Honors General Exam
Part 1: Microeconomics
(60 pts)

Harvard University

April 6, 2016

Name: _____

HUID: _____

Question 1. (12 points)

A rare baseball card investor is deciding when to sell the novice card of a recent superstar. The more time that passes, the more valuable the card will get due to scarcity. In particular, the investor estimates that consumer willingness to pay for the card after t years is $P(t) = 30 + 10t$.

(a) **(4 pts)** Suppose that it costs \$5 a year to maintain the card in its pristine condition, and money appreciates at an interest rate of 5%. When will the investor sell his card? At what price will he sell?

(b) **(4 pts)** Suppose the interest rate is instead 10%. What happens to the values of t and $P(t)$? Explain.

(c) **(4 pts)** Suppose instead that the interest rate remains at 5% but the cost of storage is \$4 per year? Explain intuitively whether the investor would hold the card for a longer or shorter amount of time compared to part (a). Solving for the exact impact is unnecessary.

Question 2. (12 points)

You have been tasked to consult on investing in a new startup. Preliminary research shows you that the startup's long-run cost function will be $C(Q) = 5Q^2 - 2Q + 125$.

(a) **(8 pts)** What is the smallest price at which the startup could supply a positive amount of output in the long run? State the condition(s) under which the firm will operate in the long run as part of your answer.

(b) **(4 pts)** Suppose that in the short run, the startup's cost curve for the good is $\frac{1}{8}Q^2 + 50Q$. If the market price for the good is \$75 per unit, how much should the startup produce?

Question 3. (12 points)

In the aftermath of the death of Justice Antonin Scalia, President Obama (POTUS) and Congress found themselves at an awkward standoff. The president would like to nominate a liberal to shift the leaning of the court left, but he'd really like his nominee to pass confirmation with Congress. Republican-controlled Congress, on the other hand, faces pressure to delay confirmation in hopes of a conservative candidate winning the 2016 presidential election. On the other hand, the congressional Republicans can get away with confirming a moderate at a small political loss since if a Democrat wins again, (s)he will surely get a liberal on the court.

The payoff matrix for this game is as follows:

		Congress	
		Confirm	*Don't Confirm*
President Obama	*Liberal*	12,0	3,3
	Moderate	4,4	7, 3
	Conservative	0,10	0,0

(a) **(4 pts)** Does the game have any pure strategy Nash Equilibria? If so, what are they?

(b) **(8 pts)** Does the game have any mixed strategy Nash Equilibria? If so, what are they?

Question 4. (12 points)

Megyn gets her utility from a combination of commodities x and y. Her utility from consuming x and y amounts of each commodity is given by $U_M(x, y) = (x + 4)(2y - 6)$.

(a) **(4 pts)** When we first observe her, Megyn employs a marginal rate of substitution of -5. How many units of y is she consuming if she consumes 2 unis of x?

(b) **(4 pts)** Megyn lives in a closed economy with Donald, who has a utility function of $U(x, y) = 4x + 6y^{1/18}$. When we find him, Donald is seen consuming $x = 10$ and $y = 23$.

Draw an Edgeworth box for this economy. Be sure to label everything clearly (including the endowment point at the time we first see Megyn and Donald).

(c) **(4 pts)** 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?

Question 5. (12 points)

In the aftermath of their recent spat, Kanye and Taylor Swift receive utility shocks in proportion to the bombast that they display. If Kanye exerts x units of bombast, he receives a utility shock of $55x - 2x^2$. TSwift also profits from her bombast, but because Kanye has made demeaning comments about her, she suffers from the extra media attention that she and Kanye get. Thus, if TSwift exerts y units of bombast, she receives a utility shock of $40y - 1.5y^2 - (0.5)xy$.

(a) **(6 pts)** Suppose that TSwift's fans pressure Kanye into compensating Taylor for the cost that his bombast imposes on her. What levels of bombast do Kanye and Taylor choose in equilibrium? What utilities do they obtain?

(b) **(3 pts)** Suppose that Kanye and TSwift's managers get together over drinks and figure out a plan to collude and jointly set both of their clients' bombast. What levels of bombast do they choose?

(c) **(3 pts)** What is the change in aggregate welfare from the managers' collusion? Is Kanye better off relative to part (a)? How about Taylor? Show all your welfare calculations.

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Honors General Exam
Part 2: Macroeconomics
(60 points)

Harvard University

April 6, 2016

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Question 1. (30 points)

This question asks you to use a Solow Model to analyze what happens to an economy when a government imposes a proportional tax on output.

(A) **(8 pts)** To start off, assume that there is no government in the economy, so the Solow setup is completely standard. Specifically, the economy has a production function $Y = K^{\alpha}(EL)^{1-\alpha}$, where K is physical capital, L is labor input, E is labor-augmenting technical progress, and α is an exogenous constant. The exogenous growth rates of E and L are g and n, respectively. Every period, a fraction δ between 0 and 1 of the physical capital stock deteriorates. The exogenous savings rate is a constant rate s. Under these conditions, what are the steady-state values of the following quantities in terms of the exogenous variables? (Note: You do not need to draw any graphs for this part of the question.)

- The capital-output ratio $\frac{K}{Y}$?
- The ratio of capital per effective unit of labor $k = \frac{K}{EL}$?
- The growth rate of output Y?
- The growth rate of output per worker $\frac{Y}{L}$?
- The growth rate of the marginal product of capital MPK?
- The growth rate of the marginal product of labor MPL?

(B) **(5 pts)** Now assume that there is a government that collects a small positive fraction τ of real output Y each period as a tax. After the government collects this tax, you can assume that the output simply disappears and it is not used to purchase any goods or services, or to pay any government employees. (In other words, you can assume that the government collects a constant fraction of real GDP τ each period and throws it in the ocean.) Draw a graph to show how the standard Solow graph that has $k = \frac{K}{EL}$ on the horizontal axis is affected by this change, under the assumption that the fraction of output allocated to consumption C is the same before and after the tax.

(C) **(2 pts)** How does the government tax affect your answers to part (A)? That is, what are the new steady-state values of:

- The capital-output ratio $\frac{K}{Y}$?
- The ratio of capital per effective unit of labor $k = \frac{K}{EL}$?
- The growth rate of output Y?
- The growth rate of output per worker $\frac{Y}{L}$?
- The growth rate of the marginal product of capital MPK?
- The growth rate of the marginal product of labor MPL?

(D) **(5 pts)** Describe what would happen to output per worker and living standards $\frac{C}{L}$ if the tax were suddenly levied on an economy that did not have one before. In your answer, describe how these variables would change after the new tax (if at all) in both the short and long runs. You do not need to draw a graph.

(E) **(5 pts)** Now assume that the tax allows the government to create a set of blueprints that causes the growth rate of technological progress to rise to g', a rate that is higher than the original technological growth rate, g. Draw a standard Solow model graph to show how this type of tax would affect the steady-state value of capital per effective unit of labor k (if at all). (In your answer, you can ignore the effect of any government payments to the creators of the blueprints. Just pretend that as before, the output absorbed by the tax get thrown in the ocean, but in this process the rate of technical progress magically rises from g to g'.)

(F) **(5 pts)** How would the combination of the tax and the higher rate of technological progress that is described in part (E) affect output per worker $\frac{Y}{L}$ and living standards, if at all? Discuss both the short and long runs. You do not need to draw a graph.

Question 2. (30 points)

In early 2016, several large economies around the world experienced changes in international capital flows. This question investigates the causes and consequences of movements in capital flows for large open economies in some detail.

(A) **(8 pts)** How would an increase in government purchases G affect (a) output, (b) the net capital outflow, (c) investment and (d) the real exchange rate in the standard long run large open economy (LOE) model? Use graphs to illustrate your answer, and be sure to explain your economic reasoning in words. Also explain how the answer to this question would be different if the economy were a small open economy (SOE) instead. (You do not have to draw a graph for the SOE case, just explain the difference between the LOE case and the SOE case for output, the net capital outflow, investment, and the real exchange rate.)

(B) **(7 pts)** Now use a long-run model to explain what would happen if the LOE experienced no change in G, but were instead judged to be a better place for foreigners to invest at any given rate of return. (For example, foreigners might increasingly view the LOE as a safe haven in a turbulent world market.) Use a graph to explain how the change in foreigners' views would affect (a) the domestic real interest rate, (b) output, (c) investment, and (d) the net capital outflow, and (e) the trade balance. You do <u>not</u> have to compare your answers to a small open economy case.

(C) **(7 pts)** How would you change the answers you obtained for the change in foreigners views for a large open economy described in (B) if you had used a short-run model instead of a long-run model? Again, use a graph to explain how the change in foreigners views' would affect (a) the domestic real interest rate, (b) output, (c) investment, (d) the net capital outflow, and (e) the trade balance. Explain your answers in words as well.

(D) **(8 pts)** In early 2016, some people have argued that the United States is undergoing capital flows of the type described in parts (B) and (C) of this question. How should the Fed respond to this movements in capital flows if it wants to stabilize short-run output, the price level, or both? How would the results of the Fed's actions relate to the long-run outcome for the large open economy described in part (B)? (As you answer this question, you can ignore the fact that the Fed is currently near the zero lower bound, and just pretend that the level of output Y before the change in foreigners' views was close to its long-run level.)

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Honors General Exam
Part 3: Econometrics
(60 pts)

Harvard University

April 6, 2016

Name: _____

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Lead Pipes and Homicides

In the second half of the nineteenth century, many U.S. cities built water supply systems. Some cities used only iron pipes, while others used at least some lead pipes. Although lead in very high concentrations was known to have short-run toxic effects, it was not until the 1940s that the first research showed that prolonged exposure to low doses of lead through water could have lasting health effects.

This question examines the relationship between lead exposure through lead pipes and city homicide rates for 1921-1936. Figure 1 shows U.S. cities that built water systems in the late 1800s using no lead (46%) or some/all lead (54%) in their pipes. Table 1 summarizes regression results.

1. **(6 pts)** Interpret the coefficient on *Rail Distance (1900)* in regression (2).

2. The standard errors in Table 1 are clustered standard errors, with the clustering at the city level.

(a) **(5 pts)** Explain the problem that clustered standard errors solves.

(b) **(5 pts)** In this application, do you think that clustering at the city level is appropriate or not? Explain.

3. Lead pipes cost more than iron pipes, but corrode more slowly. This suggests that richer cities could afford lead pipes, while poorer cities chose iron.

(a) **(5 pts)** Provide the "omitted variable bias formula" relating the bias in $\hat{\beta}$ to the correlation between the regressor and the error term.

(b) **(5 pts)** Use the omitted variable bias formula and your judgment to explain whether the potential link between income and lead pipes results in the coefficient on *Lead pipes (1897)* in regression (1) being biased towards zero, or away from zero, or having no omitted variable bias.

4. In 1900, eleven cities scattered through the U.S. had lead refineries (smelters) (see Figure 2). Regression (3) uses two stage least squares, with the instrument being the distance by rail from the nearest lead smelter to the city, in hundreds of miles (*Rail distance (1900)*).

(a) **(5 pts)** Is the estimated coefficient on *Lead pipes (1897)* in (3) large or small in an economic (real-world) sense?

(b) **(5 pts)** Is the instrument weak or strong?

5. **(7 pts)** Regardless of your answer to 3(b), suppose that the omission of income in regression (1) does in fact lead to omitted variable bias. In your judgement, is this concern resolved by the instrumental variable regression (3)?

6. Consider the local average treatment effect (LATE).

(a) **(5 pts)** Provide a definition of the LATE (either mathematical or in words).

(b) **(5 pts)** In your judgement, does the LATE in regression (3) equal the average treatment effect? Explain.

7. **(7 pts)** Current residents of Flint, Michigan have been exposed to lead from their water pipes because of operational failures by the city, state, and federal governments. Suppose that the estimate in regression (3) is internally valid. Is the estimate externally valid in the sense of applying to future outcomes for the exposed youth of Flint? Explain.

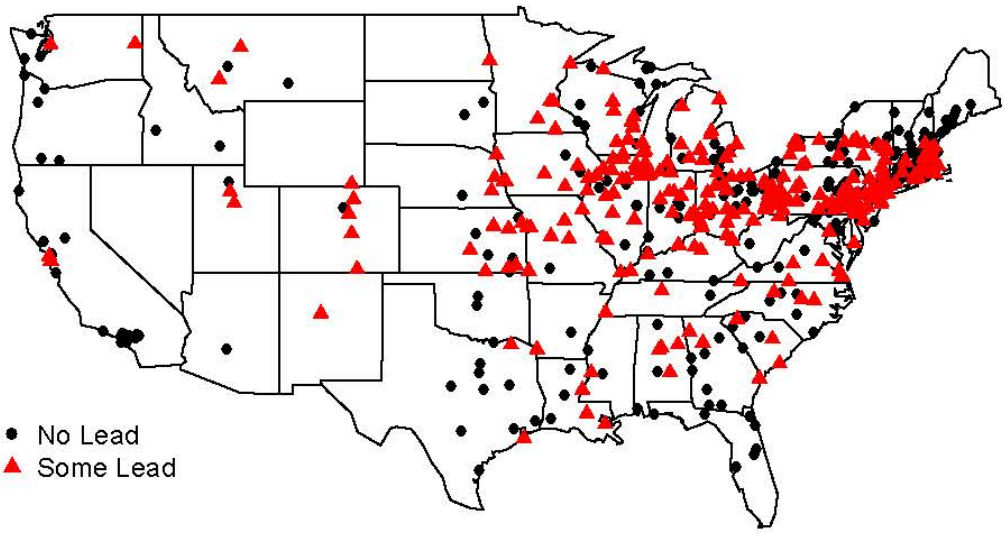

Figure 1. Location of sample cities and the type of water pipe used as of 1897 (the full sample has 545 cities, a subsample of which are shown here for display purposes).

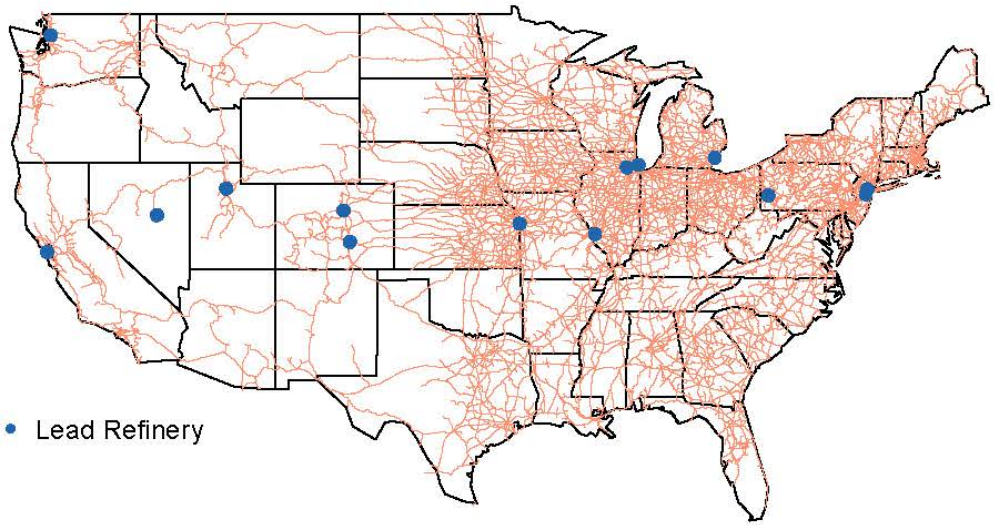

Figure 2. Lead refineries (smelters) and railroad network in 1900

Table 1. Effect of lead pipes on homicide rates: regression results
Data: Annual by city, 1921 - 1936

	(1)	(2)	(3)
Dependent variable	Homicide rate	Lead pipes (1987)	Homicide rate
Method	OLS	OLS	Two stage LS
Instrument	--	--	*Rail distance (1900)*
Regressors			
Lead pipes (1897)	0.219** (0.064)	--	1.022** (0.262)
Rail distance (1900)	--	-0.099** (0.015)	--
Control variables (see list)	Yes	Yes	Yes
Year effects	Yes	Yes	Yes
Number observations	7434	7415	7415
Number of cities	545	543	543

Notes: Significant at the *5% **1% level. Standard errors are clustered at the city level.

Variable definitions

Homicide rate = homicides per 100,000 population (mean = 12.4); annual, by city, 1921-1936

Lead pipes (1897) = 1 if city had some lead in its pipes in 1897, = 0 if no lead

Rail distance (1900) = distance by rail from nearest lead refinery to the city as of 1900 (hundreds of miles)

Control variables: percent black in 1900, percent foreign-born in 1900, percent employed in manufacturing in 1900, percent of single men in 1900, home ownership rate in 1900.

Source: J. Feigenbaum and C. Muller, "Lead Exposure and Violent Crime in the Early Twentieth Century," manuscript, 2016.

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