Econ 200 AE Spring '25 Week 9

Anirudh Ravishankar, onirudh3@uw.edu

May 30, 2025

Section Information / Reminders

Friday 11:30am, MOR 221.

Office Hours: Tue Thur 11am-12pm, SAV 403.

Weekly material posted on https://onirudh3.github.io/teaching.

Grading:

- Homework: 20% (lowest grade dropped), due every Thursday 11:59pm.
- Writing assignments: 20% (due May 1 and June 5).
- Midterm: 30% Tuesday, April 29.
- Final: 30% (non-cumulative) **June 5. Final exam is in class on Thursday, June 5th. You might see an exam listed on MyUW during finals week, but you should ignore that time.**

Unit 7

$$\text{Profit} = \text{total revenue} - \text{total cost} = PQ - TC = Q(P - AC)$$

$$\text{Marginal profit} = MR - MC$$

$$\text{Marginal revenue} = \frac{\Delta\text{Revenue}}{\Delta Q} = \frac{\Delta(PQ)}{\Delta Q}$$

$$TC = FC + VC = FC + cQ \quad (\text{if } MC = \text{constant } c)$$

Economies and Diseconomies of Scale

If we increase all inputs by a given proportion:

- If output increases more than proportionally, the technology exhibits increasing returns to scale or economies of scale.
- If output increases less than proportionally, the technology exhibits decreasing returns to scale or diseconomies of scale.
- If output increases proportionally, the technology exhibits constant returns to scale.

Average and Marginal Cost

$$AC = \frac{C(Q)}{Q}$$

The marginal cost (MC) is the additional cost of producing one more unit of output, corresponding to the slope of the cost function:

$$MC = \frac{\Delta C}{\Delta Q}$$

Elasticity and Surplus

Elasticity (e > 1 is elastic, e < 1 is inelastic). Suppose that if price changes by ΔP, demand changes by ΔQ. Then elasticity of demand can be written as:

$$\varepsilon = -\frac{\%\Delta Q}{\%\Delta P} = -\frac{100\Delta Q/Q}{100\Delta P/P}$$

$$\varepsilon = -\frac{\Delta Q/Q}{\Delta P/P}$$

$$\varepsilon = -\frac{P}{Q} \cdot \frac{\Delta Q}{\Delta P}$$

Since $\frac{\Delta P}{\Delta Q}$ is the slope of the demand curve:

$$\varepsilon = -\frac{P}{Q} \cdot \frac{1}{\text{slope}}$$

$$\text{Total Surplus} = \text{Consumer Surplus} + \text{Producer Surplus}$$

Isoprofit Curves

$$\text{Slope of isoprofit curve} = -\frac{(P - MC)}{Q}$$

$$\text{Price Markup} = P - MC$$

$$\text{MRS} = -\frac{(P-c)}{Q} \quad \text{(slope of isoprofit curve)}$$

$$\text{MRT} = -\frac{P}{\varepsilon Q} \quad \text{(slope of demand curve)}$$

$$\text{At optimum:} \quad \frac{(P-c)}{Q} = \frac{P}{\varepsilon Q} \Rightarrow \frac{(P-c)}{P} = \frac{1}{\varepsilon}$$

Unit 8

- Excess demand/supply = Quantity demanded/supplied − Quantity supplied/demanded
- Tax revenue = tax · quantity sold after tax
- Deadweight Loss (DWL) of a tax = $\frac{1}{2} \cdot (\text{tax}) \cdot (\Delta Q)$

Unit 10

Marginal Social Cost (MSC) = Marginal Private Cost (MPC)+Marginal External Cost (MEC)

Coase Theorem: If property rights are well-defined and transaction costs are negligible, parties can bargain to an efficient outcome regardless of the initial allocation of rights.

Pigouvian Tax: A tax on a good that creates negative externalities.

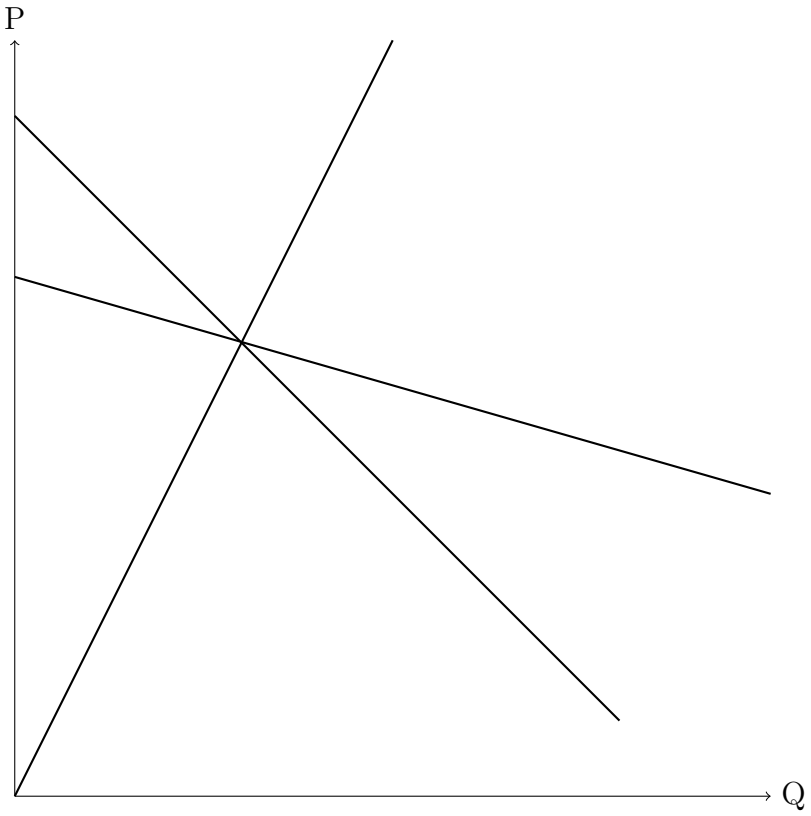
General Formulas

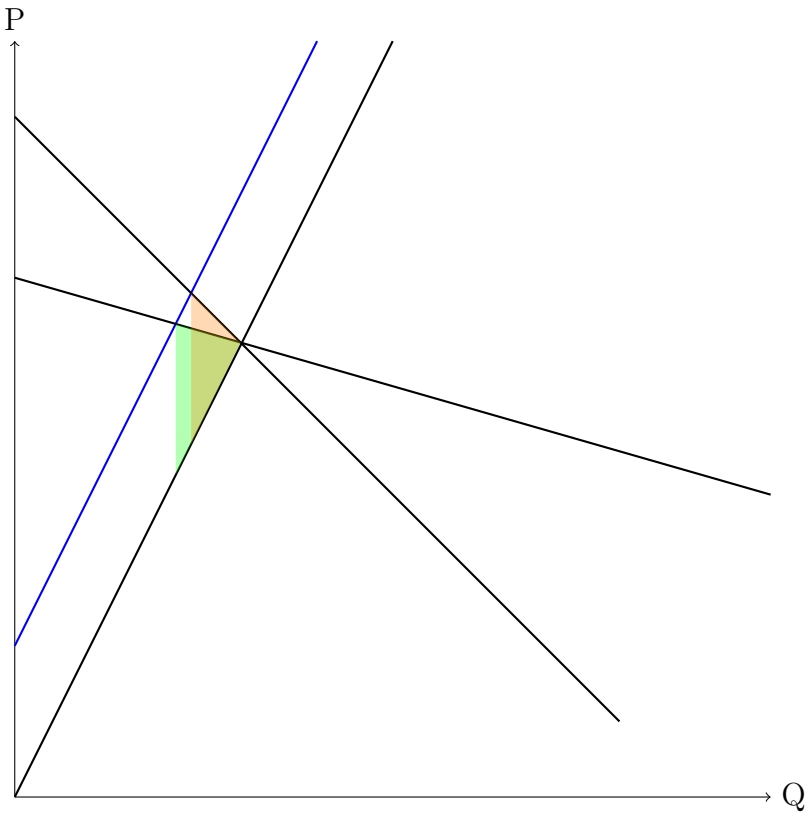
$$\text{Percent change} = \frac{(\text{final} - \text{initial})}{\text{initial}} \times 100\%$$

$$\text{Area of triangle} = \frac{1}{2} \cdot \text{base} \cdot \text{height}$$

Problems

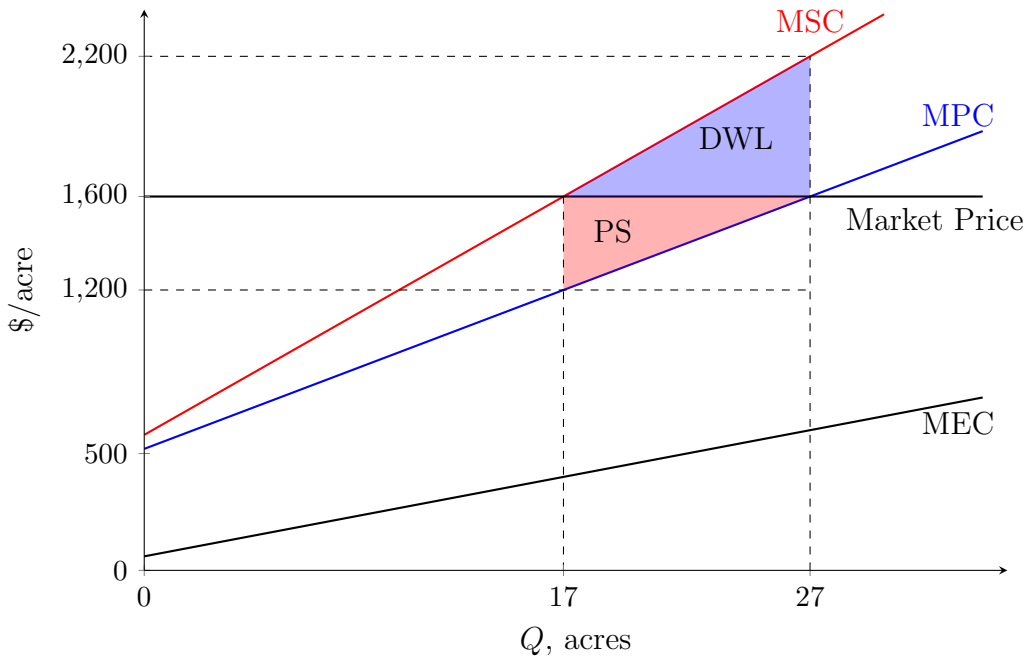
1. The figure below shows two possible demand curves. Which demand curve would experience a greater deadweight loss if a tax of T were imposed on sellers?





Since DWL depends on change in Q (and the heights will be equal to T in both cases), the demand that leads to the greatest change in Q is also going to create the greatest DWL. So the flatter demand curve gives the higher DWL.

2. The figure shows the private cost (MPC) for a farmer to irrigate an acre of land to grow melons in California's Imperial Valley. The market for melons is perfectly competitive and the price the farmer can receive for each acre devoted to growing melons is $1000. Each acre of land irrigation also generates salty runoff that winds up in the Colorado River and harms the Mexican farmers who use the same river to irrigate their own farms. The costs incurred by the Mexican government to clean the water are shown as external costs (MEC) on the graph, and MSC is the sum of MPC and MEC.



(a) What is the Pareto efficient level of irrigation?

17 acres.

(b) How many acres will the CA farmer irrigate if she is profit-maximizing? (And what is her producer surplus?)

27 acres. Producer surplus $= \frac{1}{2}(1600 - 500) \cdot 27 = \$14850$. The "500" here is kind of an approximation to make our calculation easier i.e., where we approximate MSC and MPC ought to intersect the y-axis.

(c) What is the deadweight loss that arises from the farmer over-consuming irrigation?

$= \frac{1}{2}(2200 - 1600) \cdot (27 - 17) = \$3000$.

(d) What are the total costs to the Mexican farmers from the farmer's profit-maximizing choice?

Total cost $= \frac{1}{2}(2200 - 1600) \cdot (27) = \$8100$.

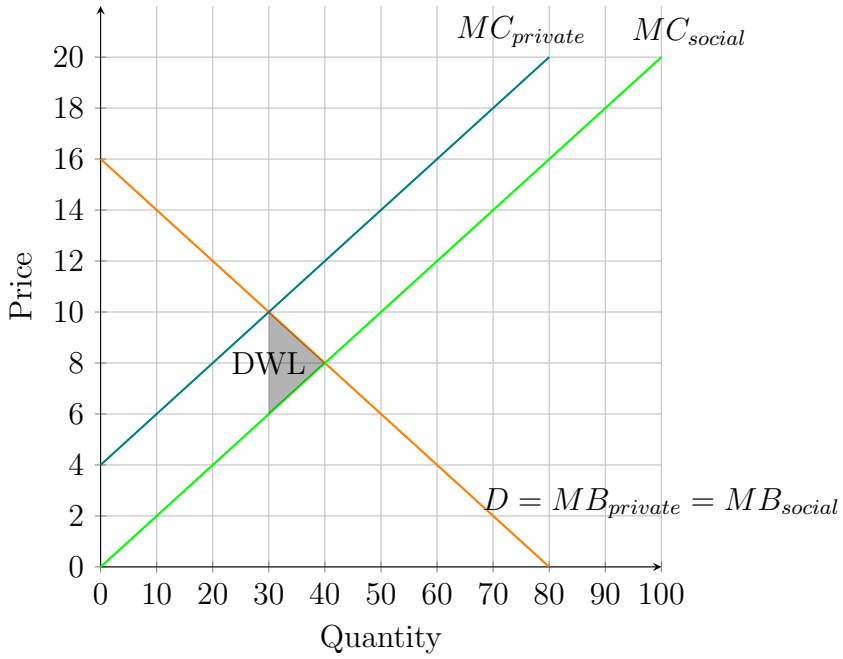
(e) How much would the Mexican government have to offer each CA farmer to get them to irrigate at the Pareto Efficient level instead?

Loss of producer surplus to farmers $= \frac{1}{2}(1600 - 1200) \cdot (27 - 17) = \$2000$.

(f) How much would the Mexican government be willing to pay?

Total external cost to farmers for Q=27 instead of Q=17 $\rightarrow$ Can either find by adding DWL to PS between these points = \$5000.

3. The figure shows market supply and demand for planting trees, based on private costs and benefits. Trees sequester carbon, meaning that they help counteract pollutants that contribute to climate change.



(a) Suppose that the carbon sequestration that results from planting a tree is worth \$4. Graph the social cost curve for tree planting that accounts for the positive externality of trees.

The social cost curve is \$4 less than the private cost curve.

(b) Ignoring the positive externality, how many trees will be planted?

30 trees will be planted. This is where the private benefit curve intersects the private cost curve.

(c) What is the Pareto efficient quantity of trees?

The socially optimal quantity of trees is 40. This is where the social benefit curve intersects the social cost curve.

(d) What is the deadweight loss that occurs when suppliers are unable to capture the \$4 external benefit they provide from planting trees? Graph the deadweight loss.

$\frac{1}{2}(40-30)(4-0) = \$20$ of deadweight loss when suppliers are unable to capture the 4 external benefit they provide from planting trees.

(e) How much should the government subsidize tree planting to bring about the socially efficient level of tree planting?

The tax should be $4.

4. Without regulation, there are 4 coal burning power plants producing 4,000 tons of pollution per year. Economists have determined that the socially optimal amount of pollution is 2,800 tons/year. The amount of pollution produced by each firm and the cost of reducing pollution for each firm is given below.

	Firm 1	Firm 2	Firm 3	Firm 4
Pollution before permits	1,000 tons/year	1,000 tons/year	1,000 tons/year	1,000 tons/year
Cost of reducing pollution (per ton per year)	$50	$20	$30	$40

(a) If the government issues each firm a non-tradable permit to produce 700 tons of pollution per year, what will be the cost of pollution reduction?

Each firm will reduce by 300 tons/year. Total cost $= 300 \cdot (\$50 + \$20 + \$30 + \$40) = \$42,000$.

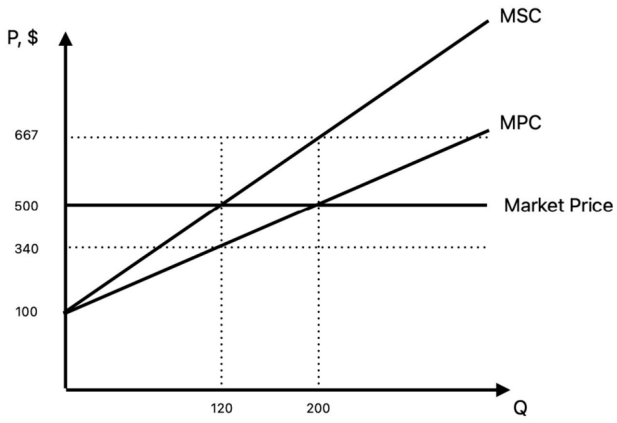
(b) If the permits are tradable, what will be the cost of pollution reduction and what will the final amount of pollution be for each firm?

Total cost = $26,000.

	Firm 1	Firm 2	Firm 3	Firm 4
Pollution reduced	0 tons/year	1,000 tons/year	200 tons/year	0 tons/year
Cost of reducing pollution	$0	$20,000	$6,000	$0

Past Exam Questions

1. The figure shows a factory's marginal private cost and marginal social cost for production of a good that carries a negative externality in the form of air pollution experienced by its neighbours. The market price of the good is $500.



(a) What output will the factory choose to produce? How much surplus will they have if they produce that amount? Be sure to explain how the firm chooses its output as part of your answer.

The factory will choose Q where MPC = Price. That is Q = 200 in this case. The surplus will be $\frac{1}{2}(\$500 - \$100) * 200 = \$40,000$.

(b) What is the cost to the factory's neighbours if the factory produces output at the quantity you found in (a)?

Cost = Area between MPS and MSC between 0 and 200 = $\frac{1}{2}(667 - 500) * 200 = \$16,700$.

(c) What is the Pareto efficient quantity in this case? If the courts have declared that factories have the right to pollute the air around them, how much would the neighbours need to offer the factory to get it to produce the Pareto efficient quantity rather than the output you found in (a)?

Pareto efficient quantity is 120. neighbours should offer the factory the loss in surplus: $40,000 - [(500 - 340) \cdot 120 + \frac{1}{2}(340 - 100) \cdot 120] = 40,000 - (19,200 + 14,400) = 6,400$.

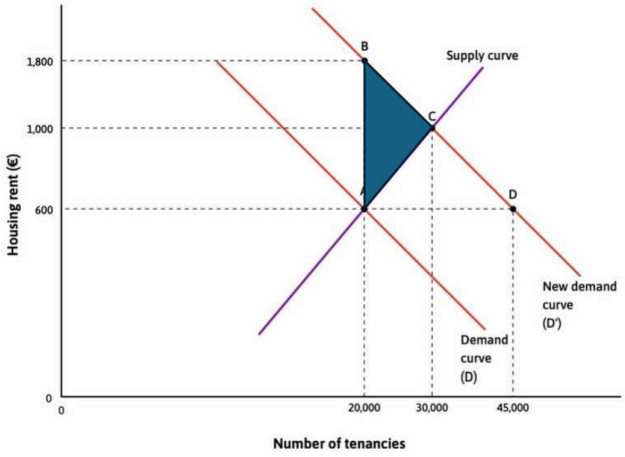
(d) Now imagine that the city decides to impose a Pigouvian tax to get the factory to produce the Pareto efficient output. How much should the tax be, and what will be the total tax revenue collected by the government?

The tax should drive the price down to where MPC = 120. In other words it should be $500 - 340 = 160$. Total tax revenue is $160 \cdot 120 = 19,200$.

(e) Now imagine that the city gets a new mayor who decides that the neighbours have the right to quiet, and the factory must shut down operations (Q=0) unless they can work out a deal to compensate the neighbours. What is the minimum amount the factory would have to offer the neighbours to be allowed to produce the Pareto efficient quantity?

This will be the total cost to the neighbours from producing at Q=120. It will be the area between the MPC and MSC curves from 0 to 120. Cost to neighbours from Q = 120 is $\frac{1}{2}(500 - 340) \cdot 120 = 9,600$.

2. The figure represents the market for rental housing (tenancies). Initially, the market is in equilibrium, represented by point A. Following an increase in rental demand, the market moves to a new equilibrium at C.



(a) Calculate the gain in producer surplus from this change.

Gain in producer surplus = $(1000 - 600) \cdot 20,000 + \frac{1}{2}(1000 - 600) \cdot (30,000 - 20,000) = 8,000,000 + 2,000,000 = 10,000,000$.

(b) Now suppose that the government imposes a price ceiling at €600. Subletting is not allowed. Does this policy create excess demand or excess supply? Calculate this.

Excess demand = 45,000 - 20,000 = 25,000.

(c) How much producer surplus is transferred to consumers due to the policy?

Transfer of producer surplus to consumers = $(1000 - 600) \cdot 20,000 = 8,000,000$.

(d) What is the net gain in consumer surplus from the policy?

Net gain in consumer surplus: Consumers lose $\frac{1}{2}(1800-1000)\cdot(30,000-20,000) = 4,000,000$ and gain $8,000,000$, for a net gain of $4,000,000$.

(e) What is the deadweight loss from the price ceiling? Draw it on the figure above.

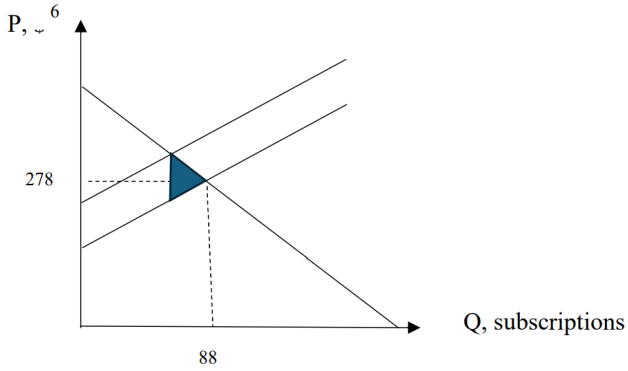
DWL = $\frac{1}{2}(1800 - 600) \cdot (30,000 - 20,000) = 6,000,000$.

(f) Suppose that renters could vote to remove rent control, but they would only be willing to do so if the landlords made a suitable transfer as compensation. Explain how it is possible for

both renters and landlords at least as well off as under rent control. Then, find a transfer from producers to consumers and show that it would make both parties at least as well off than they were under rent control.

Explanation: Total surplus increases by 6 million if rent control is removed. Consumers lose 8 million, gain 4 million (net -4 million). Producers gain 10 million (8 from rent, 2 from DWL). A transfer of 4 million from producers to consumers leaves both better off.

3. The figure illustrates the perfectly competitive market for internet service in a city. Initially, demand is P= 300 - 0.25Q, and supply is P= Q + 190.



(a) Calculate the equilibrium price and quantity of internet service subscriptions sold in this town. Then mark these quantities on the graph.

Equilibrium: $300 - 0.25Q = Q + 190 \Rightarrow 1.25Q = 110 \Rightarrow Q = 88, P = 278$.

(b) Find the y-intercepts for the supply and demand curves. Use this information to calculate the total surplus in this market.

Supply intercept = 190, Demand intercept = 300. Total surplus = $\frac{1}{2}(300 - 190) \cdot 88 = 4840$.

(c) Now suppose the government decides to tax internet suppliers with a constant per unit tax of \$50/subscription. The new supply curve will be: P=Q+240. What share of the tax is paid by buyers?

New supply: $P = Q + 240$. Solving: $300 - 0.25Q = Q + 240 \Rightarrow Q = 48$, $P = 288$. Buyers pay $10/50 = 20\%$ of tax.

(d) Draw the new supply curve from (c) and the deadweight loss of this tax on the graph in (a) and calculate it below.

DWL = $\frac{1}{2}(50)(88 - 48) = 1000$.

(e) Explain how elasticity of demand affects the share of the tax paid by buyers (for a per unit/constant tax). Use at least one figure to do so.

More elastic demand means buyers avoid price increases, so sellers bear more of the tax. Therefore, buyers pay less of the tax when demand is elastic. Refer to the figure in the very first question of this section note.

4. Seattle Sun Car holds a patent for a solar powered car, making it a monopoly producer of this product. Market demand is given in the table below. Marginal cost is constant and \$800/car.

Price (\$)	Quantity	MR
1500	0	–
1400	1	1400
1300	2	1200
1200	3	1000
1100	4	800
1000	5	600

(a) Fill in the marginal revenue in the table below.

MR values: 1400, 1200, 1000, 800, 600.

(b) Calculate the elasticity of demand for a price change from P = 1200 to P = 1100.

Elasticity $= -\frac{4-3}{3} \cdot \frac{1200}{1100-1200} = -\frac{1}{3}(-12) = 4.$

(c) If Sun Car's marginal cost is constant at \$800/car, find the price that Sun Cars will sell for and find the quantity that will be sold. Clearly state the equation or rule you used to answer this question.

Set MR = MC = 800 $\Rightarrow$ Q = 4, P = 1100.

(d) If Sun Car's fixed cost is \$300, find their average cost at the quantity you chose in part c. Then find their profit at this quantity.

Total cost = 300 + 800*4 = 3500. Average cost = 875. Profit = 4*1100 - 3500 = 900.

(e) Is Sun Car's choice in part c Pareto Efficient? Explain why or why not.

No. Pareto efficiency requires MB = MC. Here, WTP > MC at Q < 5, so firm stops short of efficient output.