factor and N the number of members in the group). However, all others in the group also get M/N more. Thus, each person's increased *income from the group account* will neither increase nor decrease inequality. An extra 1 kr contribution will, however, change inequality through the very change in i 's own *contribution* (she gets less herself).

What if you contribute more than others?

Since the group account is shared equally, you will be worse off than others. There will be inequality, and it will be disadvantageous. By decreasing your contribution marginally, you can increase your material payoff and reduce disadvantageous inequality – both of which are desirable. **Thus you will never want to contribute more than others.**

What happens if you contribute less than others?

There will be advantageous inequality. By increasing your contribution by 1 kr, you will then reduce your material payoff, but by less than 1 kr. You will also decrease inequality. Thus

there is both a loss and a gain. What you will prefer depends on the strength of your aversion towards advantageous inequality (β) and the share of your own contribution you will in fact get back, M/N . If your beta is small enough, you may be happy to contribute less than the others. If your beta is large enough, you will not want to contribute less than others.

Assume first that everyone else contributes nothing. Then it will be costly for you to contribute, and by contributing, you will also *increase* inequality (moreover, this inequality will be disadvantageous to you). **Thus you will never contribute if others contribute 0.** Assume then that everyone else contributes everything. If you do so too, there is no inequality. By reducing your contribution, you can earn more; there will be inequality, but it will be advantageous. If your beta is high enough, however, you will prefer to contribute everything as long as others do too.

Even if others contribute, you do not necessarily do so yourself: It may be that your inequity aversion is not strong enough to outweigh the loss of money. Finally, what you do will depend on others' preferences. Assume that you are willing to contribute everything, if others do too, but others are not willing to do so. Then you will end up reducing your contribution to their level.

To sum up, **an inequity averse person will never prefer to contribute *more* than others**, when initial incomes are identical. She might, however, contribute a strictly positive amount which is equal to the others'. Thus, **inequity aversion gives rise to conditional cooperation.**

In a one-shot public good game with simultaneous contributions and no communication, subjects cannot know what others will do. Conditional cooperation – being willing to contribute if others do so too – in such games must consequently be based on *beliefs* about others' strategies/behaviors.

(Formally, FS(1999), p.839, show the following:

- a) If $(M/N + \beta_i) < 1$, i always chooses to contribute nothing. (Reason: If M/N is close to 1, you will get most of your contribution back, so you do not need much inequity aversion to compensate for the cost of giving.)
- b) If sufficiently many players have $(M/N + \beta_i) < 1$, contributions = 0 for all is the only Nash equilibrium.
- c) If sufficiently many players have $(M/N + \beta_i) > 1$, there exist Nash eq. where those players with $(M/N + \beta_i) < 1$ contribute nothing, while everyone else makes a strictly positive contribution which is equal for all of them.)

Problem 2

- a) *What is a convention? Provide a definition, and give at least one example.*

A convention is a rule of behavior that everyone is expected to follow, and that everyone knows that everyone is expected to follow, where the behavior constitutes a Nash equilibrium.

Young (1998, on the compulsory reading list) writes: "[...] *a convention is equilibrium behavior in a game played repeatedly by many different individuals in society, where the behaviors are widely known to be customary.* Note the importance of knowledge: the

behaviors must not only *be* customary, they must be *known to be* customary, or else the behaviors are not in fact self-enforcing.”

In the same author’s “The Economics of Convention” (Journal of Economic Perspectives 10(2), 105-122, 1996, not on the course reading list, but the first two pages are well worth reading) he elaborates (p. 105): “By a convention, we mean a pattern of behavior that is customary, expected and self-enforcing. Everyone conforms, everyone expects others to conform, and everyone has good reason to conform because conforming is in each person’s best interest when everyone else plans to conform (Lewis, 1969). Familiar examples include following rules of the road, adhering to conventional codes of dress and using words with their conventional meanings. [...] The main feature of a convention is that, out of a host of conceivable choices, only one is actually used. This fact also explains why conventions are needed: they resolve problems of indeterminacy in interactions that have multiple equilibria. Indeed, from a formal point of view, we may define a convention as an equilibrium that everyone expects in interactions that have more than one equilibrium.”

b) What is a social norm? Provide a definition, and give at least one example.

There is no single definition in the literature of the concept of a “social norm”, so this question requires some discussion. Sociologists and psychologists typically use and define the concept differently than economists do. Some economists use “social norms” and “moral norms” interchangeably.

One possible definition is the following:

A social norm is a rule of behavior that one is expected to follow, and which is *enforced through social sanctions*.

A more elaborate one is the following, which I have used in the lectures:

A social norm is

- a *predominant behavioral pattern* within a group
- backed by a *shared understanding of allowable actions*,
- and sustained through *social interactions* (e.g. others’ approval and/or disapproval) *within that group*.

According to these definitions, a “norm” is something quite similar to a “convention” according to Young’s definition, but with the additional requirement that social sanctions (which could be positive or negative) are involved in the process of enforcing it.

c) Could your example of a social norm also be considered a convention? Discuss.

With the definitions provided above, a social norm can be considered a special case of a convention (a convention enforced through social sanctions). So the answer will probably be yes. A social norm for not smoking indoors, for example, once it has become well established, could be considered (according to the last definition by Young 1996 suggested above) an “equilibrium that everyone expects in interactions that have more than one equilibrium”.

d) Could your example of a convention also be considered a social norm? Discuss.

Driving on the right side of the road, for example, could be sustained as the expected pattern of behavior even if people did not use social sanctions: It would be self-enforcing even in the absence of social sanctions. (You would probably prefer to drive on the same

side of the road as others even if nobody shouted at you if you didn't.) A convention is not necessarily a social norm.

1 Problem 3

Assume that asthma patients benefit from clean air, while healthy people do not notice the difference. Liza and Adam both consider whether to contribute to a project improving air quality. They are both healthy, and do not care about clean air for their own sake.

Liza is a pure altruist, however, and her utility, U_L , is given by

$$U_L = \begin{cases} 9 \ln c_L + 2 \ln G & \text{when } G > 0 \\ 9 \ln c_L & \text{when } G = 0 \end{cases} \quad (1)$$

where c_L is Lisa's consumption of private goods, G is a measure of air quality, and $(2 \ln G)$ is the altruistic benefit she gets from knowing that the air quality has the level G . Adam, on the other hand, is concerned about warm glow. His utility is

$$U_A = \begin{cases} 9 \ln c_A + 2 \ln g_A & \text{when } g_A > 0 \\ 9 \ln c_A & \text{when } g_A = 0 \end{cases} \quad (2)$$

where c_L is Adam's consumption of private goods, and g_A is Adam's contribution to cleaner air.

Both Liza and Adam have an exogenously fixed income of 100, which can be spent on private consumption or contributions to cleaner air, where one unit of G costs one unit of consumption. Thus, the budget constraint of each individual i is

$$100 = c_i + g_i \quad (3)$$

Each of them thinks that if he or she does not contribute, the level of air quality will be fixed at 90. Thus, both think that

$$G = G_{-i} + g_i = 90 + g_i \quad (4)$$

where G_{-i} is others' contributions and g_i is i 's own contribution.

a) How much will Liza contribute?

First, let us look for an interior solution. Insert from (3) and (4) in (1). (Due to (4) G will always be positive, so we can look at the first line of the utility function only.) This gives us Liza's utility expressed only in terms of g_L and exogenous factors:

$$U_L = 9 \ln(100 - g_L) + 2 \ln(90 + g_L)$$

Then, differentiate this wrt g_L , and let this equal 0 (which is the requirement

for an interior optimum):

$$\begin{aligned}
dU_L/dg_L &= \frac{9}{(100 - g_L)}(-1) + \frac{2}{(90 + g_L)} = 0 \\
\frac{9}{(100 - g_L)} &= \frac{2}{(90 + g_L)} \\
9(90 + g_L) &= 2(100 - g_L) \\
810 + 9g_L &= 200 - 2g_L \\
9g_L + 2g_L &= 200 - 810 \\
11g_L &= -610 \\
g_L &= -610/11
\end{aligned}$$

This cannot be an interior optimum: g_L cannot be negative! Hence, the optimal solution must be the corner solution: Liza contributes nothing.

Why do we get this result? Because G_{-L} is already too large for her to bother about making a contribution of her own: even though Liza would like others to get cleaner air, her own contribution will not change air quality much anyway, while it does cost her one unit of consumption.

b) How much will Adam contribute?

Again, let us first look for an interior solution, and look at the case first where $g_A > 0$. Insert from (3) in (2). This gives us Adam's utility expressed only in terms of g_A and exogenous factors:

$$U_A = 9 \ln(100 - g_A) + 2 \ln g_A$$

Then, differentiate this wrt g_A , and let the result equal zero, which is the condition for an interior optimum:

$$\begin{aligned}
dU_A/dg_A &= \frac{9}{(100 - g_A)}(-1) + \frac{2}{(g_A)} = 0 \\
\frac{9}{(100 - g_A)} &= \frac{2}{(g_A)} \\
9g_A &= 2(100 - g_A) \\
9g_A &= 200 - 2g_A \\
9g_A + 2g_A &= 200 \\
11g_A &= 200 \\
g_A &= 200/11 > 0
\end{aligned}$$

To check if this is really an optimum, we could calculate Adam's utility when $g_A = 200/11$ and compare it to his utility when $g_A = 0$. When $g_A = 200/11$, Adam's utility is

$$U_A = 9 \ln(100 - 200/11) + 2 \ln(200/11) \approx 45.44$$

When $g_A = 0$, his utility is

$$U_A = 9 \ln(100) \approx 41.45$$

c) Who contributes most? Why? Give an intuitive explanation.

Adam contributes most; his contribution is strictly positive, Liza contributes nothing.

The reason is that Liza's altruism depends on the level of G , which is already large, and since her marginal altruistic benefit is decreasing in G , and G is already high, she is not willing to contribute anything. Adam has the same utility structure except that his altruistic benefits depend only on his own contribution, not the total level of the public good; he is thus not discouraged by the already relatively high level of G .

This can be further demonstrated by noting that Liza would, in fact, have contributed a strictly positive amount if it were the case that $G_{-i} = 0$. In that case, we would have to replace (4) with $G = g_i$, and the first order condition would become $g_i = 200/11 \approx 18.2$ (which equals Adam's contribution in Problem 2b) above).

2 Problem 4

a) This corresponds to the standard Homo Oeconomicus model. We know from theory that Homo Oeconomicus will only contribute voluntarily to the environment if the increased environmental benefits to himself outweighs his costs. In this case we can say immediately that this cannot be the case: The costs to Bill are substantial, while he does not expect to notice the environmental change at all.

A more elaborate answer:

Assume a budget $F_B = g_B + x_B$

and environmental quality $E = E^0 + g_B$

where F_B is Bill's exogenous income, g_B is his contribution (climate ticket), and x_B is his private consumption. Let us normalize the price of g_B to 1 (this does not matter, it only determines the measurement unit for contributions). Assume that Bill expects others' purchase of climate tickets to be exogenously given.

Inserting from the budget constraint, we get

$$U_B = u(F_B - g_B) + v_B(E^0 + g_B)$$

Max. this wrt g_B gives the following f.o.c. for interior optimum:

$$u'(F_B - g_B) = v'_B(E^0 + g_B)$$

i.e. he will be willing to purchase climate tickets until his marginal utility of consumption equals his marginal utility of increased E .

The question is whether there will be an interior solution, i.e. whether he will be willing to purchase climate tickets at all. Consider the situation where he purchases no climate tickets ($g_B = 0$). Then $E = E^0$ and $x_B = F_B$. Bill may be willing to contribute to a better environment if, viewed from the situation

when $g_B = 0$, his marginal utility of consumption is lower than his marginal utility of E :

$$v'_B(E^0) > u'(F_B) \quad (5)$$

If not, he will not be willing to contribute.

However, we know from the text that Bill does not expect to be able to perceive at all the difference in global climate due to his own contributions. That must imply $(E^0 + g_B) \approx E^0$ and $v(E^0 + g_B) \approx v(E^0)$; hence the marginal environmental benefit v' must be negligible ($v'(E^0) \approx 0$). We also know that the cost of a climate ticket is not negligible. Thus, eq. (5) must be expected to hold, and Bill will not purchase climate tickets.

b) This corresponds to pure altruism. We know from theory that this is formally equivalent to the Homo Oeconomicus model (but with a stronger preference for the environmental good). In this case we also know that Bill does not expect anyone else to notice the difference in E , so environmental benefits are negligible for everyone. Thus, the conclusion will not differ from that in a): Bill will not purchase climate tickets if these are his preferences.

A more elaborate answer: Inserting from the budget constraint now gives

$$U_B = u(F_B - g_B) + v_B(E^0 + g_B) + v_{-B}(E^0 + g_B)$$

Max. this wrt g_B gives the following f.o.c. for interior optimum:

$$v'_B(E^0 + g_B) + v'_{-B}(E^0 + g_B) = u'(F_B - g_B)$$

That is, his marginal benefits from his contribution, which is the sum of his marginal concern for own and others' benefits, should equal his marginal utility of consumption.

The individual will contribute a strictly positive amount only if his marginal benefits of contributions ($v'_B + v'_{-B}$) are higher than his marginal utility of consumption u' for $g_i = 0$. That is, he contributes if

$$v'_B(E^0) + v'_{-B}(E^0) > u'(F_i) \quad (6)$$

We know that Bill does not expect anyone to be able to notice the change in global climate due to his own contribution. It thus seems reasonable to assume not only $v'_B \approx 0$, but also $v'_{-B} \approx 0$. The result, then, will be similar to above, and Bill would not purchase climate tickets.

c) Bill now does not care about the environmental quality as such at all. His only reason to contribute is thus that it produces social approval. Now,

$$U_B = u(x_B) + s(g_B) = u(F_b - g_B) + s(g_B)$$

Maximizing wrt g_B gives the first order condition

$$\begin{aligned} -u' + s' &= 0 \\ s' &= u' \end{aligned}$$

Bill will contribute until the marginal social approval derived from contributing equals his marginal utility of consumption. Unless $u'(F_i) > s'(0)$, he will contribute, even though he does not expect his contribution to affect the global climate in a noticable way, and even if he does not care about the global climate.

d) Now social approval is increasing in the climate ticket purchase by others: $s_B = g_B \cdot \alpha g_{-B}$, where $\alpha > 0$. Assume Bill considers g_{-B} exogenous. Then $\frac{\partial s_B}{\partial g_B} = \alpha g_{-B}$. We can now use the result from c) above, i.e. that the first order condition for utility maximum will be $s' = u'$, i.e., $u' = \alpha g_{-B}$. As above, he will contribute unless $u'(F_B) > s'(0)$. Here, $s' = \alpha g_{-B}$, which is independent of Bill's *own* contribution; so he will contribute unless $u'(F_B) > \alpha g_{-B}$.

If $g_{-B} = 0$, then $s' = 0$, and we know for sure that he would not contribute: Since u is strictly increasing, we know that $u'(F_B) > 0$.

e) Now,

$$\begin{aligned} U_B &= u(x_B) - 1/2(g_B - g^*)^2 \\ &= u(F_B - g_B) - 1/2(g_B - g^*)^2 \end{aligned}$$

Maximizing this wrt g_B gives the f.o.c.

$$\begin{aligned} -u' - (g_B - g^*) &= 0 \\ -g_B + g^* &= u' \\ g^* - g_B &= u' \end{aligned}$$

The left hand side of the bottom equation is the marginal self-image gain of Bill's contributions. The right hand side is the marginal cost in terms of lost consumption benefits. We can see immediately that Bill will never contribute MORE than what he considers the morally ideal contribution: That would imply $g^* - g_B < 0$, and then the first order condition could not hold (since u' is always positive). There can, however, be an interior solution where he contributes a strictly positive amount less than g^* . Thus, a concern for one's own self-image as morally responsible (in this case: as someone who strives towards what he believes to be morally right) can be sufficient to make an individual contribute to a public good - even if he actually does not care about the public good as such.