

Fall 2018 – Practice Questions

Course Overview

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Course Introduction and Intro to Market Demand (Lecture 1)

1. 2016 Problem Set 1, Q1

United Airlines. United Airlines operates a non-stop route between New York City and Paris. There are two types of travelers: business and tourists. The annual demand for round-trip flights for these two groups are given by:

$$P_B(q) = 3,000 - \frac{1}{5}q$$

$$P_T(q) = 1,000 - \frac{1}{5}q$$

where B and T denote business and tourist, respectively. Quantities are the total number of round-trip tickets sold per month and prices are on a per-ticket basis.

- a) What is the aggregate demand for this route? Express aggregate demand in terms of quantity as a function of price.

$$Q_{agg}(p) = \begin{cases} \underline{\hspace{2cm}} & \text{if } p \leq \underline{\hspace{2cm}}, \\ \underline{\hspace{2cm}} & \text{if } p \geq \underline{\hspace{2cm}}, \end{cases}$$

- b) How many tickets would United sell if it priced this route at \$500 per round-trip ticket?

Number of Tickets:

- c) How much is this growth in demand going to increase (in percentage terms) the total flights per-month demanded under United's original pricing of \$500 per flight?

% increase =

- d) If they keep the price fixed, would their customer mix (business versus tourist) shift towards more business travelers or towards more tourists?

towards more business travelers ☐

towards more tourists ☐

- e) Discuss, in a few sentences, how United would likely adapt to this change and how such changes in United's pricing strategy would impact the welfare of tourists that use this route.

2. 2013 Final Exam, Short question e)

Amazon.com has been testing a same-day product delivery program where they would charge an annual membership fee to "Amazon Ultra", and also a usage fee for each product delivered on the same day as ordered.

The company estimates that they have two equally sized customer segments that value same-day delivery differently: "occasional" shoppers and "convenience-lovers". Annual demands for same-day deliveries when a same-day delivery costs p are given by

$$\begin{aligned}Q_{occ}(p) &= 10 - p, \\Q_{con}(p) &= 20 - 2 \cdot p.\end{aligned}$$

Amazon's pricing department recommends a membership fee of \$39 per year and a usage fee of $p = \$3$ per delivery.

- a) If they offer "Amazon Ultra" at the suggested membership fee and usage fee, what will be the outcome?

No one will sign up

☐

Convenience-lovers will sign up

☐

Occasional shoppers will sign up

☐

Convenience-lovers and occasional shoppers will sign up

☐

b) If Amazon's cost per delivery worked out to \$6, will they make money off the convenience-lovers over the course of a year?

No, they will lose \$42 ☐

No, they will lose \$3 ☐

They will break even on them ☐

Yes, they will make \$3 ☐

Yes, they will make \$42 ☐

Equilibrium and Elasticity (Lecture 2)

3. 2014 Problem Set 1, Q3+Q4 (partial)

Chinatown buses. In the past ten years, low cost bus carriers have exploded as a transportation option for students, particularly in the Northeast. These buses pick up from less populated street locations, rather than central stations, and thus avoid expensive port fees. The weekly demand (in thousands of tickets) for low-cost bus travel between adjacent cities is

$$Q_D(p) = 30 - 0.5p,$$

and supply (in thousands of tickets) is:

$$Q_S(p) = 2p - 20,$$

where price is given in dollars.

- a) Calculate the equilibrium price and quantity, as well as the producer and consumer surplus.

Quantity _____

Price _____

Consumer surplus _____

Producer surplus _____

- b) By what percent does consumer surplus drop due to the construction?

Percentage drop _____

Thankfully, the construction ends and demand for buses returns to normal. The bus carriers have enjoyed great success, at the expense of pricier alternatives such as Amtrak.

Rail carriers are lobbying the government to restrict low-cost bus carriers, and now the government is proposing a \$2.50 tax on each intercity ticket for a bus not departing from a bus station (the tax would be paid by the bus companies for each ticket sold). The government would use the tax proceeds as a subsidy for the rail companies.

- c) What are the elasticities of demand and supply at the equilibrium you calculated in 3a?

Elasticity of demand _____

Elasticity of supply _____

- d) Which side of this market would bear most of the tax burden – consumers, or bus companies?
Why?

☐ Consumers

☐ Bus Companies

4. 2016 Final, Q3 (partial)

Pandora allows members to stream music over the internet. To support the “free” version of their service, Pandora sells advertising that then appears periodically in-between songs. Users, unsurprisingly, do not like listening to ads.

Pandora currently displays, on average, one advertisement per ten songs and streams about 30 billion songs per month to these customers. In the process of evaluating the attractiveness of alternatives to the current advertising approach, their data science team ran an experiment and found that if they raised the frequency of advertisements to one advertisement for every eight songs, users would stream only 21 billion songs per month.

- a) What is the “elasticity” of demand for streaming music through Pandora with respect to the number of advertisements? Note: compute the elasticity using the percentage changes relative to the baseline with one advertisement per ten songs.

Elasticity = _____

Pandora, of course, makes money from the display of advertisements. They currently receive \$0.025 per advertisement they show and have to pay, on average, \$0.0014 per song streamed to the artist that created the content.

- b) Assuming content costs are the only meaningful cost, what percent of Pandora’s ad revenue per 1,000 songs is profit?

% of revenue that is Profit = _____

3) Government Interventions: Taxes and other Regulations

5. 2014 Problem Set 1, Q3

Cigar tax. The weekly supply, Q_s , and demand, Q_d , of cigars in Philadelphia are given by

$$Q_s(p) = p$$

and

$$Q_d(p) = 102 - 2p$$

where prices are in dollars and quantities are in hundreds of thousands of cigars.

- a) How many cigars are consumed in equilibrium and at what price?

Quantity _____

Price _____

- b) What are the consumer surplus and producer surplus?

Consumer surplus _____

Producer surplus _____

In March, Pennsylvania Governor Tom Wolf proposed a 40% tax on cigars for the 2015 state budget. Although the proposal was soundly defeated, a cigar tax is still in consideration. Assume that a compromise is reached and a 20% tax will be levied on retail cigar sales.

- c) After the introduction of the tax, how many cigars are consumed in equilibrium and what price do consumers pay? What price do producers receive?

Quantity _____

Price paid by consumers _____

Price paid by producers _____

- d) Using the changes in equilibrium prices and quantities compared to (a), compute the price elasticity of demand and supply.

Elasticity of demand _____

Elasticity of supply _____

- e) What is the economic incidence of the tax hike on cigar consumers?

Fraction _____

- f) With the tax, what are the consumer surplus, the producer surplus, and the tax revenue collected by the government?

Consumer surplus _____

Producer surplus _____

Tax revenue _____

- g) Calculate the deadweight loss (DWL) induced by the tax. Briefly explain why the DWL can be interpreted as “inefficiency”.

DWL _____

Reasoning:

6. 2014 Exam, Q4

High-fructose corn syrup. High-fructose corn syrup (HFCS) is the industrial sweetener of choice in the US. As the technology for producing HFCS is well known, the market is perfectly competitive. Let the supply for the American HFCS market be given by

$$P_S(q) = 225.5 + 0.0001q,$$

and the demand by

$$P_D(q) = 1,130 - 0.02q.$$

where quantity is in thousands of pounds, and price is in dollars.

- a) What is the market equilibrium price and quantity of HFCS?

Price _____

Quantity _____

HFCS has been linked to obesity and rising health care costs. This negative externality has led the government to consider taxing it.

- b) Suppose a per-unit tax of \$19.50 per thousand pounds were imposed on the production – what would the new market equilibrium be, and what fraction of the tax revenue would be “paid” by consumers? Which side of the market is more inelastic? You may round the equilibrium quantity value to the nearest hundred.

Price _____

Quantity _____

Share of tax revenue coming from consumer surplus _____

Check one of these two boxes:

Demand is more inelastic

☐

Supply is more inelastic

☐

- c) The government received a report from the FDA stating that a 3% reduction in the consumption of HFCS (relative to the equilibrium in (a) above) would yield great benefits to society. What is the per-unit tax (per thousand pounds of HFCS) that would achieve that exact reduction in consumption?

Tax per thousand pounds which reduced consumption by 3%: \$ _____

4) Externalities

7. 2017 Problem Set 1, Q3 (partial)

Wine. Imagine the demand for wine in Pennsylvania (in millions of bottles per year) is given by:

$$P_D(q) = 28 - \frac{1}{4}q$$

And supply is given by:

$$P_S(q) = \frac{1}{3}q$$

- a) Find the equilibrium price and quantity with no taxes.

Price _____

Quantity _____

In order to fund rebuilding of the city of Johnstown after a large flood in 1936, liquor in Pennsylvania became subject to an 18% tax by the state. Although the city was rebuilt by the mid 1940's the tax has continued to this day. For simplicity, assume this same tax is applied to all wine and no other taxes are included on wine.

- b) With this tax, what is the equilibrium price to consumers, price earned by producers, and quantity transacted? Be careful to note that this is a percentage tax, not a per unit tax.

Price for Producers _____

Price for Consumers _____

Quantity _____

- c) How much more do consumers pay due to the tax? What percentage increase is this in the price they pay?

Change in Price _____

Percentage increase _____

- d) The PA Department of Revenue states on its website: "The tax is borne by the consumer, but manufacturers, distributors and importers remit the tax to the commonwealth." Is this statement:

True. The consumer bears/pays the full cost of the tax.
The retailer simply passes the payment on to the state.

☐

False. While the tax is included in the price the consumer pays,
the incidence is shared by both the consumer and the producer.

☐

- e) Imagine that the externality from alcohol is proportional to the amount of alcohol consumed, regardless of its quality. Would the optimal Pigouvian tax (expressed as a percentage of price) be higher for a 750 ml bottle of 90 proof Old Crow (retail price \$9.99) or a 750 ml bottle of 90 proof Old Forrester (retail price \$39.99)? Give 1-2 sentences of reasoning.

Higher for Old Crow as a percentage of price

☐

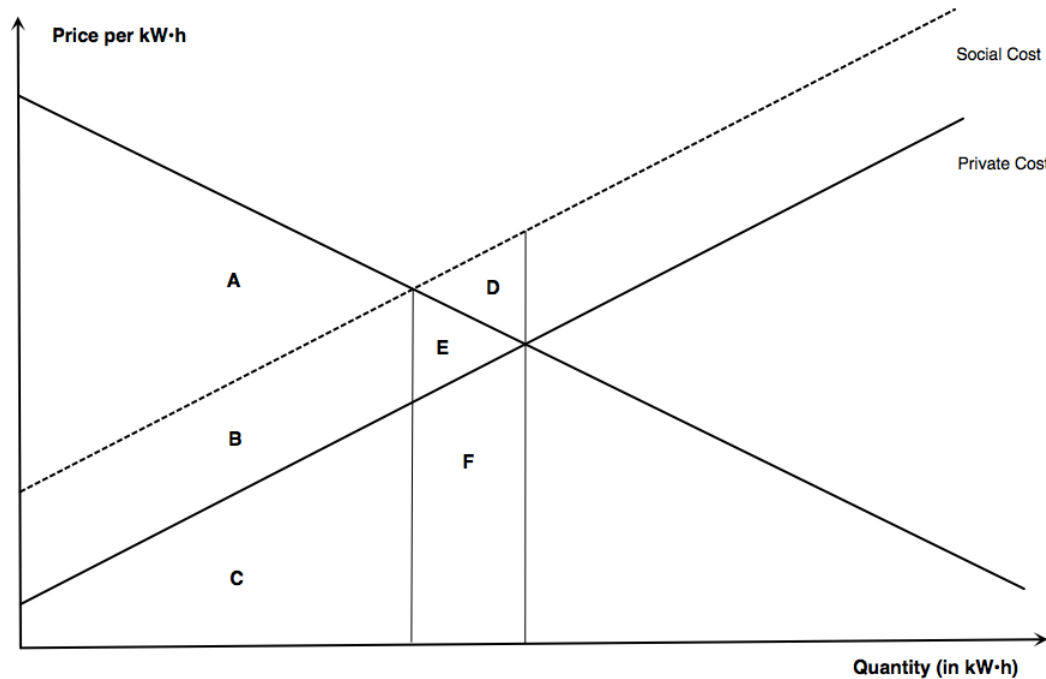
Higher for Old Forrester as a percentage of price

☐

Reasoning:

8. 2015 Final, Short Answer Question

Electricity. A recent government study finds that the production of electricity causes a negative externality of \$0.10 per kilowatt hour (increased levels of acid rain reduce public health and destroy local crops). This is depicted in the graph below.



- a) In general, if a good imposes a negative externality on society, _____ will be produced in the absence of intervention. If a good imposes a positive externality on society, _____ will be produced in the absence of intervention.

Too much; too much ☐

Too much; too little ☐

Too little; too much ☐

Too little; too little ☐

- b) Write the social welfare (or surplus) generated by this market with no intervention in terms of the labeled regions on the graph above (For example, A+B):

Social Welfare _____

- c) What would be the optimal tax per kilowatt hour for the government to levy?

Tax _____

- d) Write the social welfare (or surplus) generated by this market if the optimal tax were levied in terms of the labeled regions.

Social Welfare _____

5) Production and Supply Curves

9. 2017 Final, Q6

Mobile Apps. LeewayHertz is a software developer hired by major brands. Over the past decade they have built hundreds of mobile apps and have figured out the relationship between the number of engineers they have on staff and the quantity of apps those engineers can build each year. In particular, their production function is:

$$q = f(S, J) = S^{\frac{1}{4}} \cdot J^{\frac{3}{4}}$$

where S is the number of senior engineer full-time equivalents (i.e., S need not be a whole number), J is the number of junior engineer full-time equivalents (i.e., J need not be a whole number), and q is the number of apps produced each year, where any fractional part represents an app that is only partially completed (i.e., q need not be a whole number).

- a) Compute the marginal productivity of senior engineers (S) and junior engineers (J) in terms of S and J .

$$MP_S(S, J) = \underline{\hspace{4cm}}$$

$$MP_J(S, J) = \underline{\hspace{4cm}}$$

- b) Compute the marginal productivity of investment for senior engineers (S) and junior engineers (J) in terms of S , J , p , and w .

$$MPI_S(S, J) = \underline{\hspace{4cm}}$$

$$MPI_J(S, J) = \underline{\hspace{4cm}}$$

- c) How many junior engineers should LeewayHertz hire for each senior engineer they hire in order to minimize the cost of producing q apps. Your answer should be in terms of p and w .

For every senior engineer, LeewayHertz should hire junior engineers.

In 2017, the cost for Junior engineers was $w = \$150,000$ and for senior engineers was $p = \$800,000$.

- d) Assuming LeewayHertz was engaged in cost-minimizing production and hired 3 senior engineers in 2017, how many junior engineers J did they hire, what were their total engineering costs, C , and how many apps, q , did they produce?

$J =$ _____

C (in dollars) = _____

$q =$ _____

- e) Say LeewayHertz wanted to produce twice as many apps as were produced in Part (d). What would be the cost minimizing number of senior engineers (S) and junior engineers (J) to have?

$S =$ _____

$J =$ _____

In 2018, due to competition from other app developers, the cost for junior engineers will double to \$300,000 and the cost of senior engineers will go up 50% to \$1,200,000.

- f) Assume LeewayHertz ultimately chose to build the number of apps from Part (d) in 2017. If they want to build the same number of apps in 2018 at minimum cost, how must their staffing adjust relative to part (d)? (Note: No work needs to be shown.)

Hire fewer junior engineers and hire fewer senior engineers ☐

Hire fewer junior engineers and hire more senior engineers ☐

Hire more junior engineers and hire fewer senior engineers ☐

Hire more junior engineers and hire more senior engineers ☐

10. 2013 Final, Q5

Aluminum Smelting. Aluminum is produced by adding large amounts of electricity to aluminum oxide. Combining e thousand kilowatt-hours of electricity and o metric tons of oxide creates

$$q = f(e, o) = 20 \times (4 \times e \times o)^{1/4}$$

metric tons of aluminum metal.

- a) The price of oxide is currently \$240 per metric ton, and the price of electricity is \$60 per thousand kilowatt-hours. In a cost-minimizing production plan, how many thousand kilowatt-hours of electricity should be used for every metric ton of oxide?

Thousand kilowatt-hours _____

- b) Suppose the manager of a smelting plant wants to produce 1,000 tons of aluminum. How many thousand kilowatt-hours of electricity and how many tons of oxide should be used?

Thousand kilowatt-hours _____

Tons of oxide: _____

A smelting plant producing q metric tons of aluminum has a daily variable cost of

$$VC(q) = 0.3 \times q^2$$

Throughout, let p denote the price per metric ton of aluminum.

- c) What is the plant's short-run supply curve, $Q_{plant}^S(p)$?

Supply Curve: _____

Assuming that there are 60 such plants (all with identical cost structure) in the world, what is the global supply of aluminum, $Q_{global}^S(p)$?

Global supply of aluminum: _____

Daily demand for aluminum in the global market is given by:

$$Q_{global}^D(p) = 1,000,000 - 500p$$

- d) What is the equilibrium price and daily quantity of aluminum sold?

Equilibrium Price _____

Quantity _____

6) Producing in Perfectly Competitive Industries

11. 2015 Problem Set 2, Q1

Golf carts. Golf carts were initially an innovative product produced by few manufacturers (Sears Roebuck among them), but as they gained popularity, many firms making other small vehicles (everything from motorcycles to riding mowers) realized they could join in the market. Each individual firm is itself insignificant to global supply, and their golf cart production can be considered nearly identical. Golf cart production involves a few principal costs: rent for factory space, equipment, materials, and worker time. This is the annual total cost function for an individual firm in dollars:

$$TC(q) = 14400 + 144q^2$$

where q is the quantity of golf carts in millions. You are going to analyze the market for golf carts and the behavior of individual firms.

- a) First, solve for a firm's marginal cost and average cost functions.

$MC(q)$: _____

$AC(q)$: _____

- b) In the short run, the current prevailing wholesale market price is \$3456 per golf cart. How many golf carts will each firm produce, and how much will they earn in profits?

Output: _____

Profits: _____

- c) There are no barriers to entry for firms in this golf cart market, and so we would expect entry if firms are profitable. After entry, how much will each firm produce? What will be the long-run wholesale price for a golf cart? What will each firm earn in profits?

Output: _____

Long-run price: _____

Profits: _____

One of these small manufacturers, Zip Golf Ltd., discovers an innovation that allows them to make golf carts cheaper. Zip Golf Ltd.'s new cost function is:

$$TC(q) = 14400 + 100q^2$$

- d) The wholesale price remains at the level found in (c). How much will Zip Golf Ltd. produce, and what is its profit?

Output: _____

Profits: _____

The following year, all other firms adopt this technology, and the resulting long-run equilibrium price for golf carts falls to \$2400. Unfortunately, Slow Carts Co. has been unable to convince their workers to adopt the innovation, and so still has the old cost function. To make matters worse, they were locked into a lease on their factory space and equipment, and so have to keep paying their fixed costs until the end of this year no matter what.

- e) How many golf carts will Slow Carts decide to produce this year, if any? How many would you expect them to produce next year (after their long-term lease expires) if they still don't adopt the new cost-cutting manufacturing trick?

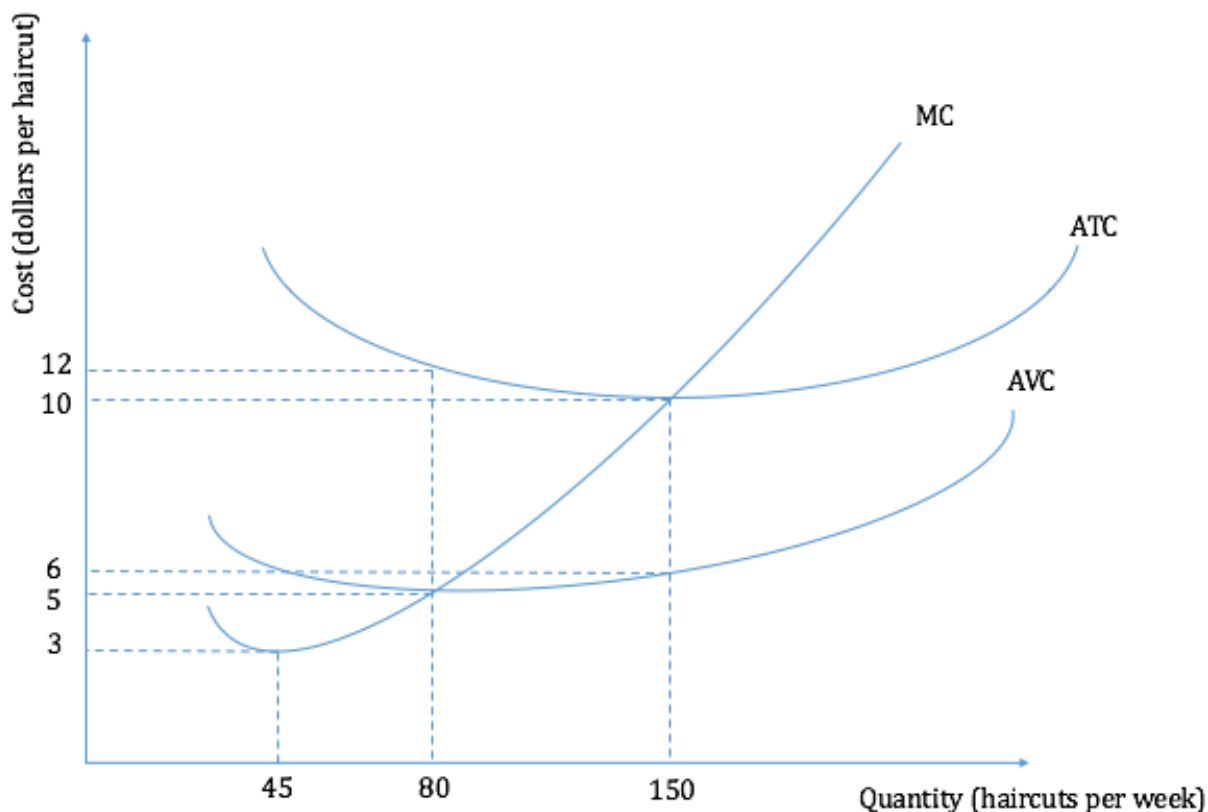
Output this year: _____

Output next year will be:

- | | |
|--|--------------------------|
| Greater than this year | <input type="checkbox"/> |
| Same as this year | <input type="checkbox"/> |
| Less than this year, but greater than zero | <input type="checkbox"/> |
| Zero (the firm will exit). | <input type="checkbox"/> |

12. 2016 Final, Short question a)

Hair Cuts. Amazing Clips provides budget hair cuts in Center City. Their costs (in dollars per haircut) can be summarized by the graphs below. Assume that the market for budget hair cuts in Center City is perfectly competitive (therefore anyone can enter).



- a) What is the lowest price above which Amazing Clips cleaners makes a profit in the long run?

Price _____

- b) Between which two prices per haircut would Amazing Clips continue to produce in the short run, but shut down in the long run (before the next fixed costs are due)?

Prices: _____ and _____

- c) Below which price per haircut would Amazing Clips shut down even in the short run?

Price _____

- d) Assume that the price is currently exactly high enough to stay open in the long run, but not higher. What quantity does Amazing Clips produce?

Quantity _____

7) Producing with Market Power: Monopoly

13. 2014 Final, Q5

Copay Coupons. Pharmaceutical companies are clever about maximizing the profits from their drugs, even after patents have expired. Consider Lipitor, a blockbuster cholesterol drug whose patent expired at the end of 2011. Pfizer, the company behind Lipitor then faced a market where they had generic competitors (same product, sold under a different name).

There are two types of consumers in the market for this drug: well-insured, and poorly-insured. The well-insured are not very price-sensitive, and prefer the branded Lipitor over the generic. The poorly-insured face a larger price difference due to their insurance contracts, and so are more likely to switch to a generic or other rival depending on the price. There are currently 4 poorly-insured individuals in the market for every 1 well-insured individual.

The monthly demand curve per million well-insured consumers is

$$P_W(Q) = 210 - 0.5Q$$

While for a million poorly-insured consumer it is

$$P_P(Q) = 110 - 2Q$$

Price is in dollars for a monthly supply, and quantity is in thousands of monthly supplies of the drug. Pfizer's marginal cost is a constant \$20 per monthly supply for all types.

- a) How would Pfizer like to price Lipitor to each group if they could select a price for each type of consumer?

Price for well-insured: \$ _____

Price for poorly-insured: \$ _____

- b) For contractual reasons, Pfizer cannot actually charge different prices to these different types of consumer (an insurer negotiates a price for all of its covered consumers). What is aggregate demand for a set of 5 million consumers? What is the optimal price if Pfizer must set a single price to the entire market?

$$Q_{agg}(p) = \begin{cases} \text{_____} & \text{if } p \geq \text{_____,} \\ \text{_____} & \text{if } p < \text{_____,} \end{cases}$$

Price for all: \$ _____

- c) To get around the contractual obligation to charge the same price to the insurer for all consumers, Pfizer came up with the idea of “copay coupons”.

Since consumers only pay a fraction of the actual prices (the “copay”), with insurers paying the rest, a copay coupon makes Lipitor cheaper to the decision-maker (the patient) without changing the price charged to the insurer. Pfizer devised a system where consumers of the poorly-insured type could apply for a rebate on the copay, which effectively made many “poorly-insured” types act like “well-insured” types. They are so effective at targeting poorly-insured customers with coupons that they manage to reach almost all of them.

As a result, the effective market becomes only 1 poorly insured per 6 well-insured, instead of 4 poorly insured per well-insured, as before. This takes into account the cost of the coupons, so marginal cost is still \$20. What is the optimal price to set now? Who will buy Lipitor?

Price: \$ _____

Check the box for each group that will purchase Lipitor:

Well-insured ☐

Poorly-insured with copay coupons ☐

Poorly-insured without copay coupons ☐

14. 2015 Problem Set 2, Q2

Microsoft Office. Overwhelmingly, the office software suite used by Wharton students is Microsoft Office for Students. The company’s marketing group currently estimates aggregate annual demand for Microsoft Office suite by Wharton students is

$$P(q) = 100 - \frac{1}{2} \cdot q$$

where the quantity is number of software packages and the price is in dollars. Its cost function is

$$TC(q) = 10q$$

- a) Solve for Microsoft’s revenue function, marginal revenue function, optimal price to charge in this market, and monthly profits.

$R(q) =$ _____

$MR(q) =$ _____

$P =$ _____

Profits: _____

- b) Leslie, a Wharton MBA doing an internship at Microsoft, warns the company that students are increasingly converting to tablets that come with or do not allow Microsoft Office downloads. She devises an experiment where a random sample of incoming Wharton MBA students are given discount coupons for the Office software suite, and compared the uptake between that group and a control group. The results are below.

Group	Price	Uptake (purchase rate)
<i>Control</i>	As found in Part (a)	27%
<i>Discount</i>	\$5 off price found in Part (a)	30%

Based on this, and what Leslie remembers about the Inverse Elasticity Pricing Rule from MGEC 611, what can you say about the current price being offered to Wharton students?

It is the correct price to be charging Wharton students. ☐

It is not the correct price, and the discounted price is better. ☐

It is not the correct price, and the discounted price is worse. ☐

Reasoning:

8) Pricing in Vertical Markets

15. 2015 Exam, Q4

New Release. Paramount Studios has struck a deal with Netflix to allow the streaming service to show its new movie line-up through a “New Release” channel. “New Release” would be available as a premium subscription service, where Paramount would license the content to Netflix, and Netflix would resell it to customers at a price of p dollars per subscriber per month. Beyond payment to Paramount for the content, Netflix does not incur any additional distribution costs. Additionally, Paramount’s marginal cost for providing the movies to Netflix is zero, as in this case the movies are already made and streaming-ready.

The companies agree that the monthly market demand for the “New Release” channel is:

$$q^D(p) = 15 - \frac{1}{3}p$$

where q is in millions of subscribers.

Under one possible payment structure, Paramount would license its content to Netflix for a monthly charge, called a “carriage charge,” of c dollars per subscriber per month.

- a) In terms of the carriage charge c , what is Netflix’s profit maximizing number of subscribers and price for “New Release”?

Subscribers: _____

Price: _____

- b) What is Paramount’s optimal per-subscriber carriage charge? How much profit will Paramount make from “New Release” per month?

Carriage Charge: _____

Profit: _____

- c) Given the carriage charge set by Paramount in (b), what price will Netflix charge customers for “New Release”? How much profit does Netflix earn per month?

Price: _____

Profit: _____

Instead, Paramount decides that it would only be willing to sell content to “New Release” if Netflix pays a flat monthly fee, F (independent of the number of subscribers) *and* a per-subscriber carriage charge, c .

- d) How should Paramount set c to maximize joint profit, and what will be the total profit between both companies?

Optimal carriage charge c : _____

Profit: _____

- e) What is the range of possible values of F , the fee paid by Netflix to Paramount, where both Netflix and Paramount would be willing to sign on to this new pricing scheme, and launch “New Release”?

Range: _____ $> F >$ _____

16. 2016 Problem Set 2, Q4

The Chaddsford Winery can currently produce up to 35,000 cases annually; due to its location in suburban Philadelphia, it cannot easily increase its capacity beyond 35,000 cases. It sells its wine to retailers in only two markets: Pennsylvania and New Jersey, and the marginal cost of producing a case of wine is \$200; the winery does not incur any additional marginal cost to distribute the wine to retailers. The demand in Pennsylvania is given by $Q_{PA} = 400(400 - p_{PA})$ and the demand in New Jersey is given by $Q_{NJ} = 200(300 - p_{NJ})$.

- a) Find the number of cases that Chaddsford should sell in each state and the price it will charge. Calculate the winery’s profits. Assume that cases sold in one market cannot be resold in the other market.

Cases in PA: _____

Cases in NJ: _____

Price in PA: \$ _____

Price in NJ: \$ _____

Profits: \$ _____

Regulations governing the sale of alcoholic beverages in both states mean that Chaddsford Winery -- instead of selling directly to retailers -- actually has to sell its wine first to a wholesale wine distributor (in the case of Pennsylvania, that is the Pennsylvania Liquor Control Board; in the case of New Jersey, a private company) and the distributor then sells the wine to retailers.

- b) If Chaddsford charges the distributors a price per case to be resold by them to retailers in each of the two states, what should that price be? How many cases will Chaddsford sell to the distributor in each state? What will be Chaddsford's profit? (Assume the distributors' marginal cost is zero and that again, cases sold to a distributor in one market cannot be resold by that distributor in the other market.)

Cases in PA: _____

Cases in NJ: _____

Price in PA: \$ _____

Price in NJ: \$ _____

Profits: \$ _____

- c) In the US, the three-tier distribution system that prohibits any form of vertical integration between producers, distributors, or retailers in the sale of alcoholic beverages continues to exist in many states. Based on the above, who benefits and who loses due to the producers' inability to circumvent distributors?

Producers: ☐ benefit ☐ lose ☐ are indifferent

Distributors: ☐ benefit ☐ lose ☐ are indifferent

Consumers: ☐ benefit ☐ lose ☐ are indifferent

- d) Instead of selling individual cases to each distributor, Chaddsford can make them a take-it-or-leave-it offer of X cases for a fixed fee F for all X cases. What will be the number of cases Chaddsford will offer to each distributor and how much will they charge each of them for their package? Calculate Chaddsford's profit. As before, resale is not possible and the distributor's marginal cost continues to be zero.

Cases in PA: _____

Cases in NJ: _____

Fee charged in PA (for all units): \$ _____

Fee charged in NJ (for all units): \$ _____

Profits: \$ _____





9) Simultaneous-move Games

17. 2016 Problem Set 2, Q4

Wharton Socializing. Your learning team, and another, are both headed out for dinner in Philadelphia tonight. Both learning teams are separately considering having dinner at Casta Diva or at Audrey Claire.

Going to either restaurant will net either team a value of 100. However, if they end up at the same restaurant, both teams would get a bonus of 20 value from having more Wharton friends around.

a) Fill out the payoff table below.

		Other Team	
		Casta Diva	Audrey Claire
Your Team	Casta Diva		
	Audrey Claire		

b) While it would be nice to coordinate, cell phone reception in Huntsman can be spotty, and so you have no way of communicating with the other team. Are there any strictly dominant strategies?

Yes

☐

No

☐

c) What are the one-shot Nash equilibria of this game, if any?

One-Shot Nash Equilibria: _____

- d) Would your answer to (c) change if Casta Diva actually had a higher base value than Audrey Claire (because cash-only is a pain at Audrey Claire)?





Yes

☐

No

☐

- e) It turns out that tastes differ, and while your team gets a base value of Casta Diva of 110, the other team gets a base value of Audrey Claire of 110 (before the bonus of 20 if you all end up at the same place. Fill in the updated game board below.

		Other Team	
		Casta Diva	Audrey Claire
Your Team	Casta Diva		
	Audrey Claire		

- f) Suppose you're now crossing the Walnut Street bridge, and so phones are working again. If you call up the other learning team, will you easily be able to agree on a location?

Yes

☐

No

☐

10) Sequential and (Finitely) Repeated Games

18. 2016 Problem Set 3, Q1

Entry Decisions. Uber, Didi and Lyft are three large ride-sharing services that are considering entering the ride-sharing market in the Philippines. They will decide one at a time, in the order Uber, then Didi, then Lyft whether to enter or not. If only one firm enters, expected revenues to that firm are \$50M; if two firms enter, expected revenues per firm are \$25M, and if all three enter, \$15M. All three firms face entry costs of \$20M.

- a) Draw a game tree and determine the equilibrium entry decisions.

Equilibrium decisions:

Uber: ☐ Enter ☐ Not enter

Didi: ☐ Enter ☐ Not enter

Lyft: ☐ Enter ☐ Not enter

- b) In an effort to compete with Uber's global dominance, Lyft and Didi enter into an agreement, whereby they will share entry costs by sharing a driver and customer network in this market only. Thus, if one enters a market, because the entry costs will already be paid, the other will too, at an entry cost of only \$10million each. Redraw the game tree under this new agreement and determine the new equilibrium decisions.

Equilibrium decisions:

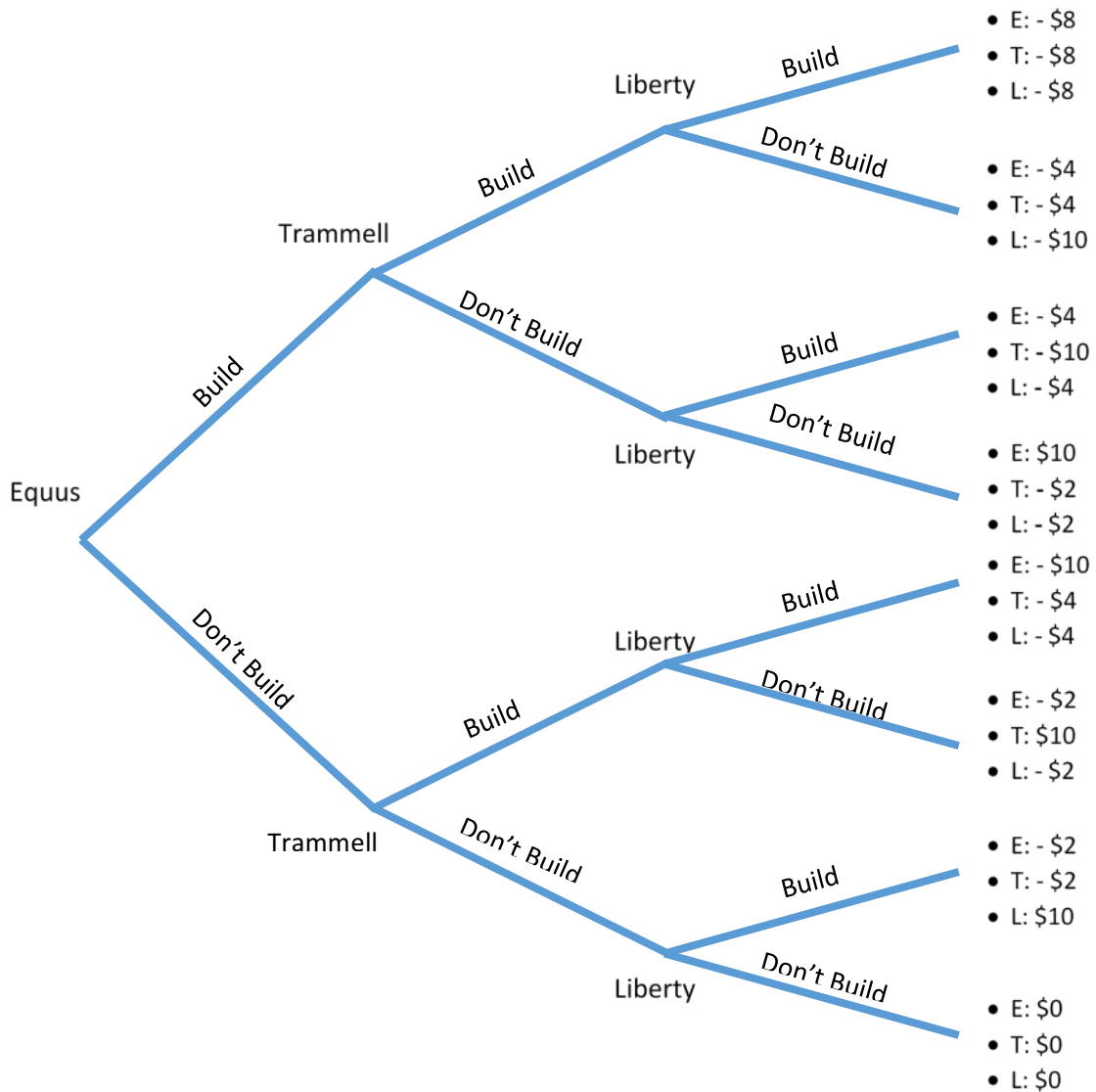
Uber: ☐ Enter ☐ Not enter

Didi: ☐ Enter ☐ Not enter

Lyft: ☐ Enter ☐ Not enter

19. 2017 final, Q2 (short)

Real Estate. The three largest Philly real estate development firms are each deciding whether to build a new office building in Center City. Equus Capital Partners (E), Trammell Crow (T), and Liberty Property Trust (L) will decide one at a time, in that order. Payoffs are in millions of dollars, depend on the firms' strategies, and are given by the following tree. Note that it is possible for firms to lose money, even if they don't build (because the new buildings affect rents for existing units that these firms own).



- a) Please indicate the action that will be taken by each firm (showing your work on the tree above):

Equus: ☐ Build ☐ Don't

Trammell: ☐ Build ☐ Don't

Liberty: ☐ Build ☐ Don't

The Philly government is considering creating (and publicly announcing) a tax credit of \$5M for Trammell if Equus decides not to build and Trammell decides to build. Note that this subsidy only changes payoffs; it does not change the order in which the firms move.

- b) What would the equilibrium be if this tax credit were available to Trammell? (Note: No work needs to be shown.)

Equus: ☐ Build ☐ Don't

Trammell: ☐ Build ☐ Don't

Liberty: ☐ Build ☐ Don't

11) Infinitely Repeated Games

20. 2017 Practice Problems

Grocery Stores. In a small town, two grocers play the following game every quarter, where the payoffs are in thousands of dollars. For parts (a) to (c) of this problem, you can ignore the e and f in the payoff grid below (i.e. until told otherwise, assume that $e = f = 0$).

		Smaller grocer	
		High prices	Low prices
Larger grocer	High prices	$10+f$ $100-f$	$20-e$ $80-e$
	Low prices	8 $200-f$	9 90

- a) Is there a dominant strategy for the Larger Grocer in the one-shot game (i.e. played just for one quarter)? For the smaller grocer? (Note: Show your work in the game board above.)

Dominant strategy for the Larger grocer (CIRCLE ONE): Yes No

Dominant strategy for the Smaller grocer (CIRCLE ONE): Yes No

- b) What are the strategies played at the Nash equilibrium of the one-shot game (i.e. played just for one quarter)?

The Larger grocer will set (CIRCLE ONE): High Prices Low prices

The Smaller grocer will set (CIRCLE ONE): High prices Low prices

- c) Assume that both grocers have the same quarterly discount rate. What is the highest such rate for which grim trigger strategies could sustain both firms setting high prices as a Nash equilibrium of the infinitely repeated game? (Note: assume ties are broken in favor of setting high prices.)

Highest Discount Rate: _____

In the past, both grocers have had discount rates of 5% per quarter. Unfortunately, the smaller grocer has run into cash flow issues, which has driven its discount rate up to 15% per quarter. The larger grocer's discount rate stays at 5% per quarter. To deal with this development, the Larger grocer is considering two options.

- d) The Larger grocer could (credibly) threaten to bring a frivolous lawsuit against the Smaller grocer (say for some sort of zoning violation) in the case that the Smaller grocer sets Low prices when the Larger grocer sets High prices.

Assume that the Larger grocer can choose the "intensity" of its legal action (which we denote by e), but that a lawsuit of intensity e costs both grocers the same amount, namely e , in every quarter. This lawsuit would go on indefinitely, so that the game-board would be permanently changed.

What is the lowest e that the Larger grocer could threaten that would restore collusion as an equilibrium of the infinitely-repeated game, implemented by grim trigger strategies? How much will the Larger grocer ultimately pay in legal fees in this collusive equilibrium? (Note: Assume $f = 0$.)

Smallest Intensity of legal action e : \$ _____

Legal costs paid by the Larger grocer in equilibrium: \$ _____

- e) Alternatively, the Larger grocer could commit to pay the Smaller grocer a reward f every time the Smaller grocer chooses to set High prices. As in Part (d), this reward would permanently change the game-board. If the reward is \$4,000, i.e. $f = 4$, what is the Nash equilibrium of the one-shot version of the altered game? (Note: Assume $e = 0$.)

The Larger grocer will set (CIRCLE ONE): High prices Low prices

The Smaller grocer will set (CIRCLE ONE): High prices Low prices

- f) Assume that the Larger grocer goes with the plan from Part (e). If it becomes common knowledge that both grocers will simultaneously retire in exactly 10 quarters (i.e. the game is only finitely repeated, not infinitely repeated), what equilibrium do we expect in each quarter?

The Larger grocer will set (CIRCLE ONE): High prices Low prices

The Smaller grocer will set (CIRCLE ONE): High prices Low prices

21. 2016 Final, Q2

Every summer in Pawnee, Indiana the city's legendary Harvest festival attracts thousands of attendees. Given this success, a new festival, Fall Fest, is being developed that would compete with the Harvest Festival.

Based on past experience, there are 7,000 people that would attend a festival in Pawnee each summer, and each person is only willing to attend a single festival per summer. To make giving change easy, festivals only charge one of two possible prices: \$20 or \$15 per attendee. Each fest can handle 6,000 people at capacity, and wants to maximize its own revenue.

As each festival must announce its price in the Sunday newspaper, they must simultaneously decide what entrance price to charge. If they charge the same price, then each festival will have a total 3,500 people that attend. If one festival charges a lower price, then 6,000 people will attend that festival with the lower price and the remaining 1,000 will go to the festival with the higher price.

- a) Draw the game board including payoffs for the simultaneous move game being described above.

		Harvest Fest	
Fall Fest			

- b) If the new festival operated for one weekend, what prices will each festival charge and how much revenue does each make?

Harvest Fest: Price _____ Revenue _____

Fall Fest: Price _____ Revenue _____

- c) Let's say the festivals plan to operate for three weeks in October. Knowing they will be competing for exactly three weekends (and assuming demand is the same for each of the three weekends as in the one-week case), what is the Nash equilibrium for the *first* weekend?

Harvest Fest: Price _____

Fall Fest: Price _____

Now, suppose due to the popularity, the festivals decide to operate every week year-round. Continue to assume demand is the same every week (people in Pawnee really love festivals!). Suppose the weekly discount rate is δ , so one dollar next week is worth $\frac{1}{1+\delta}$ today, and that the two festivals announce their prices simultaneously in the paper each week.

- d) What is the highest discount rate δ such that the two festivals can sustain an equilibrium of charging \$20 indefinitely, using a grim trigger strategy (that is: each festival chooses the high price, but switches to the low price forever if the other festival charged the low price in the previous period)?

$\delta \leq$ _____