Written Exam at the Department of Economics summer 2017

# Foundations of Behavioral Economics

Final Exam

June 02, 2017

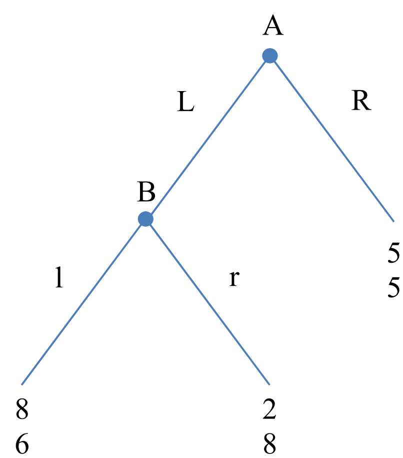
(3-hour closed book exam)

Sketch for solution

Note: The following illustrations are a sketch of how to solve the exam questions, rather than a full-fledged “solution manual”. Some derivations of results are omitted for brevity and some responses only exemplify possible solutions to the questions (in both cases, further details can be found in the lecture notes of the respective sections).

**Question 1**

Consider the following strategic situation:




Note: upper payoffs are the payoffs of player A and lower payoffs are the payoffs of player B

(a) Traditional economic theory assumes that individuals are selfish and maximize their personal payoffs. Please derive formally the subgame perfect equilibrium for the above-described decision situation under the assumption that player A and B are selfish.

*Using backward induction the following holds:*

- *Player B chooses r over l and gets 8 as u(8)>u(6)*
- *Player A knows how player B will react and chooses R in response as u(5)>u(2).*

(b) Now assume that both players are inequality averse a la Fehr & Schmidt (1999). Under what condition will the players choose (L,l) in equilibrium?
Reference: Fehr, E., & Schmidt, K. M. (1999). A theory of fairness, competition, and cooperation. Quarterly Journal of Economics, 817-868.

*Using backward induction the following holds:*

- *Player B chooses l as long as* $6 - \alpha\,[8\text{-}6] > 8 - \beta[8\text{-}2]$.
- *Assume now that this is the case. Given this player A chooses L as long as* $8 - \beta\,[8\text{-}6] > 5$ *which implies* $\beta<3/2$.

(c) Using the model of sequential reciprocity by Dufwenberg and Kirchsteiger (2004), explain formally how player B perceives the kindness of player A following player A's choice L. Furthermore, explain under what conditions he will choose l instead of r in equilibrium**.** Given this, under what conditions will player A choose L in equilibrium?
Reference: Dufwenberg, M., & Kirchsteiger, G. (2004). A theory of sequential reciprocity. Games and Economic Behavior, 47(2), 268-298.

*In a nutshell, Player B's perceived kindness of player A is:*

$\lambda=\beta 6+(1-\beta)8-½(\beta 6+(1-\beta)8+5)$

*where* $\beta$ *is player B's second-order belief, i.e. his belief about the belief of player A about the likelihood with which he chooses l.*

*In equilibrium beliefs are assumed to be correct, i.e.* $\beta=1$*. This means,* $\lambda=6-5.5=½$*.*
*Furthermore, his kindness from choose l and r are:*

$\kappa(l)=8-½(8+2)=3$
$\kappa(r)=2-½(8+2)=-3$

*Given this, player B will choose l instead of r if:*

$6 + Y(½)(3)>8+Y(½)(-3)$ *which implies that* $Y>2/3$*. If this is the case player B will choose l over r. Player A is both better off in material terms by choosing L as well as feeling kindly treated which he would like to reciprocate, i.e. both own material interests as well as psychological payoffs make player A to choose L in this equilibrium independent of his sensitivity to reciprocity.*

(d) Explain in your own words the difference between the outcome-based model of inequality aversion and the belief-dependent model of reciprocity.

*The answer to this question should mention that the model of inequity aversion is very close to the standard approach as only outcomes (i.e. outcome differences in this case) matter. The model of belief dependent reciprocity on the other hand assumes that (higher-order) beliefs directly enter the utility of the players. In many situations these models might make the same predictions but in others they do not. In particular the model of belief-dependent preferences implies that it matters how a certain outcome has come about.*

**Question 2**

Consider a decision maker who is confronted with the following two choices between lotteries:

*Choice 1:*

| *Lottery 1A:* | *vs.* | *Lottery 1B:* |
|---|---|---|
| 110 kr. with prob. p=0.25<br>100 kr. with prob. p=0.74<br>0 kr with prob. p=0.01 | | 100 kr. with prob. p=1 |

*Choice 2:*

| *Lottery 2A* | *vs.* | *Lottery 2B* |
|---|---|---|
| 100 kr.; p=0.26<br>0 kr.; p=0.74 | | 110 kr.; p=0.25<br>0 kr.; p=0.75 |

The decision maker chooses Lottery 1B in Choice 1 and Lottery 2B in Choice 2.

a) Show formally that this choice pattern is inconsistent with Expected Utility Theory.

*Preferring 1B over 1A in choice 1 implies:*
$u(100) > .25\, u(110) + .74\, u(100) + .01\, u(0)$
*or, equivalently:* $0.26\, u(100) > 0.25\, u(110) + 0.01\, u(0)$

*Peferring 2B over 2A in choice 2 implies*
$0.25\, u(110) + 0.75\, u(0) > 0.26\, u(100) + 0.74\, u(0)$
*Or equivalently:* $0.25\, u(110) + 0.01\, u(0) > 0.26\, u(100)$

→ *Contradiction*

*b)* Which psychological phenomenon might explain the observed choice pattern according to Kahneman and Tversky's paper "Prospect Theory" (1979)?

*Certainty effect: people tend to overweight outcomes that are considered certain, relative to outcomes which are merely probable.*

**Question 3**

Imagine you are analyzing people's labor supply. You assume that the labor supply function—i.e., the (log) hours of work per day offered by workers, $h^S$, as a function of the (log) hourly wage, *w*—has the following form:

$$\ln h^S(w) = \beta \ln w.$$

$\beta$ is a parameter and determines the wage elasticity of labor supply. Camerer, Babcock, Loewenstein, and Thaler (1997) estimate a labor supply function of exactly this type for New York City cab drivers. Their empirical specification is

$$\ln h_i = \beta \ln w_i + \varepsilon_i.$$

Here, $i$ indexes the observations, $i = 1, \ldots, N$. $\varepsilon_i$ is an error term with $E[\varepsilon_i] = 0$. $\beta$ is the parameter to be estimated.

a) Camerer et al. (1997) open their paper with the statement: *"Dynamic models of labor supply predict that work hours should respond positively to transitory positive wage changes, as workers intertemporally substitute labor and leisure, working more when wages are high and consuming more leisure when its price—the forgone wage—is low (e.g., Lucas and Rapping [1969])."*

   In other words, standard dynamic models of labor supply—i.e., multiperiod models *without* reference-dependent preferences—predict that the labor supply function is upward-sloping (i.e., $\beta > 0$) for transitory wage changes.

   By contrast, why does income targeting—i.e., a particular case of reference-dependent preferences—predict that $\beta < 0$ for transitory wage changes?
   *Hint: explain verbally; no formal derivation required.*

*Main intuition:*

- *People aim at achieving a certain reference level of income.*
- *Loss aversion generates strong incentives below income target.*
- *Incentives are weaker above income target (gain domain).*
- *Thus, higher wages could result in lower labor supply, because the income target is more easily met.*
- *See Camerer et al (1997) and slides from lecture 10 for further details.*

b) What are the reasons why New York City cab drivers are a good sample for studying individual labor supply (as opposed to, say, high school teachers)?
   - State first what the ideal setup would consist of regarding (*i*) the flexibility of working hours and (*ii*) temporary vs. permanent wage shocks.
   - Then state why NYC cab drivers fulfil the required characteristics well.
   - Third, mention empirical correlations that Camerer et al. check to investigate that these criteria / their identification assumptions are actually met.

*Compare lecture notes from lecture 10 and discussion in Camerer et al.*

*Ideal setup requires*

- *workers with flexibility of work hours and effort;*
- *exogenous, transitory wage changes; and*
- *an idea to what extent wage changes are anticipated or surprising.*

*NYC cab drivers have the following characteristics:*

- *They face wages that fluctuate on a daily basis due to demand shocks (weather, holidays, conventions): many transitory wage changes.*
- *Rates per mile set by law—but spend less time searching for customers on busy days, yielding a higher hourly wage.*
- *High flexibility of labor supply: free to drive for as many hours as they like during a shift (typically up to 12 hours in NYC).*
- *Drivers own cab or rent cab at a fixed cost. Drivers keep 100% of fares ("selling the firm to the worker").*

*Moreover, empirically, Camerer et al. find:*

- *Correlation of wages (within-driver) across days is close to zero, hence each day can be considered in isolation. Wealth effects of wage changes are negligible.*
- *Within-day autocorrelation (within-driver) of wages is non-negative. If it were, also standard model would predict stopping early for high (early) wages.*

c) Briefly summarize the main findings of the paper. Focus on the following questions:
- What is the sign of the estimated wage elasticity, $\beta$, according to the paper's main (OLS) specifications?
- Are there systemmatic differences in the estimated $\beta$ coefficients for different subgroups of taxi drivers?
- What are possible sources of these differences?

*Points to include in the discussion:*

- *Main OLS estimates exhibit negative labor-supply elastiscities*
- *Some estimates indicate positive elasticities for more experienced drivers*
- *Unclear whether this is due to learning of selection effects*

d) Camerer et al. (1997) cannot observe the hourly wage $w_i$ directly. Instead, they calculate it as the earnings of an entire day, divided by the number of hours worked on that day. In this case, what happens with the estimate of $\beta$ in the presence of measurement error, i.e., if hours are not recorded perfectly but with noise and if one uses OLS regression?
- What is this effect called, and what sign does it have? Explain.
- How do Camerer et al. address this problem?

*In the presence of measurement error, calculating $w_i$ this way leads to the so-called "division bias" or "attenuation bias." In the words of Camerer et al. (1997), "Since the average hourly wage is computed by dividing daily revenue by reported hours, overstated hours will produce high hours–low wage observations and understated hours produce low hours–high wage observations, creating spuriously negative elasticities." That is, the estimate of $\beta$ is downward-biased—simply because there is a purely mechanical negative relation between the dependent variable and the explanatory variable.*

*To address this problem, Camerer et al. provide IV estimates, where the wage of other workers on a given day is used as an instrument for worker i's wage. The estimated supply elasticities are still mostly negative.*

e) How can a model with belief-dependent reference points (e.g., Kőszegi and Rabin 2006) reconcile some of the seemingly contradictory findings in the literature on labor supply? In particular, how could the model help explain the observation that wage elasticities are positive on the "extensive" margin (working vs. not working on a given day), but negative on the "intensive" (within-day) margin?
*Hint: explain the key intution verbally; no formal derivation required.*

*See discussion in lecture notes and Kőszegi and Rabin (2006), p. 1150ff.*

*Key intuition:*
*If people are loss averse compared to their expectations…*

- *they are more willing to work on a given day if they anticipate higher earnings (positive extensive-margin reaction to anticipated wage increase, for example like in Fehr and Götte)*
- *…they provide higher effort within a given day when wages are predictably high,*
- *… but lower effort when income is unpredictably high. The last effect might thus yield negative within-day elasticities.*

**Question 4**

Consider a decision maker whose preferences can be described by the linear per-period utility function, $u(c) = c$, in combination with *quasi-hyperbolic discounting*, also called $(\beta, \delta)$ discounting. Within the scope of this question, all we need is three periods, $t = 0, 1, 2$. Thus, in combination with the linear per-period utility function, we have the following lifetime utility functions $U^t$ at the different time points $t$:

$$\begin{aligned} U^0(c_0, c_1, c_2) &= c_0 + \beta\delta c_1 + \beta\delta^2 c_2; \\ U^1(\quad c_1, c_2) &= \qquad c_1 + \beta\delta\ c_2; \\ U^2(\qquad c_2) &= \qquad\qquad c_2. \end{aligned}$$

Here, $c_t$ denotes consumption in period $t$.

a) Assume that, in period 0, the decision maker is indifferent between consuming $c_0 = 121.5$ units in period 0 or $c_1 = 180$ units in period 1 or $c_2 = 200$ in period 2. What are the values of the discounting parameters $\beta$ and $\delta$ that give rise to this indifference?

$U^0(0, 180, 0) = \beta\delta 180 = U^0(0, 0, 200) = \beta\delta^2 200$
$\rightarrow \delta = 180 / 200 = 0.9;$

$U^0(0, 180, 0) = \beta\delta 180 = U^0(121.5, 0, 0) = 121.5$
$\rightarrow \beta = 121.5 / (180\ \delta) \Rightarrow \beta = 121.5 / 162 = 0.75.$

b) A naïve decision maker with $\beta = 0.9$ and $\delta = 0.95$ has the choice to distribute 100 units of consumption in t=0 over the three periods 0, 1, and 2. From period to period, saved

consumption bears a real interest rate, $r$ = 15 % = 0.15. How would this decision maker in period 0 plan consumption for the three periods 0, 1, and 2?
*Hint: Note that due to the linearity of the per-period utility function, you only have to consider corner solutions where the decision maker consumes everything in the same period.*

*From the perspective of period 0:*

- *Consuming in period 0:* $U^0(c_0, 0, 0) = 100$
- *Consuming in period 1:* $U^0(0, c_1, 0) = 100 \times 1.15 \times 0.9 \times 0.95 = 98.325 < 100$
- *Consuming in period 2:* $U^0(0, 0, c_2) = 100 \times 1.15^2 \times 0.9 \times 0.95^2 = 107.420 > 100$

*This means that in period 0 the decision maker will save everything and plans to consume it in period 2.*

c) What will the decision maker from 0 do, once period 1 has arrived? Will she stick to her decision or revise her plan? Show formally.

*In period 1, the decision maker has 100 × 1.15 = 115 of units available (his savings from period 0). Choice from the perspective of period 1:*

- *Consuming in period 1:* $U^1(c_1, 0) = 115$
- *Consuming in period 2:* $U^1(0, c_2) = 115 \times 1.15 \times 0.9 \times 0.95 = 113.074 < 115$

*This means that, once period 1 has arrived, the person will "revise" her plan and consume everything already in 1 instead of saving for period 2.*

d) Now assume that a commitment savings product is available in period 0. If used, this commitment device forces you to save for two periods (say, a government bond with a maturity of two periods). However, the commitment savings product pays lower interest: it only pays 14% per period, instead of 15%.

Would a naïve agent (with $\beta$ = 0.9 and $\delta$ = 0.95) use this commitment device? Would a fully sophisticated agent (with $\beta$ = 0.9, $\delta$ = 0.95 and $\hat{\beta} = \beta$) make use of this commitment device, instead of saving from period to period at 15%? Justify your answers formally!

*Naïve agent: no. In period 0 she assumes that she will stick to her plan of saving until period 2. She thus does not accept any alternative that bears a lower interest rate:*
$100 \times 1.15^2 \times 0.9 \times 0.95^2 > 100 \times 1.14^2 \times 0.9 \times 0.95^2$

*Sophisticated agent (let's use $x_2$ instead of $c_2$ to reflect the new, lower interest rate):*
$U^0(0, 0, x_2) = 100 \times 1.14^2 \times 0.9 \times 0.95^2 = 105.56 > U^0(c_0, 0, 0) = 100 > U^0(0, c_1, 0) = 98.325.$

*Hence, the sophisticated agent would use the commitment device: Knowing that she would actually not stick to her plan and consume everything in period 1—which gives a utility of only 98.325 from the perspective of period 0—and given that the utility of consuming everything immediately will yield utility of only 100, she will pick the commitment device, since this gives a utility of 105.56, the highest utility of the three options.*