

MIT 14.13 – Final Exam Spring 2020

May 19, 2020

- What materials can you use?
 - You can use slides and notes from lectures, recitations, and psets. You can also use a calculator.
 - You CANNOT receive help from others while taking the exam (online, in person, or any other way).
 - You CANNOT try to find answers to the questions online other than the Learning Modules website.
 - You CANNOT try to find questions or answers online other than looking at existing Piazza posts.
 - You can ask PRIVATE Piazza questions to clarify things if you think that is important and/or if you face technical difficulties, but you CANNOT ask public questions on Piazza.
 - You CANNOT watch lecture videos during the exam.
 - Support animals are fine!
- **Honor code:** We trust you to follow these rules. Part 4 asks you to type your name as an electronic signature confirming that you followed the rules given above for taking them exam.
- While taking this exam, always keep in mind that you are a wonderful person regardless of your answers in this exam. You will pass this class as long as you try your best.
- Good luck!

QUESTION 1: True, False, or Uncertain [30]

Please answer ALL of the the following five questions. State whether each of the following statements is true, false, or uncertain. Always explain your answer carefully and concisely. Your score is largely determined by the quality of your explanation. You only need to give the intuition for your answer, not a formal proof.

1. (6 points) Market solutions can help people with self-control problems but can also make things worse.
2. (6 points) Consider a retail firm whose customers have reference-dependent preferences. A profitable strategy for the firm could be to advertise high prices and then give consumers discounts when they arrive at the store.
3. (6 points) The Chetty et al. (2009) paper on salience and taxation discussed in class finds that consumers are fully attentive to all forms of taxes.
4. (6 points) Loewenstein (1987) finds that survey respondents i) prefer to kiss a movie star in three days rather than now, and ii) prefer to suffer a painful electric shock now rather than in one year. These responses can be explained by both discounting and anticipatory utility.
5. (6 points) The evidence from Read and Van Leeuwen (1998) supports the idea that participation in commitment devices may depend on the state in which they are offered.

QUESTION 2: Multiple Choice [30 points]

Please answer ALL of the below questions. Each of the following questions has a single correct answer option. Please select one answer option per question.

1. (6 points) Which of the following is an example of projection bias?
 - (a) Believing that the 10th coin toss is likely to come up tails because the first 9 tosses have all come up heads
 - (b) Deciding not to go running on a sunny day because it was rainy and miserable the last time you ran
 - (c) Buying too many groceries (especially potato chips!) when you go shopping on an empty stomach
 - (d) Planning to finish your problem set three days in advance, then procrastinating it until the last minute

2. (6 points) Reference-dependent preferences can explain why investors
 - (a) exhibit delayed reactions to relevant market news
 - (b) never save for retirement
 - (c) hold stocks that have increased in value above the purchase price and sell stocks that have decreased in value below the purchase price
 - (d) sell stocks that have increased in value above the purchase price and hold stocks that have decreased in value below the purchase price

3. (6 points) Madrian and Shea (2001) study 401(k) savings behavior among employees of a large company. They find that
 - (a) Default enrollment in the 401(k) plan significantly increases 401(k) participation rates
 - (b) Default enrollment in the 401(k) plan has no effect on 401(k) participation rates
 - (c) Financial education significantly increases 401(k) participation rates
 - (d) Increases in the employer's matching contribution rate significantly increase 401(k) participation rates

4. (6 points) An Expected Utility Maximizer with Constant Relative Risk Aversion (CRRA) preferences
 - (a) is risk neutral
 - (b) has preferences that are consistent with the finding in Kahneman and Tversky (1989) that people appear to be loss averse
 - (c) mispredicts utility from uncertain situations
 - (d) wants to invest a constant share of wealth in risky assets, irrespective of their level of wealth

5. (6 points) Which of the following is an example of the Gambler's Fallacy?
 - (a) A woman rolls a fair die twice. It turns up six both times. She thinks the probability of a six on the next roll is $\frac{1}{6}$.
 - (b) A basketball player performed extremely well in the first half of the game. The crowd thinks "today is his day" and believes he's certain to perform well in the second half.
 - (c) A man sees four tosses of a fair coin all turn up heads. He concludes the fifth is almost certain to be a tail because it would be extremely unlikely for five out of five tosses to be heads.
 - (d) A test for a rare disease is 95% accurate. A woman gets a positive test result and concludes the probability that she has the disease is 95%.

PART 3, QUESTION 1: Reference Dependence [30 Points]

Please make sure to explain your answers in this section carefully and concisely. Do not simply write an answer without an explanation of how you arrived at this answer. Answers without adequate explanation will not receive full credit.

Maddie has reference-dependent preferences over the number of cups of coffee she consumes in a day and the amount of money she has available for other food and drink for the day. Her daily utility over coffee and money takes the form

$$u(c_c - r_c) + v(c_m - r_m)$$

where c_c is the number of cups of coffee she consumes, c_m the amount of money she has for other food and drink, r_c her reference point for coffee, and r_m her reference point for money.

$u(x)$ takes the form

$$u(x) = \begin{cases} -10 & \text{if } x \leq -2 \\ -6 & \text{if } x = -1 \\ 0 & \text{if } x = 0 \\ 3 & \text{if } x = 1 \\ 4 & \text{if } x \geq 2 \end{cases}$$

and $v(x)$ takes the form

$$v(x) = \begin{cases} x & \text{if } x \geq 0 \\ 2x & \text{if } x < 0 \end{cases}$$

Maddie does not have equipment to make coffee at home so she buys coffee from a shop nearby, which charges \$2.50 per cup. Maddie does not like old coffee so she consumes any cup she purchases immediately and never saves it for later.

She has gotten into a routine of consuming two cups of coffee a day. She has a total of \$25 to spend on food and drink per day, so consuming two cups a day gives her \$20 to spend on other food and drink.

- (5 points) First interpret Maddie's preferences. Does she exhibit loss aversion? Does she exhibit diminishing sensitivity? Why might we expect her to have $r_c = 2$ and $r_m = 20$?
- (5 points) Assume $r_c = 2$ and $r_m = 20$. Suppose Maddie has had 2 cups of coffee one day. Alex is stopping by the coffee shop and asks Maddie if she would like him to pick up a coffee for her (for which she would need to reimburse him the price of \$2.50). Assuming Maddie considers only her utility of that particular day (i.e. she ignores any effects on her future utility), what is the maximum price Maddie is willing to pay for another cup of coffee? Will she accept Alex's offer?
- (5 points) On another day, Maddie buys her second cup just as the shop is closing for the day. On her way out, she runs into Will, who arrived at the shop to buy a coffee just a minute after it closed. Will decides to try to buy the cup Maddie just bought from her at price p . For what range of prices will Maddie accept Will's offer? (Continue to assume that $r_c = 2$ and $r_m = 20$; also assume there is no other way for Maddie to buy coffee on that day.) Explain why your answer is different from your answer to the previous question.
- (5 points) In the week before her dissertation was due (i.e. last week!), Maddie's need for coffee changed and she began drinking three cups a day. Explain why one might expect her reference points to adjust to $r_c = 3$ and $r_m = 17.50$ by the end of this week.
- (5 points) Assume we now have $r_c = 3$ and $r_m = 17.50$. Frank becomes concerned that Maddie is consuming too much coffee. He forbids her from going to the coffee shop but offers her the following deal: she can pay him \$2.50 to buy her a cup for the first two cups he buys, but she must pay him $\$q > \2.50 for the third cup and he

will not let her have any more than three cups. What is the minimum value of q that Frank must set to ensure that Maddie consumes only two cups a day?

6. (5 points) Frank implements the policy, with a q in the range you identified in the previous part, for one month. After that, he removes the policy, allowing Maddie to buy as many cups a day at \$2.50 as she would like. Is it possible that when given free reign after a month of the policy, Maddie would choose to consume two rather than three cups a day?

PART 3, QUESTION 2: The Better is the Enemy of the Good [30 points]

Please make sure to explain your answers in this section carefully and concisely. Do not simply write an answer without an explanation of how you arrived at this answer. Answers without adequate explanation will not receive full credit.

Jacqueline, Jared, and Drew are students in 14.13:

- The final exam is happening two days from now, at date $t = 3$. They can decide whether to prepare for the exam today ($t = 1$) OR tomorrow ($t = 2$). It is useless to prepare more than once.
- Today ($t = 1$) they can decide to work hard (instantaneous utility $u_1 = -c_2$), work moderately hard (instantaneous utility $u_1 = -c_1$), or not work at all (instantaneous utility $u_1 = 0$).
- Tomorrow ($t = 2$), if they have not worked yet, they will have the same menu but because of stress, instantaneous utility from working hard will be $u_2 = -c_2 - k_2$, from working moderately will be $u_2 = -c_1 - k_1$ and from not working $u_2 = 0$.
- Finally, on exam day, they will derive instantaneous utility $u_3 = Y_2$ if they worked hard in $t = 1$ or $t = 2$, $u_3 = Y_1$ if they worked moderately in either $t = 1$ or $t = 2$, and $u_3 = 0$ if they did not work at all.
- We assume that $c_2 > c_1$, $k_2 \geq k_1$, $Y_2 \geq Y_1$.

Each student's utility function is as follows:

$$U_t = u_t + \beta \sum_{\tau=t+1}^3 \delta^{\tau-t} u_\tau \text{ for } 1 \leq t \leq 2 \quad (1)$$

1. (2 points) Briefly explain this utility function. What do the parameters β and δ measure? What do we typically assume about these parameters?

In the rest of the problem, we always assume $\delta = 1$ and $\beta < 1$, so that the utility function becomes:

$$U_t = u_t + \beta \sum_{\tau=t+1}^3 u_\tau \text{ for } 1 \leq t \leq 2 \quad (2)$$

2. (2 points) Briefly explain the assumptions $c_2 > c_1$, $k_2 \geq k_1$, $Y_2 \geq Y_1$.
3. (3 points) Let's first consider Drew, who only cares about passing the exam (so that $Y_1 > 0$) but does not care at all about doing really well ($Y_2 = Y_1$). Given the latter assumption, show that Drew will never work hard or consider doing so.
4. (3 points) Let's assume that Drew is fully sophisticated about his present bias ($\hat{\beta} = \beta$). Assume that $c_1 + k_1 < \beta Y_1$. Derive the threshold k_1^* (as a function of parameters c_1 and β) such that if $k_1 > k_1^*$, Drew will work today. Do not worry about the knife-edge case $k_1 = k_1^*$. When will he work (if at all) if $k_1 < k_1^*$?
5. (3 points) How would your answers to the previous question change if Drew was fully naive ($\hat{\beta} = 1$), but with the same true β ?

6. (3 points) Jared is fully sophisticated and, just like Drew, does not care about his grades (he only wants to pass the class), i.e. $Y_2 = Y_1$. Jared's utility parameters satisfy the following assumptions:

$$c_1 > \beta Y_1 - k_1 \quad (3)$$

$$c_1 < Y_1 - k_1 \quad (4)$$

$$c_1 < \beta Y_1 \quad (5)$$

$$c_1 > \frac{\beta}{1-\beta} k_1 \quad (6)$$

What will be Jared's work decisions in period 1 and 2?

7. (3 points) Now we assume that Jared is fully naive but maintain all the parametric assumptions on his utility from the previous question. How does your answer to the previous question change?

8. (5 points) Now consider Jacqueline, who cares a lot about her grades (we relax the assumption that $Y_2 = Y_1$) and is fully naive about her present bias. We assume that Jacqueline's utility parameters verify the following inequalities:

$$c_1 + k_1 < \beta Y_1 \quad (7)$$

$$c_1 < \beta(c_1 + k_1) \quad (8)$$

$$c_2 > \beta(c_2 + k_2) \quad (9)$$

$$c_2 + k_2 - c_1 - k_1 < Y_2 - Y_1 \quad (10)$$

$$c_2 + k_2 - c_1 - k_1 > \beta(Y_2 - Y_1) \quad (11)$$

$$c_2 - c_1 < \beta(Y_2 - Y_1) \quad (12)$$

What will be Jacqueline's level of work, and when will she be working, if at all?

9. (3 points) What would be Jacqueline's decisions if she did not care about her grade ($Y_2 = Y_1$) but otherwise had the same preferences as in the previous question? i.e.:

$$c_1 + k_1 < \beta Y_1 \quad (13)$$

$$c_1 < \beta(c_1 + k_1) \quad (14)$$

10. (3 points) We define Jacqueline's welfare for a given path of decisions as $W = u_1 + u_2 + u_3$.

Compare Jacqueline's welfare in the two previous questions. Comment. Is Jacqueline better or worse off when she cares about her grades than when she does not? Why?

PART 3, QUESTION 3: Beliefs and Studying Behavior [30 points]

Please make sure to explain your answers in this section carefully and concisely. Do not simply write an answer without an explanation of how you arrived at this answer. Answers without adequate explanation will not receive full credit.

Harry is studying for his last final exam, which takes place tomorrow. Today, he believes he will pass with probability p and fail with probability $1 - p$. Harry's utility tomorrow if he passes is 10 and 0 otherwise. His long-term daily discount factor is $\delta \in (0, 1)$ and his short-term daily discount factor is $\beta \in [0, 1]$. That is, his expected utility today is

$$\beta\delta \cdot 10p.$$

- (5 points) Suppose Harry can study for his exam. Studying costs $\gamma > 0$ today, and increases his chance of passing tomorrow to $(1 + \theta)p$, where $\theta > 0$. Give a condition (in terms of β , δ , p , γ , and θ) that characterizes when Harry will study for his exam.
- (5 points) Suppose Harry does not study for his exam. Provide at least two economic reasons why he might not be studying (using the parameters from the previous questions).

For the rest of this problem, suppose Harry is anxious about his performance. Specifically, his quality of sleep tonight depends on his beliefs about how well he will do tomorrow on his exam (but sleep does not directly affect his performance). His (expected) utility is now

$$f(p) + \beta\delta \cdot 10p.$$

The better Harry thinks he will do, the better he sleeps, so $f(p)$ is strictly increasing in p . In particular, $f(p) = \ln p$.

- (5 points) Show that if Harry studied for the exam in part 1, then he will also study now.
- (5 points) We now further explain the origins of p . The exam is "hard," with probability $1 - q$, or "easy" with probability q . Harry knows he will pass the easy exam (i.e., he will pass the easy exam with probability 1), but will have more trouble passing the hard exam (he passes with probability $\hat{p} \in (0, p)$). In particular,

$$p = q \cdot 1 + (1 - q) \cdot \hat{p}.$$

Suppose Harry has lost his books and cannot study no matter what. Harry has a friend, Hermione, who knows (don't ask how) whether the exam is hard or easy.

Hermione is going to text Harry today with news of whether tomorrow's exam is hard or easy. Will this text message make Harry better off (in terms of expected utility)?

- (5 points) A mysterious stranger has found and returned Harry's books. Studying still costs γ . It has no benefit when the exam is easy, but changes Harry's probability of passing when the exam is hard from \hat{p} to $(1 + \hat{\theta})\hat{p}$, where $\hat{\theta} > \theta$ satisfies $(1 + \theta)p = q + (1 - q)\hat{p}(1 + \hat{\theta})$.

Suppose that if Harry did *not* know Hermione, and therefore wouldn't receive a text from her, he would study for the exam.

When does Hermione's text to Harry increase Harry's expected utility? (I.e., for which parameter values?) When does the text reduce Harry's expected utility?

- (5 points) Suppose the setup is as in part 5, except that Harry would NOT study if he didn't receive a text from Hermione. When does Hermione's text to Harry increase Harry's expected utility? When does the text reduce Harry's expected utility?

PART 3, QUESTION 4: Are Your TAs Altruistic? [30 points]

Please make sure to explain your answers in this section carefully and concisely. Do not simply write an answer without an explanation of how you arrived at this answer. Answers without adequate explanation will not receive full credit.

After taking 14.13, you become interested in understanding the extent to which your team of TAs has social preferences. Casual observation suggests the TAs are all very nice. However, you decide to study this more rigorously, by having your TAs play a series of lab experiment games to determine the extent to which each of them are altruistic.

In all of the lab experiment games, the TAs split 1kg of apples according to various rules.

You know that Aaron and Alex have preferences with the following form:

$$u_s(x_s, x_o) = \begin{cases} \rho_s x_s^{1/2} + (1 - \rho_s) x_o^{1/2} & \text{if } x_s \geq x_o \\ \sigma_s x_s^{1/2} + (1 - \sigma_s) x_o^{1/2} & \text{if } x_s < x_o \end{cases}$$

where x_s is the kilograms of apples that Aaron or Alex get for themselves and x_o is the kilograms of apples that the other TA in the game gets.

- (3 points) Suppose that, for Aaron, $\rho_s = \sigma_s = .5$. Describe Aaron's preferences. How does Aaron's marginal utility of apples change in the kilograms of apples that Aaron gets?
- (3 points) Suppose that Aaron and Alex play a game where Aaron chooses how much each person gets and Alex makes no choice. Solve for Aaron's choices of (distributing 1kg of apples between) x_s and x_o .
- (3 points) Suppose now that Alex chooses how much each person gets and Aaron makes no choice. Suppose that, for Alex, $\rho_s = \sigma_s = 1$. Describe Alex's preferences and solve for Alex's choices of x_s and x_o .
- (3 points) Suppose that the game is changed. First, Alex makes Aaron an offer under which Alex will get x_s and Aaron will get x_o . Then Aaron chooses to accept or reject the offer. If Aaron accepts, then Alex gets x_s and Aaron gets x_o . If Aaron rejects, then Alex and Aaron both get nothing.

Suppose that Alex believes that Aaron will reject any offer with $x_o < 0.5$. What will Alex choose as his offer for x_s and x_o ? What is the intuition for how Alex makes his choice?

- (3 points) Suppose that the format of the game is the same as in Part 4, but Aaron makes the offer and Alex accepts or rejects.

Also suppose that Aaron believes that Alex will reject any offer lower than \$0.5. What will Aaron choose as his offer for x_s and x_o ?

- (4 points) Do Aaron and Alex make different choices when making offers in Part 4 and Part 5? Could we distinguish Aaron and Alex's preferences using the games from Part 4 and Part 5 only? Would having data from the games from Parts 2 and 3 help us distinguish Aaron and Alex's preferences? Why?
- (4 points) Suppose that Will has preferences with the following form:

$$u_W(x_W, x_A, x_a, x_M, x_P) = \begin{cases} \rho_W x_W^{1/2} + (1 - \rho_W) \sum_{j \in \{A, a, M, P\}} x_j^{1/2} & \text{if } x_W \geq \sum_{j \neq W} x_j \\ \sigma_W x_W^{1/2} + (1 - \sigma_W) \sum_{j \in \{A, a, M, P\}} x_j^{1/2} & \text{if } x_W < \sum_{j \neq W} x_j \end{cases}$$

where x_W is the kilograms of apples that Will gets and x_j ($j \neq W$) is the kilograms of apples that TA j gets.

Suppose that Will and Maddie play a game where Will chooses how much to keep for himself x_W and how much to give to Maddie x_M and Maddie makes no choice.

After the game, Will can give some apples to Aaron x_A , Alex x_a , or Pierre-Luc x_P (with $x_A + x_a + x_P \leq x_W$). Will keeps $x_{\bar{W}} = x_W - x_A - x_a - x_P$.

Suppose Will has $\rho_W = \sigma_W = .5$. What will Will choose for x_W and x_M in the game? What will Will keep $x_{\bar{W}}$ at the end of the day?

8. (4 points) Suppose we incorrectly assumed that Will had preferences with the following form:

$$u_W(x_W, x_A, x_a, x_M, x_P) = \begin{cases} \rho_W x_W^{1/2} + (1 - \rho_W) x_M^{1/2} & \text{if } x_W \geq x_M \\ \sigma_W x_W^{1/2} + (1 - \sigma_W) x_M^{1/2} & \text{if } x_W < x_M \end{cases}$$

Suppose that we only see how much Will gave to Maddie (and that we assume that Will gives no apples to Aaron, Alex, or Pierre-Luc). Show that we would infer $\rho_W = 2/3$ from Will's choice (of x_W and x_M) that you solved for in Part 7.

9. (3 points) Describe, in words, what it means when to infer that Will has $\rho_W = 2/3$ as opposed to $\rho_W = 1/2$. Explain why the conclusions from Part 8 make sense if we only see how much Will gave to Maddie (and assume he gives nothing to the other TAs).

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