Environmental Economics

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EPFL ENAC LEUrE

ENV-471

Master semester 2 or 4

Basics

FIXED COSTS

Optimal production by private company: profit maximisation

- Q is quantity produced, C(Q) is cost of producing quantity Q, p is price at which each unit of Q sold
- Firm chooses Q with a view to maximizing its profit
- Profit $\Pi(Q) = p \times Q - C(Q)$
- Why maximise profit?

Optimal production with proportional cost

- Profit $\Pi(Q) = pQ - C(Q)$
- Suppose $C(Q) = aQ$
- Unit cost $C(Q)/Q = a$
- Proportional cost $\rightarrow$ constant unit cost $\rightarrow$ constant return to scale
- Only produce if $p > a$
- In this case Q^* = max capacity Q_{max}
- $\Pi(Q) = (p-a)Q_{max}$

Optimal production with quadratic variable cost

- Profit $\Pi(Q) = pQ - C(Q)$
- FOC for maximum profit: $p - C'(Q^*) = 0 \rightarrow C'(Q^*) = p$
- Suppose $C(Q) = a_1Q + a_2Q^2$
- $\Pi(Q) = p \times Q - a_1Q - a_2Q^2 \rightarrow$ FOC: $p - a_1 - 2a_2Q = 0$
- Profit is maximised for $Q^* = (p - a_1) / 2a_2$
- $Q^* > 0$ for $p > a_1$
- $\Pi(Q^*) = (p - a_1)^2 / 4a_2 > 0$
- Unit cost $C(Q)/Q = a_1 + a_2Q$ increasing with $Q \rightarrow$ <u>decreasing</u> returns to scale

Fixed costs, increasing returns to scale

Example

- Fixed cost (F) = 1000
- Variable cost (c) = 10/unit
- Number units produced (Q)
- Total cost (TC) = 1000 + 10×Q
- Unit cost = TC/Q = F/Q + c = 1000/Q + 10
- For Q = 2 unit cost = 510
- For Q = 200 unit cost = 15
- For Q = 2000 unit cost = 10.5

This Tesla Gigafactory in Nevada produces Model 3 electric motors and battery packs, in addition to Tesla's energy storage products https://www.tesla.com/gigafactory

Optimal production with quadratic cost (incl. fixed cost)

- Suppose $C(Q) = a_0 + a_1Q + a_2Q^2$
- $\Pi(Q) = p \times Q - a_0 - a_1Q - a_2Q^2 \rightarrow$ FOC: $p - a_1 - 2a_2Q = 0$
- Profit is maximised for $Q^* = (p - a_1) / 2a_2$
- $Q^* > 0$ for $p > a_1$
- $\Pi(Q^*) = (p - a_1)^2 / 4a_2 - a_0 > 0$ **?**

- **Fixed cost and sunk cost …**

Comparing average cost with price

- $C(Q) = a_0 + a_1 Q + a_2 Q^2$
- $Q^* = (p - a_1) / 2a_2$
- Average cost $C(Q^*)/Q^* = a_0/Q^* + a_1 + a_2 Q^*$
  $= a_0/Q^* + a_1 + a_2(p-a_1)/2a_2 = a_0/Q^* + (p+a_1)/2$
- Without the first term, this is smaller than p if $a_1 < p$
- With the first term, we do not know in general