Stockholm University
Department of Economics

Course name:	**The Economics of Uncertainty and Asymmetric Information**
Course code:	**EC2110**
Type of exam:	**Written exam**
Examiner:	**Mathias Herzing**
Number of credits:	**7,5 credits**
Date of exam:	**Thursday 9 January 2020**
Examination time:	**3 hours [14:00-17:00]**

Write your identification number on each answer sheet (the number stated in the upper right hand corner on your exam cover).

Start each new question on a new answer sheet.

Explain notions/concepts and symbols. If you think that a question is vaguely formulated, specify the conditions used for solving it. Only legible exams will be marked.

No aids are allowed.

The exam consists of 3 questions. The maximum score of question 1 is 32 points. The maximum score of questions 2 and 3 is 34 points each. The maximum score on the exam is 100 points in total. For the grade E 45 points are required, for D 50 points, for C 60 points, for B 75 points and for A 90 points.

Your results will be made available on your Ladok account (www.student.ladok.se) within 15 working days from the date of the examination.

Good luck!

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Exam for EC 2110, Uncertainty and asymmetric information, 9 January 2020

1. Short questions:

a) Hen has the following elementary utility function: $v(c) = \sqrt{c}$, where c is the value of Hen's fortune which consists of a bike worth 25. Hen has to take a decision on whether to buy bike theft insurance. The likelihood of the bike being stolen is 40%. Calculate the highest premium that Hen is willing to pay for full insurance.

b) What is a "complete asset market"? Which conditions need to be satisfied for a "complete asset market"?

c) Consider an economy consisting of two individuals (A and B), who will end up in state 1 with probability π and in state 2 with probability $1 - \pi$. Individual A is endowed with state claims $(\overline{c}_1^A, \overline{c}_2^A)$, and individual B is endowed with state claims $(\overline{c}_1^B, \overline{c}_2^B)$. Both individuals are risk averse. Their elementary utility functions are $v_A(c)$ and $v_B(c)$. It is possible for A and B to trade state claims. Let (c_1^{A*}, c_2^{A*}) and (c_1^{B*}, c_2^{B*}) denote the market equilibrium amounts of state claims. State all six conditions that need to be satisfied to obtain the market equilibrium under uncertainty. (Note: You are not supposed to calculate the equilibrium outcome. Just state the conditions that have to be satisfied.)

d) Consider a factory owner who needs to hire staff. The value of output produced is given by $S(q) = \ln(1 + q)$, where q is the amount produced by a worker. The factory owner pays a wage t to workers. There are two types of workers who differ with respect to the cost incurred when producing the good. Workers of type $\underline{\Theta} = 2$ incur cost $C(q, \underline{\Theta}) = 2q$, while workers of type $\overline{\Theta} = 4$ incur cost $C(q, \overline{\Theta}) = 4q$ when producing quantity q. Workers' utilities are given by $u_\Theta(q, t) = t - C(q, \Theta)$. The factory owner has no information regarding the efficiency of workers, but knows that the share of efficient workers is ν. State the factory owner's optimization problem and all constraints that need to be satisfied. Which constraints are relevant? Explain why the other constraints are not relevant.

2. Consider a market with a monopsonist employer. There are two types of workers. Type 0 has marginal productivity $\Theta_0 = 1$ and an outside opportunity wage of $w_0(\Theta_0) = \frac{9}{4}$. Type 1 has marginal productivity $\Theta_1 = 4$ and an outside opportunity wage of $w_0(\Theta_1) = 3$. The cost of education z is given by $C(z, \Theta_0) = \frac{z}{\Theta_0} = z$ for type 0 and $C(z, \Theta_1) = \frac{z}{\Theta_1} = \frac{z}{4}$ for type 1. A worker's utility function is defined by $U(w, z, \Theta) = w - C(z, \Theta)$. Workers know their own type but the employer cannot tell the high from the low productivity workers.

   a) Illustrate in a figure, with wage on the y-axis and the amount of education on the x-axis, which contracts will make it possible to separate type 1 from type 0 workers.

   b) Which contract will the monopsonist offer? For simplicity assume that, if two contracts yield a worker the same level of utility, the worker prefers the one with less education. Illustrate your answer in the same figure as before.

   c) Which contract would be offered under the competitive (Nash) equilibrium? Illustrate your answer in the same figure as before.

   Now suppose that the reservation wage of type 0 workers decreases to $\widehat{w}_0(\Theta_0) = \frac{3}{2}$, while it remains the same for type 1 workers ($w_0(\Theta_1) = 3$).

   d) Illustrate in the same figure as before which contracts will make it possible to separate type 1 from type 0 workers.

   e) What will the outcome be when there is a monopsonist employer? Illustrate your answer in the same figure as before. Is this outcome more or less efficient than the one in b)? Motivate your answer.

   f) Which contract would be offered under the competitive (Nash) equilibrium? Illustrate your answer in the same figure as before. Is this outcome more or less efficient than the one in c)? Motivate your answer.

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 $\overline{V} = 9$ with probability π_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 ($V = \overline{V}$), the entrepreneur has to make the repayment $\overline{z}$, 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 $\overline{t} = \overline{V} - \overline{z}$ 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 $EU_1 = \pi_1\overline{t} + (1 - \pi_1)\underline{t} - \Psi_1$ if $e = 1$ and $EU_0 = \pi_0\overline{t} + (1 - \pi_0)\underline{t}$ if $e = 0$. The bank's expected profit for offering a high-effort inducing loan contract is given by

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

   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 $\overline{t}$ on the vertical axis.

   d) What will the bank's expected payoff for implementing the contract(s) be? For which 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 which 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 losses cannot exceed 0.5.

   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 which 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.