FINAL EXAM

Fall 2023

- This is a closed-book exam. Only a 8.5"x11" formula sheet is allowed.
- No electronic devices are allowed, except for the simple calculator we provide.
- You may not communicate with other students during the exam. You will also keep the exam contents confidential.
- You may not communicate with anyone during the exam. You will also keep the exam contents confidential.
- There are **180 points in the exam**. You also have **180 minutes**.
- Do not be concerned if your answers are not whole numbers. Large numbers are avoided to lower the burden of calculation. Don't worry if you find the numbers unrealistic---you could make sense of these numbers in your head by picking the right units yourself (but no need to answer with these units).
- Please be as complete as possible. Write down the reasonings for your answer (unless instructed otherwise).
- Complete all **SHORT ANSWER** questions in one Blue Book, and all **LONG PROBLEMS** in a 2nd Blue Book. Write your name and "SHORT"/ "LONG" on the cover of your Blue Books.
- Answers written **anywhere else, including on the question sheet** will **NOT** be graded.
- Please return the **Blue Books** AND **the question sheet** after the exam.
- A camera will be set in the classroom to monitor exam situations (Exam recordings will be deleted once final grades are posted unless required for an ongoing Honor Committee case).
- If you have clarifying questions but there is no proctor in your classroom, please find TAs at each of the "four wings (#2210,#2410,#4200,#4400)" of the building. Faculty will also circulate in each classroom throughout the exam.

Section I: Short Questions [72 points]

Please be concise. None of the answers require more than a brief paragraph. All questions are worth 9 points each.

a) (9 points) The state of Illinois increased its tax rate on cigarette by almost 200% in 2019. Among smokers (assuming they don't quit immediately), non-smokers, and tobacco companies, which group would bear the highest percentage of tax incidents? Why?

Answer: Smokers have highly inelastic demand among the three groups, and hence would bear the most among others.

b) (9 points) Amazon's warehouse uses both machines and labor to produce packages. Suppose that the price of labor increases due to changes in the minimum wage regulations. Given that Amazon had the optimal (cost-minimizing) combination of labor and machines before the price change, how will Amazon respond following the price change? Why?

Answer: MPIs were the same before. When the price of labor increases, MPI for labor decreases, and hence Amazon fire workers and buy/rent more machines to equalize the new MPIs.

c) (9 points) Charley's place in Evans Hall used to charge $8 per meal pre-pandemic. It now charges $12 per meal. They have found a 10% decrease in sales. What is the demand elasticity at the price of $8 (approximately)? Was it pricing optimally before?

Answer: Price changed by 50%, quantity by 10%. Elasticity is approximately 1/5=20%. Inelastic at $8, so not optimal.

d) (9 points) A friend claims that while it is true that an import tariff is likely to increase prices to consumers, since the government collects that tariff revenue, the country is not any worse off. Do you agree or not, and why?

Answer: The tariff introduces deadweight loss; the government revenue is less than the surplus destroyed. Therefore, no, the country is indeed worse off. If they mention DWL, full credit.

e) (9 points) Suppose that, after having done some marker researchers, Tesla has identified two segments of car buyers, with different willingness to pay: Luxury buyers, who have high reservation prices for a Tesla, and Eco buyers, who have lower reservation prices. Tesla wishes to price discriminate among them but cannot distinguish between Luxury

and Eco buyers, so it is considering setting up a self-selecting pricing scheme to extract as much surplus as possible from its consumers. With such a pricing scheme, will Tesla be able to extract all possible surplus from its Luxury customers? What about from its Eco customers? Explain.

Answer: With self-selecting price discrimination, we are able to extract all the surplus from the low-valuation type consumers (thanks to the "willing to buy" constraint), but we have to leave some surplus to the high-valuation consumers (due to the "buy the right one" constraint). For this reason, Tesla will extract all surplus from the Eco buyers but only some surplus from the Luxury buyers.

f) (9 points) You are in the process of opening a new golf course in New Haven and you have to set up prices. You are considering charging your customers a membership fee. The marginal cost of each additional entry to the golf course is greater than zero. Is a membership fee the best pricing scheme in this case? If yes, explain why. If not, please provide an alternative.

Answer: A membership fee will make you lose money on some units if MC=0. An better idea in this context is to use a two-part tariff: membership + usage fee.

g) (9 points) Does the introduction of a mandate in health insurance markets make everyone better off? Does it make the market efficient? Please briefly argument your answer.

Answer: A health insurance market does NOT make everyone better off; there are winners and losers. The losers will be consumers with very low risk/expected costs/willingness to pay for HI, who will be forced to buy HI at a price higher than their willingness to pay. If consumers are risk averse (which implies that their WTP >= cost of insurance to the company) then the mandate does make the market efficient: it ensures all the possible surplus is realized by forcing everyone to buy.

h) A local store selling handmade sweaters is currently paying its salespeople a fixed hourly wage, but sales are dwindling. The owners are brainstorming strategies to increase sales. Among others, they are discussing changing salespeople's compensation to a package that includes an hourly wage and a sale-contingent bonus. Is it worth it for the store to adopt this compensation scheme? What does your answer depend on?

Answer: It is not necessarily better to adopt the wage+bonus compensation scheme. The answer depends on w* and b* in equilibrium and on the profit margin the company makes on the sale of each sweater. In turn, w* and b* depend on the probability that a sale is made given a certain effort level and on workers' risk preferences. Give full credit if they

mention profit/sale margin, w* and b*, and risk effort. Give partial credit if they only mention profit/sale.

Section II: PROBLEMS (64 points)

Problem 1: Electric Vehicles (18 points)

Electric Vehicles (EVs) have lower carbon footprints than gasoline-powered cars and do not produce as much fine particle matter pollution as combustion from gasoline/diesel car engines do. However, these environmental benefits are not directly taken into account when purchasing EV's. In other words, EVs have *positive externality*.

a) (2 points) Without any market interventions, will EV consumption be lower or higher relative to the efficient level?

Under-consumption due to positive externality.

Suppose that, in the city of New Haven, the demand of gasoline-powered cars is given by

$$Q_D(p) = 40 - p,$$

Meanwhile, suppose that the supply of EVs is given by

$$Q_S(p) = 4p$$

b) (4 points) What is the equilibrium price and quantity of gas-powered cars in New Haven (without government intervention)? What are the demand and supply elasticities at this equilibrium? Which side is more elastic?

40-p=4p => 5p=40, p=8, q=32.
Demand elasticity: p/q*(-1)=8/32*(-1)=-0.25
Supply elasticity: p/q*4=8/32*4=1

Supply is more elastic.

The city of New Haven decided to intervene the market and encourage consumers to switch from gas-powered cars to EVs. Suppose that the city imposes a per-unit tax in the amount of $10.

c) (4 points) What is the equilibrium price and quantity of gas-powered cars in New Haven after tax? What percentage of tax burdens do consumers bear.

New demand:

$$Q_D^{tax} = 30 - p$$

New equilibrium price producers get:

$$30 - p = 4p \implies p = 6$$

New equilibrium price consumers pay: 6+10=16

New equilibrium quantity: 4*6=24

Consumers bear (16-8)/10=80%

d) (3 points) What is the amount of deadweight loss in the gas-powered car market?

Deadweight loss= ½*10*(32-24)=40.

e) (3 points) Suppose that after tax, all the gas-powered car consumers with reservation prices lower than the new equilibrium price switch to EVs. How many more EVs are purchased after tax?

32-24=8 units

f) (2 points) Overall, what can you say about this policy?

Taxing gas-powered cars reduces consumption of gas-powered cars and increases consumption of EVs, which could be beneficial as it helps with the under-production problem. However, (i) it creates deadweight loss in the gas-powered car market and (ii) it might lead to over-consumption of EV if the tax is too high.

Problem 2: Gravel market (25 points)

Quarry Inc. has a local monopoly over the gravel industry in central Connecticut. The inverse demand for gravel is given by Q =100-2P, where Q is the quantity of gravel in thousand cubic yards per month, and P is the price in dollars per cubic yard. Quarry Inc. incurs a fixed cost of production of $12 and a variable cost of $5 per cubic yard.

a) (4 points) What are the profit maximizing price and quantity choices for Quarry Inc.?

P=50-0.5Q
Revenue=P x Q = $50Q-0.5Q^2$
MR=50-Q
So MR=MC gives 50-Q=5 or Q=45 and P=27.5

b) (4 points) What is the elasticity of demand at this price? Does this elasticity make sense to you? Why or why not?

The elasticity can be derived using the Inverse Elasticity Pricing Rule, which states that (P-MC)/P=-1/elasticity. This implies that Elasticity = P/(MC-P)= 27.5/(5-27.5)=-1.22.

c) (2 points) What is the total profit of Quarry Inc. at the optimal price and quantity choice?

Profit = P * Q – TC(Q) = (27.5 * 45) – (5*45+12)=1000.5

d) (3 points) If the market were instead perfectly competitive, with many gravel providers (all with identical marginal costs as the monopolist), what would you predict the price of gravel to be? What would be the quantity sold?

In competitive markets, price equals marginal cost, so P=5.
Quantity can be derived using the inverse demand function: Q = 100 – 2*5=90.

e) (3 points) What would the firm's profit be in this scenario? What would the firm do in the long vs short run?

In the short run, the firm's profits would be negative and equal to -12l the firm would still produce to cover the fixed costs. In the long run, the firm would exit.

f) (4 points) Let's go back to the setting with Quarry Inc. being a monopoly (i.e., part (d) no longer applies.) The CT state government believes that local builders are suffering because of Quarry Inc.'s monopoly power and consequent high prices. To extract some surplus from the monopoly, the government levies a $1 tax (to be paid by Quarry Inc.) for every cubic yard of gravel sold. Compute the new price and quantity that you expect in the market.

The tax will be like increasing the per unit cost of the monopolist by 1, so MC goes up by 1.
To find profit maximizing price and quantity, we can set MR = MC like in point (a), which yields 50-Q=6. This gives Q=44 and P = 28.

g) (5 points) Do you think the above tax is effective in helping the local builders? Explain **quantitatively** why or why not?

Not effective.
Price is now higher for consumer and less quantity being sold. So consumers are now worse off.
Earlier (point a), the CS of the local builders was 0.5*(50-27.5)*45=506.25
New CS = 0.5*(50-28)*44 =484. This implies that CS went down by 22.25.

Problem 3: Job offers (20 points)

Knowing you have taken Basics of Economics, a non-MBA friend who is deciding between job options has come to you for advice. They have been offered two jobs, one that has a guaranteed salary of $120,000 per year, and the other that has a lower salary of $100,000 per year but has a 75% chance of also having a $60,000 bonus.

This student is risk-averse and so is considering both opportunities. Their utility function is represented by $u(x) = \sqrt{x}$ where x is measured in thousands so that $\sqrt{\$100k} = 10$. They have no other savings or wealth.

a) (2 points) What is the expected value of the two jobs?

Job with no bonus: 120K wp1, EV = 120K.
Job with bonus: 100K wp 0.25, 160K wp 0.75. EV = 0.25 * 100K + 0.75 * 160K = 145K.

b) (4 points) Which job do you expect them to take?

Utility of job with no bonus is $\sqrt{120} = 10.95$; Expected utility of job with bonus is $0.25\sqrt{100} + 0.75\sqrt{160} = 11.99$. Friend is better off in the job with a bonus.

a) (2 points) Would your answer change if your friend told you they are risk-neutral? Why or why not?

If friend is risk neutral, they will care about expected value. EV of bonus job is greater than EV of fixed wage job, so they will still choose the job with the bonus.

b) (6 points) What is the minimum guaranteed salary the first job would have to offer to make the student indifferent between the two jobs?

Call this salary S; we need $\sqrt{S} = 11.99$, which implies that S = 143,684. Partial credit (3 points) if the explain concept of certainty equivalent but don't write down formula.

c) (6 points) The firm offering the bonus has decided to offer a different contract for new analysts to accept. This new contract maintains the Expected Value of the existing contract but puts more weight on the bonus. Is this a good idea or bad idea when hiring potentially risk-averse employees, and why?

Answer: bad to go more high-powered if people are risk averse. Full credit if they note that putting more of the salary in the bonus exposes the individual to more risk, and that this is costly to do if they are risk averse. Give 3-4 points for anything reasonable.

GAME THEORY (45 points)

Problem 4: An extended HFT investment game (25 points)

Consider an extended version of the high-frequency-trading game discussed in the class. Suppose now that when a firm invests, it can choose whether to do a high investment (HI) or a low investment (LI). The matrix form of this extended game is as follows, where "No" means no investment and X and Y are unknown numbers:

		Firm 2		
		HI	LI	No
Firm 1	HI	30, 30	X, 25	60, 20
	LI	25, X	40, 40	Y, 35
	No	20, 60	35, Y	50, 50

a) [8 points] For what values of X and Y, will HI be a dominant strategy for each firm?

HI is a dominant strategy if X>40 [4 points] and Y<60 [4 points] (or if X>=40 and Y=<60).

b) [8 points] For what values of X and Y, will this game have more than one Nash equilibrium?

First notice that (HI, HI) is always a NE, and other outcomes cannot be a NE except for (LI, LI). (This can be seen by using best-response method.)

For (LI, LI) to be another NE, we need X=<40 [4 points] (or X<40), but the value of Y does not matter, so any Y will work [4 points].

c) [9 points] For what values of X and Y, will firm 1 earn 35 in the **sequential-move** version of this game where firm 1 moves first?

By backward induction, for firm 1 to earn 35 we need two conditions: (i) firm 1 is willing to choose No; and then (ii) firm 2 is willing to choose LI afterwards. The latter requires Y>60 [4 points], and the former requires X>40 [5 points] (otherwise firm 2 would choose LI after firm 1 chooses LI, in which case firm 1 would earn 40 so that it wouldn't choose No in the beginning). (Y>=60 and X>=40 are also fine.)

Problem 5: An extended location choice game (20 points)

Consider an extended version of the location choice game discussed in the class. Tourists are evenly distributed on a beach that is a line segment [0,1] of one mile long. **THREE** ice cream vendors simultaneously choose where to locate, each aiming to maximize their own market share. (Suppose they can locate exactly at the same spot if they want.) Tourists prefer to buy from the closer vendor. When they are indifferent between multiple vendors, they randomly choose one.

a) [5 points] Is it a Nash equilibrium that the three vendors all locate at the middle of the beach (i.e., at 1/2)? Please explain your answer.

No, it is not a NE. [3 points]

When they all locate in the middle, each vendor has a market share 1/3. But if a vendor individually deviates from the middle slightly, its market share can be close to 1/2.
[2 points for pointing out that any vendor will have an incentive to deviate.]

b) [5 points] Is it a Nash equilibrium that the three vendors locate at 1/6, 1/2, and 5/6, respectively (so that each has a market share 1/3)? Please explain your answer.

No, it is not a NE. [3 points]

The vendor at 1/6 or 5/6 has a unilateral incentive to move toward the vendor in the middle. [2 points] (The vendor at the middle actually has NO strict incentive to move.)
[only 1 point if it says ANY vendor has an individual incentive to deviate.]

c) [5 points] Suppose now we "bend" the beach so that it becomes a **CIRCLE** that has a circumference of one mile (i.e., the two endpoints 0 and 1 are now connected to each other). Is the location configuration in question (b) a Nash equilibrium? Please explain your answer.

Yes, it is now a NE. [3 points]

Given the other two vendors' locations, a vendor's market share cannot exceed 1/3 no matter where it moves to. [2 points]

d) [5 points] Return to the original case where the beach is a line segment. Suppose that vendor 1 has already entered the market and located at the left endpoint 0. Now vendors 2 and 3 simultaneously choose where to locate. What is the Nah equilibrium of the location choice game between vendors 2 and 3?

Both vendors 2 and 3 will locate at 2/3 in the NE. [5 points; no explanation needed.] It is easy to verify that none of them has an individual incentive to move away from this location.

(Here is a way to show this is the unique NE. It is clearly not a NE if vendors 2 and 3 are not in the same location. Suppose now they are at the same location, say, x. Obviously it is not a NE if x=0. Suppose then x>0. In that case, they will each have a market share 0.5(1-0.5x). If one of them, say, vendor 2 moves slightly to the right of vendor 3, it will have a market share almost equal to 1-x; if vendor 2 moves to the left of vendor 3, it will have a market share of 0.5x. In a NE, neither of the deviation should be profitable. You can easily check that this requires x=2/3.)