Exam 2
Microeconomics for Public Policy I
Fall 2017
December 5, 2017

GWID/Birthdate: _____

Instructions

1. Write your name on page 12. Write your GWID or birthdate on all other pages.
2. Answer all questions.
3. The exam has 100 points. Points for each section and points for each question are indicated on the exam.
4. Write legibly. Illegible exams cannot be graded.
5. Do your best to fit all your answers on the front side of the exam. If you need to use the back of a page, indicate that clearly.
6. Label all figures as needed.
7. Make sure you **explain** your answers as needed. When appropriate, you should also explain any assumptions that you make to arrive at your answer. Explanations may yield partial credit.
8. Be concise.
9. The final page is intentionally left blank for extra work. If you do extra work on this page (or in any other non-standard location) that you would like to be counted, you must note it clearly near the question you are answering. Do not use extra paper.
10. You are allowed a dumb calculator and no other aids. Please leave everything else in your bag for the duration of the exam.

For marking purposes only

Part A _____

Part B _____

Part C _____

total _____

A. Ripped From the Headlines (12 points, 4 each part)

Read the article from the *Wall Street Journal* at the end of the exam. "ERCOT" is not defined in the article, but is the "Electricity Reliability Council of Texas," which manages the electricity supply to most of Texas.

1. Suppose that only marginal costs matter for production decisions. Given the marginal costs discussed in this article, which type of power generator will always be part of the market supply? And which type is only in the market supply when prices are high?

The cheapest form of power, in marginal cost terms, is wind at $45/megawatt hour. The most expensive is nuclear at $150/megawatt hour. Thus, we'd expect wind to always be in the market, and nuclear only when prices are very high.

Of course, this may not be true, because there is not always wind for power, and I think it is difficult verging on impossible to start and stop a nuclear plant.

2. Re-phrase Joe Dominguez's quote in terms of the language of externalities. Briefly discuss a policy solution that could address his concerns.

Joe Dominguez is saying that nuclear plants produce no emissions, but that coal and gas plants do. Thus, nuclear has no air pollution externalities, but coal and gas plants do.

We have multiple tools for dealing with externalities: Pigouvian taxes, tradeable permits and quotas.

3. What must be true about old gas plants if new lower prices also "put pressure on older [gas] facilities" (p.3) ?

It must be that older gas plants operate at higher costs than these new gas plants. Perhaps there has been some improvement in technology that has enhanced the ability of plants to extract energy from gas, or they have developed a technology that allows them to operate with fewer workers or less expensive capital.

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B. Short Answer Questions (5 points each, except for question 4 as noted. 42 points total)

1. Name a publicly provided good that is not a public good. Explain why the good is at least not entirely a public good.

- publicly provided good is a good provided by the government
- public goods are non-rival and non-excludable
- a good answer needs to name a good provided by the government and explain why it is not non-rival and not non-excludable

2. Give two examples of factors that could shift the demand curve for a particular market. Explain whether each factor shifts the curve inward or outward.

- number of consumers
- consumer income or wealth
- consumer tastes
- prices of other goods

3. Name a firm with market power and describe its source of market power.

Source of market power are

- "natural" monopolies
- switching costs
- product differentiation
- absolute cost advantages
- government barriers to entry

4 (7 points). Imagine an insurance firm that has 100,000 identical customers, each with a $\frac{1}{2}$ percent likelihood of an accident in each period. This firm has to pay out \$20,000 in case of an accident, and charges consumers \$10 each period. Are these premiums actuarially fair? And is the insurer profiting, about to go out of business, or breaking even? Explain your answer.

Premiums are actuarially fair if the amount paid to the insurance company (mb) equals the likelihood of receiving the benefit (pb). In this question, $pb = (0.005)(20,000) = 100$. The

total amount paid to the insurance company is \$10 = mb. In other words, $pb > mb$. On average, the insurance company is paying out more than it is taking in and is going to go out of business.

5. Define a negative externality and give an example, being careful about to whom this is an externality. Explain why your example fits the definition.

A negative externality is a cost exerted on someone who is not part of an economic transaction. For example, the purchase of new mini boom boxes with which people walk around poses a negative externality to me: I don't like listening to music on the street. The person making the music and the person buying the music (or the walker and the boom box company) are together having an economic transaction of which I am not a part.

6. Given an example of a moral hazard problem caused by insurance. Explain why it is a moral hazard problem.

- A moral hazard problem is when a person who is insured behaves in a more risky fashion when insured against the adverse outcome
- A good answer must relate this definition to your example.

7. Suppose that a perfectly competitive firm has a U-shaped marginal cost curve. Draw this curve and the associated average variable cost curve. Note on your picture for which values of Q the firm will produce.

See figure at end. This answer needs to include a U-shaped marginal cost curve that intersects the average cost curve at its minimum. The firm will produce where $P > AVC$. Because this is a perfectly competitive firm, $P = MC$, so that the firm will produce where $MC > AVC$.

8. Suppose that the market for honeybees perfectly is competitive and is in equilibrium with 500 producers. Now suppose that the price of producing honeybees falls (perhaps hives become cheaper). If the 500 honeybee producers do not increase production, what should happen to profits in the short and long run? In the long run, what happens to the number of firms in the market and the equilibrium price? Why?

I made a mistake in crafting this question. It would have been clearer had I written "cost of producing honeybees," rather than "price of producing honeybees." In response, I've graded leniently, giving substantial credit to coherently argued answers.

If, in a perfectly competitive market, costs decrease and are not passed along to consumers, firms will earn economic profits. However, in the long run, new firms will enter to bid down

the price to marginal cost. The number of firms in the market will increase, and the price will decrease to equal marginal cost, which is lower than the initial equilibrium price.

C. Medium Answer Questions
(46 points, 15 points per question, one additional point for question 2)

1 (15 points total; 3 points each part) Market Power

Suppose that a firm with market power has a constant marginal cost of 50. It faces a market demand of $Q = 300 - 3P$.

(a) What is the market equilibrium quantity? Draw a picture that shows this quantity.

A firm with market power sets $MR = MC$. For such a firm, marginal revenue is not eqal to price. Instead, find marginal revenue given the formula in the book: $MR = -\frac{2}{3}Q + 100$. Set $MR = MC$, and find

$$\begin{aligned} MR &= MC \\ -\frac{2}{3}Q + 100 &= 50 \\ \frac{2}{3}Q &= 50 \\ Q &= \frac{(50)(3)}{2} \\ Q &= 75 \end{aligned}$$

(b) What is the market equilibrium price? Add this to your picture from part (a).

Find the market equilibrium price by plugging in the market equilibrium quantity into the demand curve – not the marginal revenue curve! The firm could charge the price from the marginal revenue curve, but it can also charge even more – and that even more is the price it will charge.

So, at $Q = 75$, evaluate the demand curve:

$$\begin{aligned} Q &= 300 - 3(P) \\ 75 &= 300 - 3(P) \\ 3P = &= 225 \\ P &= 225/3 \\ P &= 75 \end{aligned}$$

(c) Define producer and consumer surplus, calculate their value in this case, and note their locations in your figure.

Consumer surplus is benefits that consumers receive for which they did not pay ("difference between the amount consumers would be willing to pay and the amount they actually have

to pay"); similarly, producer surplus is benefits that producers receive above their cost of production.

See figure at end for the location of consumer surplus.

To calculate, $CS = \frac{1}{2}(25)(75) = 937.5$.

And $PS = 25(75) = 1875$.

(d) Is there a deadweight loss? If so, why? And how large is it?

Yes, there is a deadweight loss: when there is a firm with market power there are trades that would have taken place in a competitive market that fail to take place. This DWL is a triangle above the marginal cost curve. Its width is the trades that fail to take place. Its height is the difference between the competitive equilibrium price and the equilibrium price with market power.

Begin by finding the equilibrium quantity that would have occured in a perfectly competitive market, or set MC equal to the demand curve. We know that $MC = 50$, so evaluate the demand curve at a price of 50: $50 = -\frac{1}{3}Q + 100$, or $Q = 150$.

Given this, we can calculate DWL as $= \frac{1}{2}(25)(75) = 937.5$.

(e) Are consumers harmed by the presence of market power? Explain using the example of this problem.

Consumers are harmed because the market equilibrium price is "too high" relative to the competitive one, and the equilibrium quantity is "too small" relative to the market equilibrium one. In a competitive market, consumers receive the entire surplus above the MC curve. When the firm(s) has market power, consumer surplus is eaten up, partially by producer surplus and partially by deadweight loss.

2 (16 points, 3 each, except (d) which is 4) Production

Suppose that a carmel wafer firm's long-run total cost curve is $TC = 10Q^2 + 6Q + 60$, and that the firm's marginal cost curve is $MC = 20Q + 6$.

(a) Define fixed cost, and find fixed cost for this firm.

Fixed costs are the costs a firm has to pay whether it operates or not. Look at the total cost curve: the firm has to pay \$60 regardless of whether it operates. This is the fixed cost.

(b) Define and find average variable cost.

Average variable cost is the average non-fixed cost of the firm. Remember that total costs are the sum of fixed and variable costs ($TC = VC + FC$).

Note that average cost is equal to total cost divided by Q:

$$\begin{aligned} AVC &= \frac{VC}{Q} \\ &= \frac{TC - FC}{Q} \\ &= \frac{10Q^2 + 6Q}{Q} \\ &= 10Q + 6 \end{aligned}$$

(c) Suppose that this is a perfectly competitive firm, and the market price is \$106. How much does the firm produce?

The perfectly competitive firm produces where $MR = MC$. For the perfectly competitive firm, $MR = P$. In this case, $P = 106$, and $MC = 20Q + 6$. Therefore,

$$\begin{aligned} MR &= MC \\ P &= MC \\ 106 &= 20Q + 6 \\ 100 &= 20Q \\ Q &= 5 \end{aligned}$$

(d) Given that the firm knows how much it is going to produce (see part (c)), it needs to decide how much capital and how much labor to use. Suppose that the production function is $Q = \frac{1}{2}KL$, that the marginal product of capital is $MP_K = \frac{1}{2}L$, and the marginal product of labor is $MP_L = \frac{1}{2}K$. The firm faces a wage rate of 12.50 and a capital rental rate of 5. What is the firm's optimal choice for the quantity of labor? And the quantity of capital?

The firm's production function is $Q = \frac{1}{2}KL$, and we know that $Q = 5$. We can therefore write this function as $5 = \frac{1}{2}KL$.

If the firm is minimizing costs (which it must be if it is maximizing profits), then

$$\begin{aligned} \frac{MP_K}{R} &= \frac{MP_L}{W} \\ \frac{0.5L}{5} &= \frac{0.5K}{12.5} \\ 12.5L &= 5K \\ L &= \frac{5K}{12.5} \end{aligned}$$

Putting these two equations together, we can solve for K and L.

$$\begin{aligned} 5 &= 0.5(K)L \\ 5 &= 0.5(K)\frac{5K}{12.5} \\ 62.5 &= 0.55K^2 \\ 125 &= 5K^2 \\ 25 &= K^2 \\ K &= 5 \end{aligned}$$

Given K, we can find L: $L = \frac{5K}{12.5} = \frac{5(5)}{12.5} = 2$.

(e) Suppose that the firm decides to use another unit of capital. What can you say about the marginal product of this additional unit relative to marginal product of the previous unit? Why?

The marginal product of this additional unit is lower than the marginal product of the previous unit. We assume that there is declining marginal product because when all other factors of production are held equal, an additional unit of capital is not as productivity-enhancing as the previous.

3 (15 points). Public Goods

Suppose that Cathy and Dina both enjoy falafel. Cathy's demand for falafel is $Q_C = 100 - \frac{1}{5}P$, while Dina's demand is $Q_D = 400 - 2P$.

(a) Draw Cathy's and Dina's demand curves, labeling intersection points for all curves.

See figure at end.

(b) What is the market demand for falafel? Write an equation and draw a picture showing this demand, labeling all intercepts.

We calculate the market demand for falafel by adding quantity demanded when both Cathy and Dina demand falafel, and by using just Cathy's curve when she is willing to pay and Dina is not. We can therefore write

$$Q_M = \begin{cases} 500 - 2.2P, & \text{if } 0 < P \leq 200 \\ 100 - \frac{1}{5}P, & \text{if } 200 \leq P \leq 500 \end{cases}$$

The two cases can also be written as

$$P_M = \begin{cases} 500/2.2 - Q/2.2, & \text{if } 0 < Q \leq 60 \\ 500 - 5Q, & \text{if } 60 \leq Q \leq 500 \end{cases}$$

(c) If the marginal cost of falafel production is \$16 per ball (these are very very delicious falafel), how many falafel balls will Cathy and Dina consume in total?

See figure at end. You should note that at a price of \$16, both Dina and Cathy are demanding falafel. Therefore, we find demand at a price of \$16:

$$\begin{aligned} Q &= 500 - 2.2P \\ Q &= 500 - 2.2(16) \\ Q &= 464.8 \end{aligned}$$

(d) Now suppose instead that Cathy and Dina's demand curves are for smoke-free air. What is the market demand for smoke-free air? Write an equation and draw a picture showing this demand, labeling all intercepts.

See picture at end.

Note that smoke-free air is a public good.

Here both Cathy and Dina and interested in quantities of public goods between 0 and 100;

only Dina would like more than 100 units of the smoke-free air (maybe she has asthma, and Cathy does not).

We can therefore write

$$P_T = \begin{cases} 700 - 5.5Q, & \text{if } 0 < Q \leq 100 \\ 200 - \frac{1}{2}Q, & \text{if } 100 \leq Q \leq 400 \end{cases}$$

It is equivalent to write

$$Q_T = \begin{cases} 700/5.5 - P/5.5Q, & \text{if } 0 < P \leq 150 \\ 400 - 2P, & \text{if } 150 \leq P \leq 400 \end{cases}$$

(e) If Dina paid \$100 for 200 units of smoke-free air, would Cathy contribute any additional funds? Why or why not?

First of all, Cathy doesn't want 200 units of smoke-free air. She only wants, maximum, 100 units. Or, another way to think about this, at a price of \$100, Cathy would like 80 units of smoke-free air. If Dina is already buying 200 units, she doesn't need to do anything to get her optimal choice. Therefore, she would not pay anything.

https://www.wsj.com/articles/electricity-prices-plummet-as-gas-wind-gain-traction-and-demand-stalls-1512043200

MARKETS

Electricity Prices Plummet as Gas, Wind Gain Traction and Demand Stalls

Texas is a microcosm of pressures facing power generators; 'It's too late' for coal

The cost of generating power from wind turbines is falling. **PHOTO:** DORAL CHENOWETH III/ASSOCIATED PRESS

By Erin Ailworth and Russell Gold
Updated Nov. 30, 2017 10:30 a.m. ET

The rapid rise of wind and natural gas as sources of electricity is roiling U.S. power markets, forcing more companies to close older generating plants.

Wholesale electricity prices are falling near historic lows in parts of the country with competitive power markets, as demand for electricity remains stagnant while newer, less-expensive generating facilities continue to come online.

The changing American electricity landscape is pressuring power companies to shed unprofitable plants and reshape their portfolios to favor the new winners. Texas provides a clear example.

Citing low gas prices and the proliferation of renewables such as wind and solar, Vistra Energy Corp. VST **-0.67%** ▼ , a vestige of the former Energy Future Holdings Corp., said it would retire three coal-fired facilities in Texas by early next year and that it plans to merge with independent power producer Dynegy Inc.

Exelon Corp. EXC **-0.85%** ▼ , the country's largest owner of nuclear power plants, placed its Texas subsidiary under bankruptcy protection earlier this month, saying that "historically low power prices within Texas have created challenging market conditions for all power generators."

The average wholesale power price was less than $25 per megawatt hour last year on the grid that coordinates electricity distribution across most of Texas, according to the operator, the Electric Reliability Council of Texas. A decade ago, it was $55.

Prices have fallen a similar amount on the PJM Interconnection LLC, the power grid that serves some or all of 13 states, including Pennsylvania and Ohio. A megawatt hour there traded for $29.23 last year, the lowest level since 1999, as far back as the grid's independent market monitor tracks prices.

The price drop at PJM reflects the construction of dozens of new gas-burning power plants, spurred by the abundance of the fuel due to the shale drilling boom. In 2006, 8% of the electricity in PJM was generated by natural gas. In 2016, it was 27%.

Weak demand for electricity also has played a role, as Americans purchase more energy-efficient appliances and companies shave power consumption to cut costs. Last year, power demand in PJM grew 0.3% after falling the two previous years.

In competitive regions in places like California, wholesale electricity is sold through daily auctions that favor the least-expensive sources of power. **PHOTO:** GETTY IMAGES

The resulting competition—by more power plants to buyers of roughly the same number of megawatts—has most-acutely impacted older coal and nuclear plants, which are struggling to provide competitively priced power. It has even begun to affect older natural-gas-fired facilities that have higher costs.

“Generators are just fighting for existing market share,” said Ari Peskoe, a senior fellow in electricity law at Harvard Law School. “The aging fleet of coal and nuke generators, combined with low prices, makes this intense.”

FirstEnergy Corp. , an Akron, Ohio-based utility, announced late last year it was exiting competitive power markets. It is selling four natural-gas plants and hopes to sell coal and nuclear plants that provide power in the PJM wholesale marketplace.

This summer, power company NRG Energy Inc. announced a transformation plan that included selling up to $4 billion in power generation.

West of the Mississippi River, power markets also have been upended by the rapid growth of wind, as the cost of generating power from wind turbines is falling.

In 2016, all of the new generation built in the Southwest Power Pool, a grid that covers an area from Louisiana to Montana, was wind, gas and solar. The vast majority of the retirements were coal and nuclear plants.

Wind is the fastest-growing source of power on Texas’ grid. Last year, wind generated 15% of the electricity in ERCOT, more than nuclear power, which accounted for 12%. By 2019, researchers at the University of Texas at Austin’s Energy Institute expect wind to surpass coal as ERCOT’s second-largest source of electricity.

“Solar and wind are now competitive with natural gas-fired generation,” said Curt Morgan, Vistra’s chief executive. Mr. Morgan said that while he thinks natural gas will be the “workhorse” of U.S. electricity markets for at least the next decade, in Texas “I think it’s going to be a while before you see another gas plant built in ERCOT.”

Last week, Siemens AG said it was cutting 6,900 jobs, in large part because it has overestimated demand for its giant power turbines.

The changes have primarily been felt in competitive power markets, which exist in many parts of the U.S., including California in addition to Texas and the Midwest. In those areas, wholesale electricity is sold through daily auctions that favor the least-expensive sources of power, and it is subsequently purchased by utilities and others.

By contrast, some regions of the U.S. don't have competitive power markets, and instead have power generated entirely by utilities, which is sold to customers at rates regulated by state officials. Even in regulated markets, changes are afoot. Earlier this week, WEC Energy Group Inc. said it was closing its Pleasant Prairie coal plant in Wisconsin, citing a desire to add more gas and solar generation.

As companies face price pressures, some have sought aid from the government. Exelon has been pushing states to create new subsidies for them.

"Unless we value the zero emission attributes of nuclear, that is going to force the premature retirement of nuclear plants," said Joe Dominguez, an executive vice president at Exelon.

The Trump administration is aiming to provide a lifeline to the ailing coal and nuclear industries through several proposals, including a plan floated by Energy Secretary Rick Perry to assist power plants that provide constant, baseload power to ensure ample energy security.

But that proposal, which has to be approved by the Federal Energy Regulatory Commission, has been assailed by critics as both anticompetitive and unlikely to reverse market trends.

An analysis by investment bank Lazard shows that on an unsubsidized basis and over the lifetime of a facility in North America, it costs about $60 to generate a megawatt hour of electricity using a combined-cycle natural-gas plant, compared with $102 burning coal and nearly $150 using nuclear. By that criteria, Lazard estimates electricity from utility-scale solar and wind facilities is now even cheaper than gas.

A megawatt hour of electricity from utility-scale crystalline solar comes in at $49.50 and wind at $45. That metric carries an important caveat, however: It doesn't factor in that wind and solar are more intermittent producers of power than conventional generation sources, since the sun doesn't always shine and the wind doesn't always blow.

"It's too late," David Schlissel, a director at the Institute for Energy Economics and Financial Analysis, said of the Trump administration's proposals. "The lesson is if you don't put your thumb on the scale then gas and renewables will out-compete coal."

Chris Moser, senior vice president of operations at NRG, said the challenge in many parts of the U.S. now is to ensure a diverse mix of power resources so that if one encounters issues, others can fill in.

In PJM, Mr. Moser said cost pressures prompted NRG to retrofit some units to run on gas instead of coal. Meanwhile, it retired a 44-year-old natural-gas plant in Houston known as Greens Bayou Unit 5 earlier this year, as the low cost of gas continues to put pressure on older facilities, even those burning gas. The company also has units slated to retire in California.

"If the market isn't paying us to keep the generation around we want to take it out," he said, adding, "Yes, you could go all wind, but then you have no answers when it's 109 in Dallas and there's no wind."

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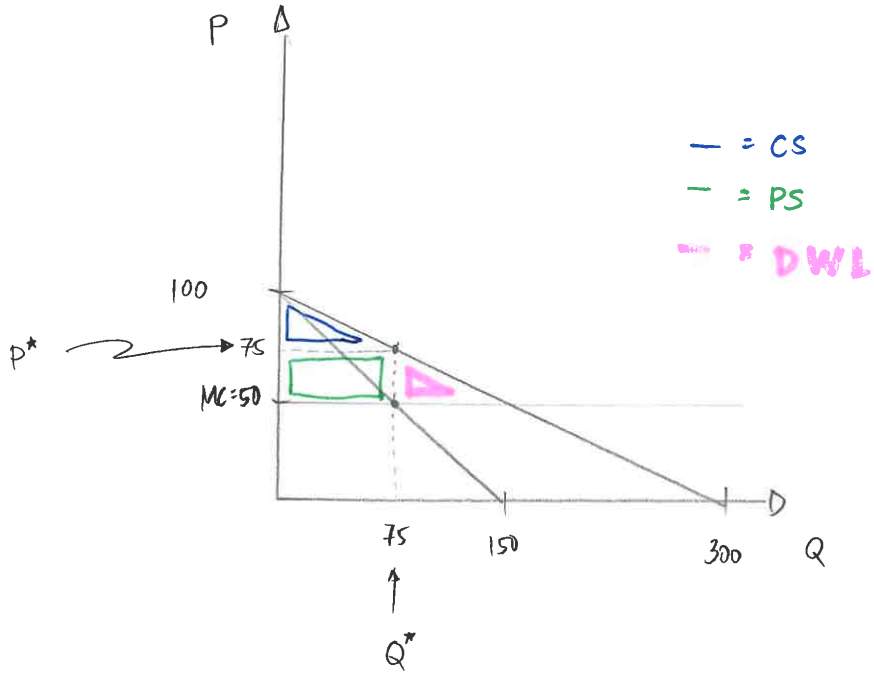
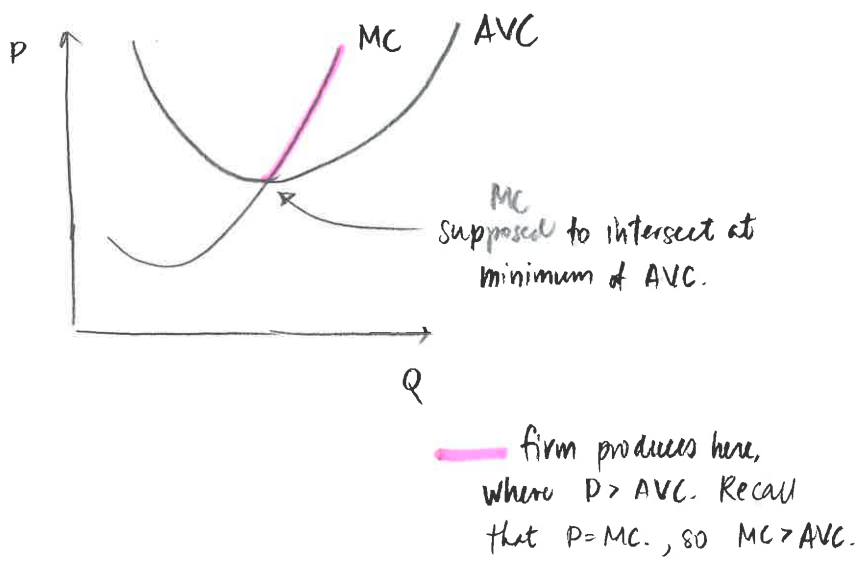
PART C

Q1



PART B

Q7



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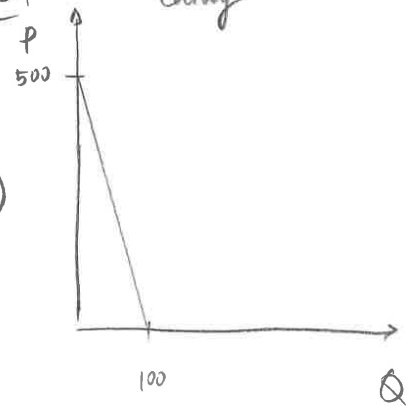
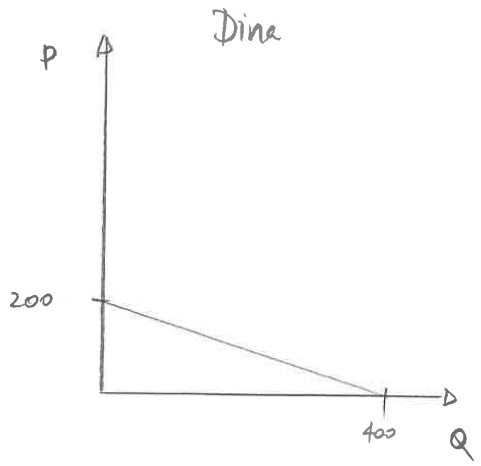
PART C

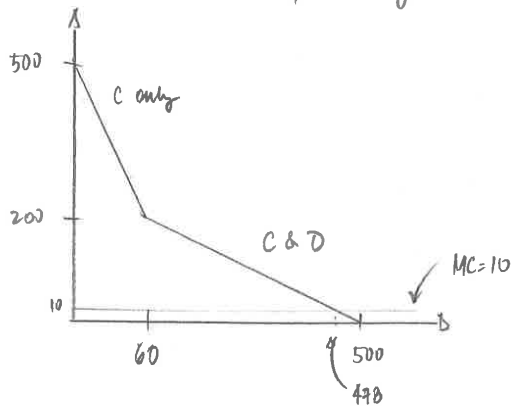
Q3

(a)

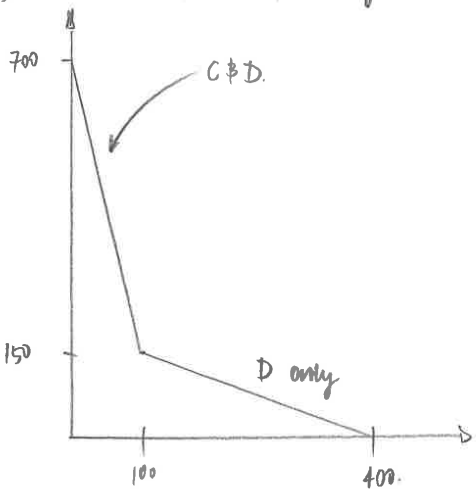




(b) market demand, private goods



(d) market demand, public good



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