Economics Department 2007 Honors General Exam

This is a 3-hour exam. (For joint concentrators with economics as the secondary field, this is a 1-hour exam. Choose one section of the exam to complete, and turn in your bluebook one hour after the exam begins.)

The exam has three sections: microeconomics, macroeconomics, and econometrics.

Each section of the exam is of equal point value. Thus you should spend roughly 1 hour on each section of the exam. Within each section, each question is of equal point value.

You must answer TWO of the four Micro questions. If you try to answer more than two micro questions, you will not get any credit for any work done on questions beyond the first two you try to answer.

You must answer TWO of the four Macro questions. If you try to answer more than two macro questions, you will not get any credit for any work done on questions beyond the first two you try to answer.

You must answer ONE of the two Econometrics questions. If you try to answer both econometrics questions, you will not get any credit for any work done on the last question you try to answer.

You must use a SEPARATE blue book for each question, so you will hand in five (5) bluebooks. Make sure your name and the question number are on the outside of each of the five bluebooks! The number should refer to the actual question number on the exam.

Neither calculators nor notes are permitted.

Good luck!

Microeconomics

Question 1 (Microeconomics, 30 Minutes). A monopolist has the cost function

$$c(y) = 10y$$

and faces the demand curve

$$p(y) = 100 - y$$

a. Find the profit maximizing output and price for this monopolist.

b. Illustrate this outcome graphically.

c. Assume the monopolist is able to perfectly price discriminate (first-degree price discrimination). Explain what it means to perfectly price discriminate. Illustrate this outcome graphically. Explain why your answer differs from your answer to part a.

d. Now assume there is a second firm, identical to the one analyzed so far, and that the two firms engage in Bertrand competition. Define Bertrand competition and determine the equilibrium price and quantity of output under this assumption.

e. Finally, assume instead that the two firms engage in Cournot competition. Define Cournot competition and determine the equilibrium level of output and price for each firm.

Question 2 (Microeconomics, 30 minutes):

a. Two Siblings, Dick and Jane, like to play the game "Hide and Seek." Dick hides either upstairs or downstairs. Jane can look for Dick either upstairs or downstairs, but not both. If Jane finds Dick she gets a scoop of ice cream and Dick gets nothing. If Jane does not find Dick, Dick gets a scoop of ice cream and Jane gets nothing.

Write down the payoff matrix for this game. State whether there is an equilibrium, and If there is, describe it. You may assume that utility is only affected by whether or not Jane or Dick gets ice cream and that getting ice cream is preferred to not getting ice cream.

b. Consider the following game, known as Chicken. It represents a situation where two players drive their cars directly at each other as fast as possible. If one swerves away at the last minute, that person is a "chicken," which is not good, but the person avoids serious injury. The other person is the "hero" and also avoids injury. If both swerve they are both chickens but avoid injury. If no one swerves, they both experience serious injury.

The payoff matrix for this game is as follows:

		Driver B	
		Swerve	*Don't Swerve*
Driver A	*Swerve*	2,2	2,6
	Don't Swerve	6,2	0,0

Does the game have a dominant strategy for Driver A or Driver B? If so, state the dominant strategies.

Does the game have any pure strategy Nash Equilibria? If so, what are they?

Does the game have any mixed strategy Nash Equilibria? If so, what are they?

Question 3 (Microeconomics, 30 minutes)

Consider a small exchange economy with two consumers, A and B, and two commodities, x and y.

Consumers A and B have preferences

$$u_A(x_A, y_A) = x_A y_A, \qquad u_B(x_B, y_B) = x_B y_B$$

The initial endowments of the goods are that A has 12 units of x and 2 units of y while B has 8 units of x and 18 units of y.

a. Draw an Edgeworth box for this economy. Be sure to label everything clearly, including the endowment point.

b. Draw the efficient lens that corresponds to the initial endowment. Explain this lens.

c. For an allocation in this economy to be Pareto efficient, it must maximize the utility of consumer A given the utility of consumer B. Is the initial endowment Pareto efficient? Why or why not?

d. Now assume A gets to choose a new allocation to maximize utility, subject to the constraint that B's utility be no lower than at the endowment point. Illustrate this situation on a separate graph.

e. Solve formally for the Pareto efficient allocations of x and y under the assumptions in part d.

Question 4 (Microeconomics, 30 Minutes)

Aardvark Drugs, a risk-neutral profit-maximizing firm, is considering investing in research to discover a new drug that cures hiccups. If it discovers the drug, the government will give it the exclusive right to produce the drug. If Aardvark wants to achieve a probability θ of actually discovering the hiccup drug, it must spend $\frac{1}{2}d\theta^2$ on research. It must spend all the money on research today, but it won't be able to start producing the drug for one year. Aardvark has already done research on the potential market demand for this drug, and knows that it has a demand curve of $Q(P) = \frac{a}{b} - \frac{P}{b}$. Once the drug is discovered, cost of production will be $C(q) = cq$. The risk-free rate of interest, at which Aardvark can borrow and lend, is $1 + r$.

a. How much will Aardvark actually spend on research, and what is the probability the cure will be discovered? What will the price of the drug be if it is discovered?

Now suppose that Aardvark's competitor Blammo Drugs is also trying to discover a cure for hiccups using a totally different research strategy than Aardvark...this means that the probabilities of Aardvark and Blammo being successful are independent. Furthermore, even though each company will have the exclusive right to sell its own drug, the two drugs would be perfect substitutes for each other. The companies know that if they both discover the drug they will end up in a Bertrand oligopoly. Assume that Blammo has exactly the same cost of research as Aardvark does.

b. Assume that the firms make their investment decisions simultaneously. What is the probability **at least one** hiccups cure will be discovered? What will the price(s) of the drug(s) be if they are discovered?

c. Now assume that if the firms both discover the drug, they will form a cartel where they split whatever profits are made equally. What is the probability that at least one cure will be discovered? What will the price(s) of the drug(s) be if they are discovered?

d. Without solving it out mathematically, how would the government decide whether they should allow these drug companies to form a cartel?

Macroeconomics

Question 5 (Macroeconomics, 30 minutes).

Suppose we live in an economy where there are two classes of people, capitalists and workers, with N of each. Suppose that all agents are infinitely lived and that workers supply inelastically 1 unit of labor but capitalists do not, they just make money off capital income (workers may also hold capital, although this is not important to the results). Suppose that they all have the same concave utility function in terms of consumption $u(c)$, and that they all have a discount factor $\beta = \frac{1}{1+\rho} < 1$. Suppose that the production function of the economy is $Y = K^{\alpha}L^{1-\alpha}$ where K is the amount of capital, L is the amount of labor, $\alpha < 1$, and that there is no depreciation. Suppose that all factors are paid their marginal product and denote the interest rate r and wage rate w. Suppose that capital income is taxed at rate $\tau \geq 0$. At all times, we are going to be comparing steady states.

a. What will be the steady state capital in terms of parameters and the tax rate? Derive any expressions needed.

b. What is the wage in the economy of terms of the tax rate and the parameters?

c. What tax rate maximizes the total amount of revenued raised?

d. Intuitively, why is this not 100%?

e. Suppose that all of the revnue from this tax is given to the workers. What is the wage plus transfers for any given level of τ (expres this in terms of τ and paramers)? Is it increasing or decreasing in τ?

Question 6 (Macroeconomics, 30 Minutes)

Consider an economy with no population growth and described by the following equations:

I. Production Function:

$$Y = K^{\alpha}(AL)^{1-\alpha}$$

II. Capital Accumulation Equation:

$$\dot{K} = sY - \delta K$$

III. Exogenous Technological Change

$$\frac{\dot{A}}{A} = g$$

a. Use equations I, II and III to write the accumulation equation for capital per efficiency unit of labor m ($m = \frac{K}{AL}$).

b. Solve for the steady state level of m.

c. What is the steady state growth rate of GDP per capita in this model?

Suppose the economy was in the steady state, and a war destroys half the capital stock in the economy. Suppose the fall in K occurs at time T.

d.What happens to GDP per capita y ($y = \frac{Y}{L}$) when K falls (at time T)? Will the growth rate of GDP per capita ($\frac{\dot{y}}{y}$) be higher or lower?

e. Draw a graph with $\frac{\dot{y}}{y}$ on the vertical axis and time on the horizontal axis, and show in your graph the evolution of $\frac{\dot{y}}{y}$ before T and after. Remember to show what happens during the transition to the steady state.

f. Draw a graph with lny on the vertical axis and time on the horizontal axis, and show in your graph the evolution of lny before T and after. Remember to show what happens during the transition to the steady state.

Question 7 (30 minutes)

Consider a simplified version of the endogenous growth model.

The production function for the final good is

$Y = Ax^{\alpha}$

where x is an intermediate good with productivity A, that the final good producers must buy from an intermediate good producer.

Assume that the final goods market is competitive but the intermediate goods market is not: an innovator that develops a good with productivity A can make a monopoly profit for one period, after which his technology becomes publicly available.

The intermediate good is produced one to one with labor, then the production function for the intermediate good is:

$x = L_x$

where L_x is the amount of labor used in production of the intermediate good.

Workers can employ themselves in the production of intermediate goods or can employ themselves as researchers, then labor market equilibrium will be given by:

$L = L_x + L_A$

where L is total labor supply in the economy (L units of labor are supplied inelastically) and L_A is the amount of labor devoted to R&D.

If a worker decides to dedicate himself to be a researcher, he will innovate with probability λ, increasing A to γA and become a monopolist in the supply of the intermediate good.

Imitators can produce the intermediate good just invented by the innovator, but at an extra cost in terms of labor. For them the production function of x is:

$x = \frac{1}{\chi} L_x$

where $\chi > 1$.

a. If the wage a production worker receives is w, what is the lowest price an imitator would charge for the intermediate good so that his profits are not negative?

b. What price would the innovator charge for the intermediate good so as to make sure that he will be the only supplier?

c. What would be the profits of a successful innovator?

d. If a worker is deciding whether to employ himself as a production worker or as an innovator, what earnings would he be comparing?

e. In equilibrium, as workers can freely decide their employment, their earnings must be the same in either sector (production or R&D). Can you use this condition to solve for the amount of labor employed in R&D in equilibrium (L_A)?

f. Write the growth rate of technology in this economy as a function of the parameters of the model. What is the growth rate of GDP?

g. What would be the growth rate in this economy if imitators could produce the intermediate good at the same cost as the innovator? Explain the intuition behind your result.

Question 8 (Macroeconomics, 30 minutes)

Consider a pay-as-you-go social security system. The generation born at time t faces the following maximization problem:

$$\begin{aligned} &\underset{c_t, c_{t+1}, s}{Max} \ \ln(c_t) + \beta \ln(c_{t+1}) \\ s.t. \quad & c_t + s = (1 - \tau) y_t \\ & c_{t+1} = (1 + r)s + b_{t+1} \end{aligned}$$

where τ is the payroll tax rate at time t and b_{t+1} is the social security benefit at time t+1 when the generation born at time t is retired.

a. If the population growth rate is n, i.e. $N_{t+1} = (1 + n)N_t$, N_t is the number of people in generation t, and the economic growth rate is g, i.e. $y_{t+1} = (1 + g)y_t$, write down the formula for b_{t+1} as a function of y_t, n and g.

b. Solve for c_t, c_{t+1} and s by substituting b_{t+1} in 1 into the maximization problem of generation t.

c. What's the effect of a more generous social security system on national savings? More specifically, if the government raises payroll tax to increase the social security benefit, will s increase or decrease?

d. Under what condition(s), are people strictly better off if there is no such a social security system? Your result should be solely based upon this model and not any factors that may complicate the discussion, such as risk, uncertainty, etc. (Hint: you should compare the life-time utility people can achieve with/without a social security system and show under what condition(s) people can achieve higher utility when $\tau = 0$ and $b_{t+1} = 0$).

Econometrics

Question 9 (Econommetrics, 60 minutes).

Consider a job training program that is intended to raise the future earnings of the participants. We want to evaluate the effectiveness of the program. The target population consists of high school dropouts. A random sample of size $n = 5000$ is taken from this population and everyone in the sample is invited to participate in the program, which takes six months. In addition, 2500 of the sample members are chosen at random and offered a subsidy of $500 per month if they participate in the program. For each of the n sample members, we observe r, s, d, and y: $r =$ earnings for the individual in 1970, before the program took place; $s = 1$ if the individual is offered the subsidy, $s = 0$ otherwise; $d = 1$ if the individual enrolls in the program, $d = 0$ otherwise; $y =$ earnings for the individual in 1975, two years after the program took place. Suppose that everyone who enrolls in the program completes it.

a. Define a causal effect of the program on earnings.

b. Consider two least-squares regressions: (i) y on a constant and d; (ii) y on a constant, d, and r. Which of these regressions would be better for estimating the causal effect in (a)? Explain your reasoning. Under what conditions would the preferred regression provide a consistent estimate of the causal effect?

c. Explain how you could use the information on the subsidy to construct an estimator of the causal effect. Provide, in some detail, the argument that motivates this estimator. What are the advantages and disadvantages of this estimator relative to your preferred regression estimator in (b)?

Question 10 (Econometrics, 60 minutes)

We have a random sample of N individuals. The list of random variables (Y_1, Y_2, Y_3, Y_4, A) has a joint distribution F, and we regard

$$(Y_{i1}, Y_{i2}, Y_{i3}, Y_{i4}, A_i) \qquad (i = 1, \ldots, N)$$

as independently and identically distributed draws from the F distribution. We observe (Y_{i1}, Y_{i2}, Y_{i3}) for each of the N individuals, where Y_{it} is the log of earnings of individual i in year t; Y_{i4} and A_i, however, are not observed. The model is

$$E(Y_{it}|A_i) = \lambda + A_i \ (t = 1, 2, 3, 4),$$

$$U_{it} \equiv Y_{it} - \lambda - A_i$$

$$Cov(U_{is,} U_{it)} = \sigma_u^2 \quad \text{if } s = t; \qquad = \gamma \text{ if } |s - t| = 1; \qquad = 0 \text{ if } |s - t| > 1$$

The values of the parameters λ, γ, σ_u^2 are unknown. We shall impose the normalization that $E(A) = 0$. This is not restrictive because we could redefine A as $A - E(A)$, and redefine the intercept λ as $\lambda + E(A)$.

a. Let $\sigma_A^2 \equiv \text{Var}(A_i)$. Provide estimators for σ_A^2, γ, σ_u^2, and λ. Try to use as much of the relevant data as you can in forming these estimates. Show that your estimates are consistent.

b Now suppose that we want to forecast the earnings in year $t = 4$ of a new individual, who was not in our sample (but could have been). Call this individual $i = N + 1$. We only have data on this individual's earnings for year $t = 1$: $Y_{N+1,1}$. How could this data on $N + 1$ be combined with the estimates from (a) to obtain a forecast of $Y_{N+1,4}$?