

1. Short questions:

- a) What is a "complete asset market"? State all the conditions that need to be satisfied for an asset market to be complete.
- b) Consider an economy consisting of two risk averse individuals, A and B. There are two states of the world. In the good state the sum of all the economy's resources is larger than in the bad state. It is possible for A and B to trade state-claims. Show how this economy can be represented by an Edgeworth box, with individual A in the lower left corner and individual B in the upper right corner and claims in the bad state measured on the horizontal axis. Indicate both individuals' certainty lines. Will the contract curve lie above or below individual A's certainty line? Will the contract curve lie above or below individual B's certainty line? Illustrate where the contract curve is located in the Edgeworth box (you are not supposed to derive it, just show where it is approximately located). State the condition that has to be satisfied along the contract curve.
- c) In the case of hidden-knowledge type of asymmetric information the principal faces the problem of incentive compatibility when designing contracts for different types of agents. Explain why the principal has an incentive to renegotiate a contract once an agent has made his/her choice. Is renegotiating contracts an equilibrium outcome?
- d) In lecture 6 you were presented a model built on the assumption that attending university does not have any positive effect on productivity. In the context of this model, provide an intuitive explanation for why you have chosen to waste your time on attending this course (and all other courses). What is the purpose of education in this model?

2. Consider an insurance market where the type of insurees is hidden knowledge. Each individual owns a bike worth 100. An individual of type  $\underline{\Theta}$  has a probability  $\underline{\Theta} = \frac{1}{5}$  of his/her bike being stolen (low-risk type), while an individual of type  $\bar{\Theta}$  has a probability  $\bar{\Theta} = \frac{2}{5}$  of his/her bike being stolen (high-risk type). The share of type  $\underline{\Theta}$  agents is given by  $\nu = \frac{3}{4}$ . The utility of each individual is given by  $u = \sqrt{w}$ , where  $w$  represents the individual's wealth, which is given by the value of the bike (0 if stolen, 100 else). By purchasing full insurance at premium  $P$ ,  $w = 1 - P$  irrespective of the bike being stolen or not.

- a) For type  $\underline{\Theta}$ , what is the expected utility of not buying insurance? Determine the highest premium  $\hat{P}_{\underline{\Theta}}$  that a type  $\underline{\Theta}$  individual is willing to pay for full insurance.
- b) For type  $\bar{\Theta}$ , what is the expected utility of not buying insurance? Determine the highest premium  $\hat{P}_{\bar{\Theta}}$  that a type  $\bar{\Theta}$  individual is willing to pay for full insurance.
- c) If  $P \leq 36$ , which type(s) buy(s) insurance? What is the expected loss per insuree?
- d) If  $P \in (36, 64]$ , which type(s) buy(s) insurance? What is the expected loss per insuree?
- e) If  $P > 64$ , which type(s) buy(s) insurance? What is the expected loss per insuree?
- f) Which premium will be offered in a perfectly competitive insurance market?
- g) Which premium will be offered by a monopolistic supplier of insurance?
- h) So far we have only considered pooling contracts. Explain how insurance contracts could be designed to make it possible to offer separating contracts, one for each type of individual. (No calculations, just words!)

3. Consider an entrepreneur (the agent) who plans to set up a production facility. However, the entrepreneur needs to borrow an amount of  $I$  from a bank (the principal) to be able to carry out the project. If the bank offers a loan, the return from production equals  $\bar{V} = 7$  with probability  $\pi_e$  and  $\underline{V} = 1$  with probability  $1 - \pi_e$ , where  $e \in \{0, 1\}$  represents the entrepreneur's effort level, and  $\pi_1 = \frac{1}{2}$  and  $\pi_0 = \frac{1}{4}$ . The cost of exerting effort  $e = 1$  is  $\Psi_1 = 1$  (the cost of exerting no effort is zero).

The loan contract specifies how much the entrepreneur has to pay back to the bank. If the return is high ( $V = \bar{V}$ ), the entrepreneur has to make the repayment  $\bar{z}$ , and if the return is low ( $V = \underline{V}$ ), the entrepreneur has to make the repayment  $\underline{z}$ . Hence, the entrepreneur will end up with  $\bar{t} = \bar{V} - \bar{z}$  if the return is high and with  $\underline{t} = \underline{V} - \underline{z}$  if the return is low. The risk neutral entrepreneur's expected profit is thus given by  $EU_1 = \pi_1 \bar{t} + (1 - \pi_1) \underline{t} - \Psi_1$  if  $e = 1$  and  $EU_0 = \pi_0 \bar{t} + (1 - \pi_0) \underline{t}$  if  $e = 0$ . The bank's expected profit for offering a high-effort inducing loan contract is given by

$$EV_1 = \pi_1 \bar{z} + (1 - \pi_1) \underline{z} - I = \pi_1 (\bar{V} - \bar{t}) + (1 - \pi_1) (\underline{V} - \underline{t}) - I.$$

- a) State the participation constraint of the entrepreneur.
- b) State the bank's optimization problem under complete information.
- c) Given that the bank is the only money lender, which contract(s) will be offered under complete information? Illustrate your answer in a figure, with  $\underline{t}$  on the horizontal axis and  $\bar{t}$  on the vertical axis.
- d) What will the bank's expected payoff for implementing the contract(s) be? For what range of  $I$  is it optimal to offer the high-effort inducing contract(s)?

Now assume that information regarding the entrepreneur's actions is hidden to the bank.

- e) Which constraints need to be satisfied? Which contract(s) will be offered? Illustrate your answer in the same figure as above.
- f) What will the bank's expected payoff for implementing the contract(s) be? For what range of  $I$  is it optimal to offer the high-effort inducing contract(s)?

Now assume that the entrepreneur's liability is limited such that no losses can be incurred.

- g) Which constraints need to be satisfied? Which contract(s) will be offered? Illustrate your answer in the same figure as above.
- h) What will the bank's expected payoff for implementing the contract(s) be? For what range of  $I$  is it optimal to offer the high-effort inducing contract(s)?
- i) Provide an intuitive explanation for why limited liability leads to a lower expected payoff for the bank. Assuming that there are many entrepreneurs who require different loan amounts  $I$ , explain how limited liability and moral hazard lead to an economically inefficient outcome.