1. **OilWells.** Suppose a small county in West Texas has 28 oil wells with cost curves subscripted “1” in the graph below and 4 oil wells with cost curves subscripted “2.” The price of oil is determined outside this market, and is shown by the horizontal demand curve.

(a) Show in the graph what quantity a type-2 well produces. How much profit does it make?

(b) If the type-2 wells are earning Ricardian rents, what does this imply for the long-run number of each type of well and the price?

(c) If the type-2 wells have recently adopted a new technology which is available to all oil wells worldwide, what does this imply for the long-run number of each type of oil well and the price?

2. **LongRun.** Currently, the industry shown in the following diagram is in a long-run, perfectly competitive equilibrium with many firms all using technology 1.
(a) What quantity does a type-1 firm produce? How much profit does it make?

(b) Suppose technology 2 becomes available. Nevertheless, there are some firms that would like to stay with technology 1 because they believe that the type of work involved in technology 1 is more creative and personally fulfilling. Can these firms stay with technology 1 in the long run?

3. ProfitMax. A monopoly firm produces quantity \( \hat{q} \) at price \( \hat{p} \) as shown in this diagram:
(a) Does this firm maximize profit? Explain.

(b) Is there any deadweight loss? How much?

(c) If this firm is under threat of government regulation, does that help explain the firm's decision to produce $\hat{q}$?

(d) Harder. Without drawing any additional curves on the diagram, show how much operating profit this firm makes.

4. *Rural Broadband.* One part of the Obama administration's stimulus package funds broadband Internet service for rural and other underserved areas. This problem consider why government funding might be justified.

Suppose that the cost and demand curves for broadband Internet in a rural area are given by the following graph:

![Graph](image)

(a) Explain concisely what could shift the AC curve up so far.

(b) Show on the diagram the smallest loss a monopoly could make serving this market.

(c) Could the government increase total welfare by subsidizing the monopoly loss? Explain with reference to the graph.

(d) Is it possible for the government to raise total welfare beyond what you showed in part (c). Again, explain with reference to the graph.
(e) The Smith family buys the broadband service and the family members get pleasure and productivity from using World of Warcraft and Skype. Are these examples of positive externalities from the government's broadband Internet initiative? Explain why or why not.

**Answers:**

1. *OilWells.a.*

(a) A type-2 firm produces quantity $q_2$, determined from setting its marginal cost equal to its price. Its profits are

$$ (p - SRAC_2(q_2))q_2 $$

which is shaded on the graph.

(b) Since the rents are Ricardian, they cannot be reproduced. No other oil wells can become type-2 wells. Therefore, the type-2 wells will continue to earn these rents in the long run, and the type 1 rents will remain in business and continue to earn zero economic profit.
(c) Since there are large rents to using the type-2 technology, the type 1 wells and/or new entrant wells will want to adopt it. As they do adopt it, this will push the industry supply curve to the right, lowering the price. Eventually, the price will fall to $D'$, at which point there will be many more type-2 wells, all earning zero economic profit. No type-1 wells will be able to remain in business.

2. *LongRun.* Currently, the industry shown in the following diagram is in a long-run, perfectly competitive equilibrium with many firms all using technology 1.

(a) Each type 1 firm maximizes its profit by setting marginal cost equal to price, producing output $q_1$. Since the firms are in long-run equilibrium, price also equals average cost at that point. As a result, the firms do not make any economic profit.

(b) Initially, a small number of type 2 firms could enter the industry and produce output $q_2$. They would earn large profits since price is well above SRAC$_2$, while the type-1 firms would continue to earn zero profit. However, the large profits available to type-2 firms would attract entry into the industry. Even if none of the type-1 firms
changed technology, capital would move into the industry from other sectors of the economy. Eventually, the entry of type-2 firms would increase market supply and thus decrease equilibrium price. The new demand curve facing a single firm would shift to $D'$ in the diagram. At this price, type-2 firms would make zero economic profit, but type-1 firms would incur a heavy loss. Eventually, all type-1 firms would have to leave the industry.

Note that all of this is based on the homogeneous-good demand curve which is given in the problem. If, somehow, the type-1 firms could differentiate their product, they could command a higher price, and perhaps then they could stay in business.

3. *ProfitMax_a.*

(a) No, this firm does not maximize profits because the marginal cost of $\hat{q}$ is greater than the marginal revenue. Profits would therefore rise if the firm cut output. The profit-maximizing output is where $MR + MC$, labeled $q_m$ on the diagram.
(b) Yes, there is a deadweight loss, labeled $D$ in the diagram. It is obviously larger than the zero deadweight loss that would occur if the firm behaved like a perfect competitor, but it is smaller than the deadweight loss of a profit-maximizing monopoly.

(c) Yes, if there is some chance the government will regulate the firm, it might want to avoid the image of being an inefficient monopoly. Increasing output, and thereby decreasing price and deadweight loss, is a way of making the firm less costly to society. Of course, this comes at the expense of reduced profits, but those profits might still be higher than what would be earned under regulation.

(d) The operating profit is the revenue minus the variable cost. In this case, total revenue is equal to the area $\hat{p}\hat{q}$. Total variable cost is the area under the marginal cost curve between $q = 0$ and $q = \hat{q}$. The difference between these is operating profit, the shaded trapezoid in the figure.

4. RuralBroadband_a.

(a) Given that the MC is upward sloping, AC will be U-shaped and cross MC at its lowest point. But it can shift anywhere up or down along the MC curve depending on how large the fixed costs are. In this case, fixed costs are very high relative to demand, which makes sense since infrastructure industries usually have high fixed costs.

(b) The monopoly would maximize profits by setting $\text{MR} = \text{MC}$. In this case, that still causes a loss equal to $C+D+E$. 

(c) Without a subsidy, the market will simply not exist since even a monopoly makes a loss. With a subsidy equal to C+D+E, the market will exist and it will generate consumer surplus of A+B+C+D. Area E represents some additional costs not justified by demand, but it is much smaller than A+B so there is a welfare gain.

(d) For clarity, there is a second graph below. At the monopoly solution from (c), there is deadweight loss shown by the shaded area. If the government increased the subsidy to C+D+E+F and combined it with a mandate that the firm produce the competitive quantity $q^c$ and charge the competitive price $p^c$, this deadweight loss would be eliminated. The consumer surplus is now a quite large area A+B+C+D+E (plus the tiny tiny triangle above E), which again needs to be weighed against some added costs F. But since F is smaller than A+B, this again increases total welfare.

It should be noted that if the government cannot perfectly measure $q^c$, there may be a difficult regulatory principal-agent problem here, and it may take some additional and unwelcome costs to solve it.
(e) Two answers are possible here. The first is to say that since the Smith family buys the Internet service, any consumer surplus they receive is internal to the transaction and thus does not qualify as an externality. The second is to say that Skype and WOW are networked goods, so there may be a positive direct network externality by adding the Smiths to the user base. This would accrue to other users, not to the Smiths.