Economics Department 2008 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). Assume that a steel firm, S, produces steel, s, and pollution, x. The steel is sold in the marketplace while the pollution gets dumped in a river. The unit price of steel is p_s. A fishery, F, is downstream from the steel firm and is adversely affected by the steel firm's pollution. The unit price of fish is p_f.

Suppose the steel firm's cost function is

$$c_s(s, x) = \alpha s^2 - \beta x + \gamma x^2$$

while F's cost function is

$$c_f(f, x) = \delta f^2 + \theta x^2$$

a. (**2 minutes**) Write down the steel firm's profit-maximization problem.

b. (**2 minutes**) Write down the fishery's profit-maximization problem.

c. (**6 minutes**) Derive and solve the first-order conditions for each firm.

d. (**2 minutes**) Assume the steel firm buys the fishery. Write down the profit-maximization problem of the combined firm.

e. (**8 minutes**) Derive the first-order conditions for the combined firm and solve. Compare the solutions to those of the individual firms.

f. (**6 minutes**) Assume the government imposes a tax on the pollution generated by the steel firm. Calculate the efficient Pigouvian tax for the government to impose. Compare the amounts of s, f, and x under this policy to the amounts that occur under the merged firm. What is the implication?

g. (**4 minutes**) Assume there is a well-defined market for pollution in the sense that the fishery owns the right to pollute and charges a price p_x for each unit of pollution it allows the steel firm to produce. Find the price that exactly internalize the externality.

Question 2 (Microeconomics, 30 minutes). 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

a. **(8 minutes)** Does the game have a dominant strategy for Driver A or Driver B? If so, state the dominant strategies.

b. **(10 minutes)** Does the game have any pure strategy Nash Equilibria? If so, what are they?

c. **(12 minutes)** Does the game have any mixed strategy Nash Equilibria? If so, what are they?

Question 3 (Microeconomics, 30 minutes). Auto-repairs are produced using three inputs: Unskilled Labor (quantities of which will be denoted by L), Skilled Labor (H) and Machinery (K). The inputs (L, H, K) produce $Q = L^{1/6}H^{1/3}K^{1/2}$ units of repairs. It is a highly competitive industry, where producers are price-takers in both output and input markets. The wages of unskilled and skilled labor are w_L and w_H respectively, and the running cost of K units of machinery is rK. The cost of acquiring the machinery is a sunk cost and will be ignored in production decisions.

Every repair shop in the economy is equipped with $K = 1$ unit of machinery, which cannot be adjusted. To produce any positive output all the machinery in the repair shop (i.e. $K = 1$) must be turned on, but if no output is produced the producer can choose not to turn on the machinery. There is no upper limit on the output of a repair shop.

The producer is a profit maximizer, and hence for any level of output Q she will adjust (L, H) to minimize cost. Input prices are $w_L = 1$, $w_H = 2$, $r = 27$.

a. **(10 minutes)** Determine the cost-minimizing ratio $L(Q; w_L, w_H, r)/H(Q; w_L, w_H, r)$ of unskilled to skilled labor. Derive the producer's cost function $C(Q; w_L, w_H, r)$, and then specialize it to the given input prices.

b. **(7 minutes)** Let the output price be p. What is the producer's optimal output and profit as a function of p?

For what range of p will the output be positive? At what output price p will the producer be indifferent between producing and not producing?

c. **(3 minutes)** Let us consider the following model of long-run competition. Repair shops of the kind described above can freely enter and exit the market, each furnished with $K = 1$; but there are no repair shops with higher or lower levels of K. In the long-run equilibrium, a producer earns zero economic profit. What is the price p in the long-run equilibrium? How much does each repair shop produce? If the market demand curve for auto-repair is $p + Q_{demand} = 1050$, how many repair shops will be operating in the long-run equilibrium?

d. **(10 minutes)** Now consider an alternative model of long-run competition. In this economy, there are numerous repair shops with every level of K and they can freely enter or exit the market. Thus in the long-run all three inputs can be adjusted optimally. Derive the long-run cost function $C_{LR}(Q; w_L, w_H, r)$. Determine the cost-minimizing input ratio $(L : H : K)$ as a function of $(Q; w_L, w_H, r)$. In the

long run equilibrium, economic profit for producers is again zero. For the input prices given above, what is the long-run equilibrium price p in this market? What would be the output of each producer in the long-run equilibrium?

Question 4 (Microeconomics, 30 minutes). We study the telephone industry, where the marginal cost of production is 0. For all the firms to be investigated below, we can also assume that their fixed costs are 0.

The quantities and profits mentioned below are annual figures; and the market interest rate is 5% per annum. For the sake of definiteness, let us assume that revenues and profits for each year are realized at the end of that year.

a. **(10 minutes)** All-Tel is the profit-maximizing monopoly in Atlantis. There are 1 million telephone consumers in Atlantis, each with demand curve

$$\begin{aligned} q_A = &\quad \sqrt{(100/p_A)} - 1 \quad \text{if } p_A \leq 100, \\ q_A = &\quad 0 \qquad\qquad\quad \text{if } p_A > 100. \end{aligned}$$

Here q_A denotes the quantity and p_A the price of the service.

Suppose All-Tel must charge all its customers a simple price p_A. How much does it produce? How much does it charge? What is its profit? Compute the total surplus in this market.

b. **(5 minutes)** BuzzCom is the telephone monopoly in Bestland. Each of the 1 million residents of Bestland has the demand curve

$$\begin{aligned} q_B = &\quad 120 \quad \text{if } p_B \leq 1, \\ q_B = &\quad 0 \quad\;\; \text{if } p_B > 1. \end{aligned}$$

Suppose BuzzCom must charge all its customers a simple price p_B. How much does it produce? How much does it charge? What is its profit? Compute the total surplus in this market.

c. **(8 minutes)** Let us consider what may happen if the two firms merge into a joint monopoly serving both markets. Under current regulations, price discrimination is strictly prohibited. This means the merged firm must charge the same simple price p in both Atlantis and Bestland. What would be the joint monopoly's price, outputs, and combined profit?

d. **(7 minutes)** All-Tel has two potential buyers:

1. BuzzCom. If BuzzCom were to acquire All-Tel, it would be viewed by the regulatory authority as a joint monopoly operating in both markets.

2. CapItal, an Italian venture capital firm that does not currently own All-Tel or BuzzCom. If it buys All-Tel, it will continue to operate as a local monopoly in Atlantis.

These investors evaluate any investment by the Present Value of the stream of economic profits that it will generate in the future.

How much (at most) would BuzzCom bid for All-Tel? How much (at most) would CapItal bid for All-Tel? If All-Tel is sold, which of these two bidders would be the new owner?

Macroeconomics

Question 5 (Macroeconomics, 30 minutes). In the standard goods market model, the fiscal policy variables G and T are independent of the level of income. In the real world this is not the case. Taxes typically depend on the level of income, and so tend to be higher when income is higher. Examine how this automatic response of taxes can help reduce the impact of changes in autonomous spending on output. Consider the following equations:

$$\begin{aligned} C &= c_0 + c_1 Y_D \\ T &= t_0 + t_1 Y \\ Y_D &= Y - T \end{aligned}$$

G and I are both constant. Assume that t_1 is between zero and one.

a. **(12 minutes)** Solve for the equilibrium output.

b. **(12 minutes)** What is the multiplier? Does the economy respond more to changes in autonomous spending when t_1 is zero or when t_1 is positive? Explain.

c. **(6 minutes)** Why is fiscal policy in this case called an automatic stabilizer?

Question 6 (Macroeconomics, 30 minutes). Consider an economy described by the following assumptions. The aggregate production function is $Y = K^{\alpha}(EL)^{1-\alpha}$, the saving rate is s, the depreciation rate is δ, the rate of growth of E is 0, and the rate of growth of L is n.

a. **(10 minutes)** Express steady state income per worker as a function of the exogenous parameters.

b. **(3 minutes)** What is consumption per worker in this steady state?

c. **(3 minutes)** Suppose that the economy has been in steady state for a while. Now suppose that suddenly there is a one-time, large increase in the efficiency level E. On the day of the change in E, what happens to the level of output per worker?

d. **(7 minutes)** In the years following the change in E, as the economy moves to its new steady state, what happens to income per worker? Illustrate your answer with a graph that has time on the horizontal axis.

e. **(7 minutes)** Suppose now that on the same day that E increases, a large fraction of the capital stock is destroyed. How does this change your answers to part (c) and (d)?

Question 7 (Macroeconomics, 30 minutes). Government Spending.

Assume that the government provides a permanent level of government spending, G, that is funded by lump sum taxes. There is a representative household whose lifetime utility is given by $U = \sum_{t=0}^{\infty} \beta^t u(C_t)$. Assume that C has to be greater than zero. Capital (K) and government spending (G) are the only inputs to total production, which is given only by $Y_t = G^{\frac{1}{2}} K_t^{\frac{1}{4}}$, and G is todays government spending. Suppose there is 100 percent depreciation and investment is equal to yesterdays savings. Suppose further that the government chooses G to maximize consumption, and that households know this and take this into account when they provide capital, i.e. they do not take government spending as given.

a. **(6 minutes)** For a given level of capital, how much government spending is there in steady state?

b. **(12 minutes)** In steady state how much capital will there be?

c. **(9 minutes)** Now suppose that instead that the G appearing in the production function is last periods government spending, so government spending is like investment. Suppose that instead of maximizing steady state consumption, the government maximizes utility. What will the level of government spending be now for a given steady state level of capital?

d. **(3 minutes)** Is this greater than or less than the answer from part (a). Intuitively explain why.

Question 8 (Macroeconomics, 30 minutes). Growth.

Suppose that the aggregate production function of the economy is $Y(t) = A(t)(K(t))^{\alpha}(L(t))^{1-\alpha}$, where $A(t) = 1 + \int_0^t y(T)dT$. Capital depreciates at rate δ, population grows at rate n, and the savings rate is s. Let lower case letters denote per capita variables, and dots above a variable indicate time derivatives. You may need the general formula for solving quadratics, which is: $\frac{-b \pm \sqrt{b^2-4ac}}{2a}$, and also that that $\frac{d\int_a^b f(x)dx}{db} = f(b)$.

a. **(6 minutes)** What is $\frac{\dot{k}}{k}$ as a function of k, A and parameters (not in steady state)?

b. **(6 minutes)** According to the Kaldor facts, economic growth is balanced, i.e. output and capital grow at the same rate at steady state. Does this model have such a steady state where the growth of these variables is constant?

c. **(9 minutes)** Suppose $A(t) = 1 + \int_0^t (k(T))^{\beta} dT$. What is β if the model has a steady state constant growth rate and matches the Kaldor facts?

d. **(6 minutes)** Intuitively, how does the role of saving here differ in terms of the usual 'exogenous growth' Solow model (where $A(t)$ is just exogenously given)? As a result, how does the optimal rate of saving depend upon time preferences and how does this contrast with the usual 'Golden Rule'? (Only short, intuitive explanations required.)

e. **(3 minutes)** Give an intuitive explanation why $A(t)$ might take the form of the functions given in this question.

Econometrics

Question 9 (Econometrics, 60 minutes). This question examine the relationship between the general level of education of citizens and the level of political corruption.

The data below are cross-sectional for the 50 U.S. states on the following variables:

Variables in the Corruption Data Set

Variable	Definition	Mean	Std. Dev.
Corruption rate	Convictions in that state of federal, state, and local public officials on corruption charges during the period 1990-2002, per 100,000 state residents	3.9	2.1
LowEd share	Share (fraction) of adults in 1990 with at most a high school diploma (*LowEd* = .35 means 35% of adults have at most a high school diploma)	.35	.07
Urban share	Share (fraction) of adults in 1990 living in an urban area	.68	.15
Foreign-born share	Share (fraction) of adults in 1990 born outside the U.S.	.02	.02
ln(*Pop*)	Logarithm of 1990 state population	14.93	1.01
Voting share	Share (fraction) of adults voting in the 1992 presidential election	.58	.07
Manufacturing share	Share (fraction) of jobs that are in the manufacturing sector in 1990	.17	.06
HS1928	High school graduation rate in 1928	.30	.12
LnInc1940	Logarithm of per capita state income in 1940	6.23	.79

The following questions refer to Table 1.

Table 1
The Determinants of Corruption: OLS Regressions Results
Dependent variable: *Corruption Rate*

Regressor	**(1)**	**(2)**	**(3)**
LowEd share	10.4 (5.2)	18.4 (8.7)	-9.7 (54.8)
Urban share		.4 (3.1)	-.5 (3.2)
Foreign-born share		21.9 (13.9)	21.3 (14.3)
ln(*Pop*)		-.61 (.38)	-.56 (.41)
Voting share		5.5 (6.0)	-11.1 (32.7)
LowEd share×*Voting share*			47.7 (94.8)
R^2	.069	.173	.177
N	50	50	50
***F*-statistics testing the hypothesis of zero coefficients on groups of variables:**			
Urban share, Foreign share, ln(*Pop*), *Voting share*		.93 (*p* = .455)	1.15 (*p* =.345)
LowEd share, LowEd share×*Voting share*			2.25 (*p* =.118)
Voting share, LowEd share×*Voting share*			0.52 (*p* =.600)
Urban share, Foreign share, ln(*Pop*), *Voting share, LowEd share*×*Voting share*			0.93 (*p* =.470)

Notes: Heteroskedasticity-robust standard errors appear in parentheses under regression coefficients, and p-values appear in parentheses under F-statistics. All regressions include an estimated intercept, which is not reported. All regressions are estimated using a cross-sectional data set consisting of 50 US states.

a. **(3 minutes)** Using regression (2), construct a 95% confidence interval for the effect on the corruption rate of an increase in *LowEd share* of .01 (that is, of a 1 percentage point increase in the percent of the adult population with at most a high school degree).

b. Consider regression (3):

(1) **(3 minutes)** Test the hypothesis that the population coefficient on *LowEd share*$\times$ *Voting share* is zero, against the alternative that it is nonzero.

(2) **(3 minutes)** Test the hypothesis that citizen participation, specifically the presidential voting share, does not affect corruption, against the alternative that the voting share affects corruption.

c. Do you agree or disagree with the following statements? Explain.

(1) **(4 minutes)** Because immigrants are less knowledgeable about the U.S. legal system, they are more susceptible to governmental corruption. The regression results in Table 1 show that this is true: more foreign-born citizens, more corruption.

(2) **(4 minutes)** The R^2 of regression (2) is low. Thus there are important determinants of corruption omitted, and therefore the coefficient on *LowEd share* in regression (2) is biased because of omitted variable bias.

(3) **(4 minutes)** The regression results in Table 1 are flawed because they use heteroskedasticity-robust standard errors: if the errors really are homoskedastic, then these standard errors will be incorrect. The table should instead report standard errors that are correct even under homoskedasticity.

d. Suppose that high levels of corruption result in low-quality public institutions, including low-quality schools, which in turn results in lower levels of education.

(1) **(3 minutes)** If so, what are the implications for the estimated effect on corruption of education in Table 1? Briefly explain.

(2) Consider the following potential instrumental variables for *LowEd share* in regression (3):

(i) **(3 minutes)** *Newspapers* = average number of newspapers per capita in 1990

(ii) **(3 minutes)** *Alphabet* = 1 if the state falls in the first half of the alphabet, = 0 otherwise (e.g. = 1 for Alabama, = 0 for Wyoming)

For each proposed instrument, is the variable arguably a valid instrument variable? Briefly explain.

The following questions refer to Table 2.

Table 2
The Determinants of Corruption: Two Stage Least Squares Regressions Results
Dependent variable: *Corruption Rate*

	(1)	(2)	(3)	(4)	(5)	(6)
Endogenous regressor						
LowEd share	29.4 (11.7)	131.0 (114.4)	32.9 (12.8)	32.5 (10.2)	54.8 (36.4)	35.4 (11.4)
Exogenous regressors						
Urban share	1.3 (2.8)	18.4 (18.4)	1.9 (2.9)	-.4 (2.5)	2.7 (5.6)	-.1 (2.5)
Foreign-born share	22.4 (14.4)	69.3 (48.9)	24.0 (14.7)	7.0 (9.4)	12.6 (14.8)	7.7 (9.5)
ln(*Pop*)	-.43 (.45)	-2.20 (1.97)	-.49 (.49)	.34 (.34)	.18 (.54)	-.32 (.35)
Voting share	14.4 (8.2)	80.4 (73.3)	16.6 (18.8)	17.4 (7.2)	32.1 (24.1)	19.2 (7.8)
Manufacturing share				-22.2 (6.3)	-28.5 (10.7)	-23.0 (6.1)
Instrumental variables	*HS1928*	*LnInc1940*	*HS1928, LnInc1940*	*HS1928*	*LnInc1940*	*HS1928, LnInc1940*
First-stage *F*-statistic*	19.0	0.7	10.6	19.7	2.6	11.3
***J*-test of overidentifying restrictions**			3.95 (p = .047)			0.48 (p = .487)
N	50	50	50	50	50	50

Notes: Heteroskedasticity-robust standard errors appear in parentheses under regression coefficients, and p-values appear in parentheses under F-statistics. All regressions include an estimated intercept, which is not reported. All regressions are estimated using a cross-sectional data set consisting of 50 US states, where the variables are defined in Table 1.

*The first-stage F-statistic is the F-statistic testing the hypothesis that the coefficients on the instruments in the first stage regression all equal zero.

e. **(18 minutes)** From the regressions in Table 2, select one or more preferred regressions that you believe provide the most reliable basis for inference about the effect of low education levels on corruption. Carefully explain your reasoning.

f. **(6 minutes)** Based on your preferred regression(s), what conclusions do you draw about the effect on corruption of the level of education? Explain.

g. **(6 minutes)** In your judgment, what are the most important threats to the internal validity of the estimates in your preferred regression(s), upon which you based your answer to part (b)?

Question 10 (Econometrics, 60 minutes). Consider a cross-section sample of firms, with data on output, labor, and capital. Assume random sampling of the firms. The firm behavior follows the competitive model: profit maximizing, taking prices as given. All the firms have Cobb-Douglas production functions, linear in the logs of output, labor, and capital. The labor and capital elasticities are the same for all firms, but there are efficiency differences, so that, in logs, the additive intercepts differ across the firms.

a. **(20 minutes)** Suppose that the normal linear model provides a good description of the conditional distribution of log output given log labor and log capital. Explain why, nevertheless, the coefficients on log labor and log capital in the linear regression function may not correspond to the labor and capital elasticities in the production function. Would you expect the regression coefficients to be higher or lower than the production function elasticities? Explain your reasoning.

b. **(20 minutes)** Suppose now that you have $T = 5$ years of longitudinal data for each of the N firms in part (a). Let Y_{it} denote the log of output for firm i in year t, and let X_{it} denote a 2 by 1 vector containing the log of labor for firm i in year t and the log of capital for firm i in year t. In his article on "Empirical Production Function Free of Management Bias," Mundlak proposed forming deviations from the firm means:

$$\tilde{Y}_{it} = Y_{it} - \bar{Y}_i, \quad \tilde{X}_{it} = X_{it} - \bar{X}_i,$$

stacking the deviations to form the $N \cdot T$ by 1 matrix $\tilde{Y}$ and the $N \cdot T$ by 2 matrix $\tilde{X}$, and obtaining estimates of the production function from a least-squares fit of $\tilde{Y}$ on $\tilde{X}$. Use a population linear predictor to motivate this estimator, explaining how it can address the problem in part (a). What assumptions are needed for this estimator to be consistent as N tends to infinity?

c. **(20 minutes)** Provide a version of the normal linear model that can be applied to the data in part (b) to address the problem in part (a) and provide inferences for the production function elasticities. State the assumptions that are needed. Discuss the sense in which these assumptions are stronger than what was needed for consistency in part (b).