Chapter 9

Perfectly Competitive Markets

Perfectly Competitive Markets

Characteristics:

- Fragmented:
  Many small firms, none of which have market power
- Undifferentiated Products:
  Products that consumers perceive as being identical.
- Perfect Pricing Information:
  Consumers have full awareness of the prices charged by all sellers in the market.
- Equal Resource Access:
  All firms have equal access to production technology and inputs

Perfectly Competitive Markets

How do Perfectly Competitive Markets work?

- Price takers:
  Due to industry fragmentation
- Law of One Price:
  From the 2nd and 3rd characteristic of perfectly competitive markets
- Free Entry (into the market):
  From the last characteristic of perfectly competitive markets

Perfectly Competitive Markets

- Economic vs. Accounting Profit
  - Economic Profit = Sales Revenue – <u>Economic</u> Costs (including opportunity costs)
  - Accounting Profit = Sales Revenue – <u>Accounting Costs</u>

Query #1

Suppose Joe starts his own business. In the first year the business earns $100,000 in revenue and incurs $85,000 in explicit costs. In addition, Joe has a standing offer to come work for his brother for $40,000 per year. Joe's accounting profit is _________ and Joe's economic profit is __________.

a) -$25,000 and $15,000
b) $15,000 and $65,000
c) $15,000 and $60,000
d) $15,000 and -$25,000

Query #1 - Answer

- Answer D
- Accounting Profit is the difference between a firm's sales revenue and its explicit costs.
- Accounting π = $100,000 - $85,000 = **$15,000**
- Economic Profit is the difference between a firm's sales revenue and the totality of its economic costs, including all relevant opportunity costs.
- Economic π = $100,000 - $85,000 - $40,000 = - **$25,000**
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Perfectly Competitive Markets

Every firm in the perfectly competitive industry faces the following profit-maximization problem:

$$max_q \; p \cdot q - TC(q)$$

where the price p is taken as given (price-taking assumption in perfectly competitive markets).

Taking first-order conditions with respect to output *q*, yields

$$\partial q: p - \frac{\partial TC(q)}{\partial q} = 0$$

and rearranging yields $p=MC(q)$.

Perfectly Competitive Markets

From our above profit maximization problem of firms operating in a perfectly competitive industry, we concluded that each of them increases their output *q* until

$$p=MC(q).$$

that is, every firm increases *q* until the point at which:

- the marginal revenue it obtains for every additional unit, i.e., the prevailing market price *p*, coincides with…
- the marginal cost of producing that additional unit, $MC(q)$.

Perfectly Competitive Markets

- We can also check if second-order conditions are satisfied, so we confirm that the condition we found above $p=MC(q)$, is a condition to maximize, rather than minimize, profits.
- Differentiating $p\text{-}MC(q)=0$, with respect to q yields

S.O.C: $0-\frac{\partial MC(q)}{\partial q}<0 \text{ since } \frac{\partial MC(q)}{\partial q}>0$

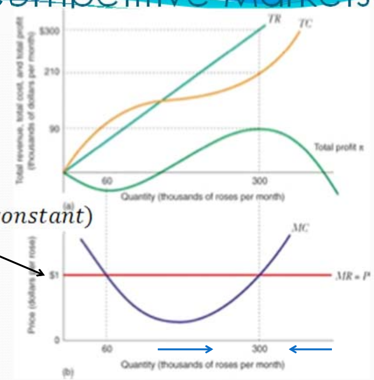
Thus, a price taking firm maximizes π when $p=MC(q)$.

Perfectly Competitive Markets

$$\pi = TR - TC$$

$$p \cdot q - TC(q)$$

$Slope\ TR = MR\ (a\ constant)$



Perfectly Competitive Markets

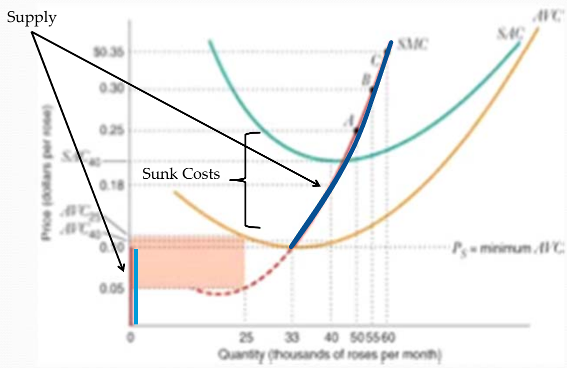
What happens if, rather than setting output at the point in which P = MC(Q), the firm sets it at a different price?

- If MR > MC (P > MC),
  we have ▲Q ➔ ▲ π
- If MR < MC (P < MC),
  we have ▼Q ➔ ▲ π

Market Price in the Short Run

- **Short-run**: Capital level *K* is fixed for all firms.
  - Number of firms is also fixed in the market.
- **Sunk fixed costs:** A fixed cost that the firm cannot avoid if it shuts down and produces zero output.
  - Example: lease that cannot be sublet
- **Nonsunk fixed costs:** A fixed cost that a firm does not need to incur if it produces no output.
  - Example: heating

Short-Run – when all fixed costs are sunk



- The profit-maximizing condition P = MC makes the supply decisions of the firm (Supply Curve) to coincide with the SMC curve (red line).
- If P < AVC, then we have that, apart from the Sunk Fixed Cost, the firm is making losses for TFC+[Q(AVC – P)], the shaded rectangle.
- This explains why the Supply Curve is Q=0 for all prices P < min(AVC), i.e., the supply curve is a vertical spike for all P < min(AVC)

- Note, finally, that there are points where $p \in (AVC, SAC)$ the firm is not compensated for its fixed costs since P < SAC, although it is for its variable costs, since P > AVC.
- **Short Run supply curve**: The supply curve that shows how the firm's profit-maximizing output decision changes as the market price changes, assuming that the firm cannot adjust all of its inputs.

Short-Run Supply Curve, Example

- STC = $100 + \underbrace{20Q + Q^2}_{VC}$, then MC = 20 + 2Q

What is the AVC curve?

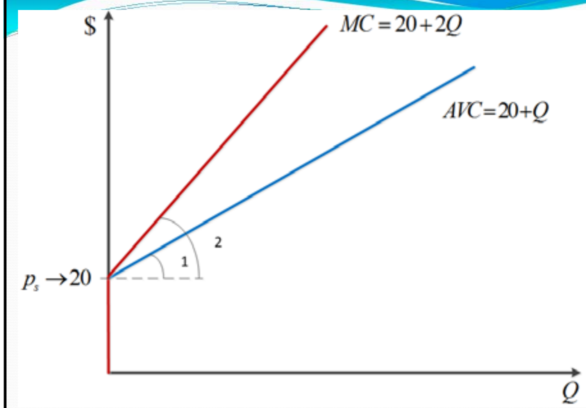
A) AVC = VC/Q = $(20Q + Q^2)/Q$ = 20 + Q

What about the supply curve? Remember we need two conditions: (1) P=MC(Q), and (2) two segments: above/below the min of AVC

Let us first find the Min of the AVC curve:

- We know that this minimum occurs where MC = AVC. Then,
  - 20 + 2Q = 20 + Q
  - 2Q = Q
  - Q = 0
  - Then min AVC = 20 + 0 = 20. ←Height

    Plug Q=0 at AVC



Short Run Example (cont.)

Short-run Supply Curve

- For p < 20,
  - we have Q = 0 (vertical spike)
- For p ≥ 20,
  - we have $p = MC \rightarrow p = 20 + 2Q$

$$p - 20 = 2Q \rightarrow Q = \frac{p}{2} - 10$$

$$\text{Supply (P)} = \begin{cases} 0 \text{ if } & p < 20 \\ \frac{p}{2} - 10 \text{ if } & p \geq 20 \end{cases}$$

Query #2

The short-run supply curve for a firm operating in perfect competition is

a) the firm's marginal cost curve.
b) the firm's average variable cost curve.
c) the firm's average variable cost curve above marginal cost.
d) the firm's marginal cost curve above the shut down price.

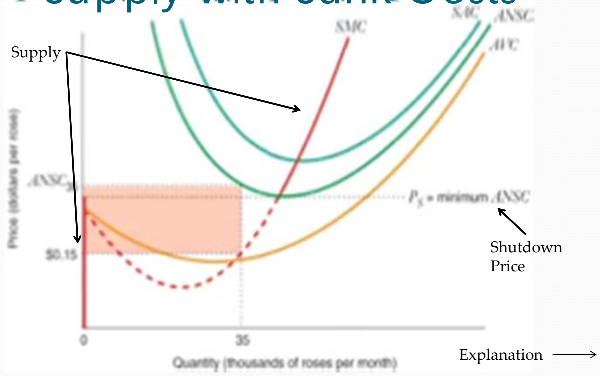
Query #2 - Answer

- Answer D
- In the short-run, a firm operating in perfect competition has a supply curve equal to the marginal cost curve above the shut-down price, or the minimum average variable cost.
- For prices below the shut-down price, the firm supplies zero output, and the supply curve is a vertical line at Q=0.

What if fixed costs are (1) sunk, and (2) nonsunk…

Supply with Sunk Costs

New



- In this case you will <u>never</u> produce when
  - P<ANSC
- <u>Shut down price</u>: The price below which a firm supplies zero output in the short run.

Generally, the shut down price is the minimum of the curve of **average avoidable cost**:

-ANSC If some fixed costs are sunk

-AVC If all fixed costs are sunk

-SAV If no fixed costs are sunk

Example

Consider again the following STC curve:

STC = 100 + 20Q + Q²

SMC = 20 + 2Q

A) Assume that, out of the $100 SFC = 36 and NSFC = 64. What is ANSC?

We need to find the nonsunk costs.

NSC = TC – Sunk Costs

= NSFC + Sunk Fixed Costs + VC – Sunk Costs

= NSFC + VC = 64 + 20Q +

Then ANSC = $\frac{64+20Q+Q^2}{Q} = \frac{64}{Q} + 20 + Q$

<u>Min ANSC</u>

It happens where ANSC = MC

64/Q + 20 + Q = 20 + 2Q ⇔ 64/Q = Q ⇔ 64 = Q^2 ⇔

$Q = \sqrt{64} = 8 = \min(\text{ANSC})$

then min ANSC = 64/8 + 20 + 8 = $36

Q=8

Height (P_s), which is the shut-down price in this context

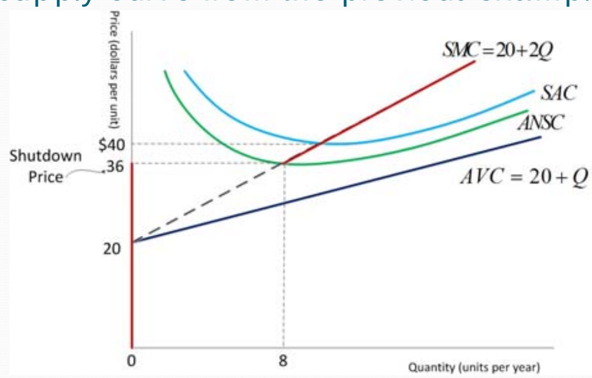
Example (cont.)

B) We use the shutdown price, P_S = \$36, to find the supply curve

- If p < 36 then Q = 0
- If p ≥ 36 then Q is determined from p = MC,
  - p = 20 + 2Q. Hence, solving for Q yields Q = $\frac{p}{2} - 10$.

$$\text{Supply (P)} = \begin{cases} 0 \text{ if } p < 36 \\ \frac{p}{2} - 10 \text{ if } p \geq 36 \end{cases}$$

Supply curve from the previous example



Query #3

For a particular perfectly competitive firm, costs are $STC = 100 + 20q + q^2$ and marginal costs are $SMC = 20 + 2q$.

If the market price is equal to 40, what is the maximum profit the firm can earn?

a) 400
b) 200
c) 100
d) 0

Query #3 - Answer

- Answer D
- At the profit-maximizing point, P = SMC.
- We know that the price P = 40, and SMC = 20 + 2Q. Hence, setting them equal to each other, we can find the number of units this firm produces.
  - P = SMC
  - 40 = 20 + 2Q
  - Q = 10

- Since Q = 10…
- Total revenue is: $TR = (P) \times (Q)$
  $TR = (40) \times (10)$
  $TR = 400$
- Total cost is given by: $TC(Q) = 100 + 20Q + Q^2$
  $TC(Q) = 100 + 20 \times (10) + (10)^2$
  $TC(Q) = 400$
- Therefore, profits are equal to: $\pi = TR(Q) - TC(Q)$
  $\pi = 400 - 400$
  $\pi = 0$
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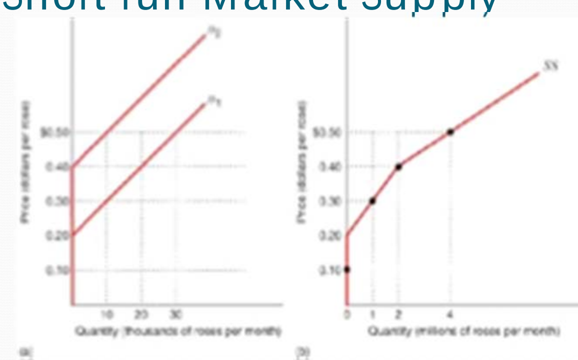
Short Run Market Supply

- How can we find the market supply curve if we know the supply curve for each individual firm?
- We horizontally sum the individual supply curves, as shown in the next slide.

Short-run Market Supply

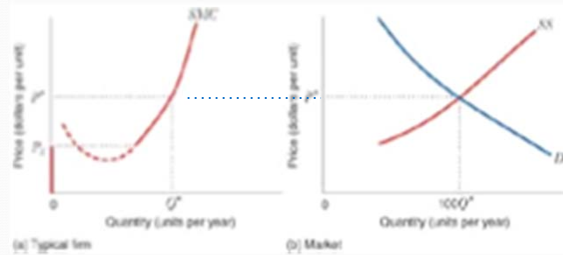


- *Be careful*: if we are adding up Supply 1, 2 for each price, we want Supply 1, 2 in terms of p. Secondly, we will divide our analysis for different price intervals.
- *Don't worry*: it is easier than you expect, but don't forget to multiply the number of types of firm per each supply curve.

- **Short-run market supply curve**
- The supply curve that shows the quantity supplied in the aggregate by all firms in the market for each possible market price when the number of firms in the industry is fixed.

Equilibrium in the Short Run

Given the short-run supply curve SS, we can now find equilibrium prices and quantities by setting SS equal to market demand.

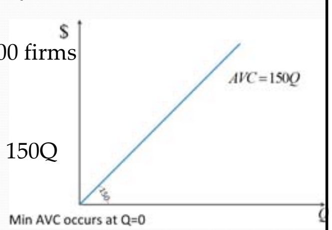


Example

- Equilibrium in the Short Run
- Market demand is given by $D(P) = 60 - P$
- $STC = 0.1 + \overbrace{150Q^2}^{VC}$, N=300 firms

Thus:

- $SMC = 300Q$ and $AVC = 150Q$



Example (cont.)

- Supply curve of each individual firm
- Min AVC occurs at AVC=SMC, 150Q=300Q so Q = 0, which implies min AVC = 0. Then, for any p > 0 we have p = MC, p = 300Q, or Q = p/300. ↖ Don't forget solving for Q
- Thus, **every** firm's supply curve is Q = p/300 for all p > 0.

Example (cont.)

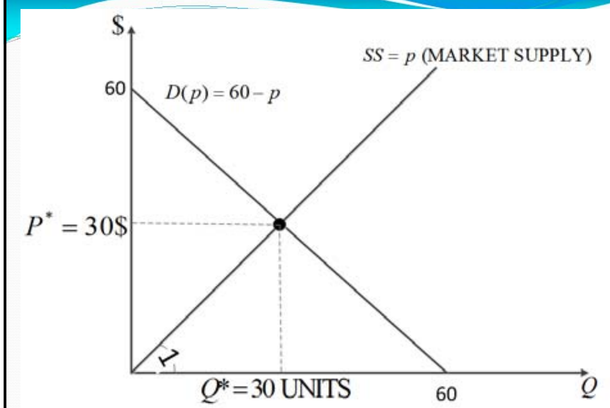
- Market Supply is
  300 × (p/300) = p, that is,
  N × supply function for every firm

- Competitive equilibrium occurs at the point where market supply equals market demand:

  Market Demand
  $p = 60 - p \rightarrow 2p = 60 \rightarrow p^* = 30$
  Market Supply

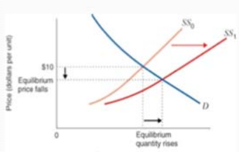
- Hence, p* = \$30, and Q* = 30

Figure (next Slide) →



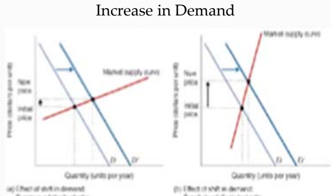
Comparative Statics

More Firms



ΔN induces ↓P
and ↑Q

Increase in Demand

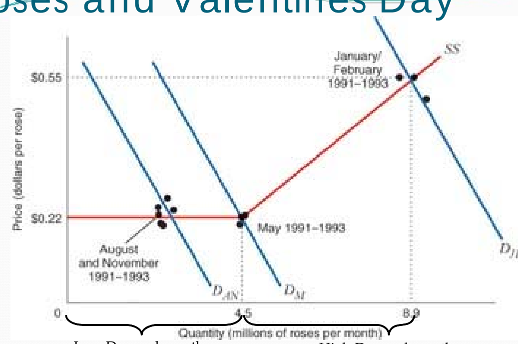


Elastic supply
(small Δp)

Inelastic Supply
(large Δp)

Hence, an increase in demand (e.g., a good becomes more fashionable) increases equilibrium prices, but this increase is particularly large when supply is inelastic.

Roses and Valentines Day



- An increase in demand for Mother’s Day doesn’t affect prices as supply is very elastic
- However, at Valentine’s Day, supply is more inelastic, thus affecting prices

Using Changes in Demand to Estimate Supply

- We observe…
  - ΔQ from 4.5 to 8.9 (see figure)
  - ΔP from 0.22 to 0.55 (also represented in the Figure)
- Hence, the slope of the supply curve is:

$$\text{Slope: } \frac{\Delta Q^S}{\Delta P} = \frac{8.9 - 4.5}{0.55 - 0.22} = 0.133$$

We can use this slope to find the price-elasticity of supply,

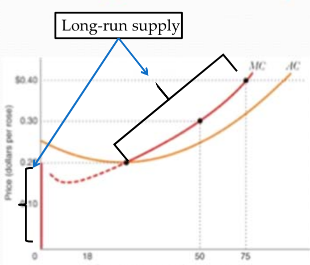
$$\varepsilon_{Q^S,P} = \frac{\Delta Q}{\Delta P} \times \frac{P}{Q} = 0.133 \times \frac{0.55}{8.9} = 0.82$$

- Interpretation: Δ1% in P→Δ0.82% in Q^S in Valentine's Day. Hence, supply is relatively inelastic to price changes, as suspected for Valentine's Day.

Another Application of Inelastic Supply

- *Nord Pool*: Electric power exchange between Norway, Sweden, Finland, and Denmark
  - Close to Perfectly Competitive Market: many suppliers, with rare disparities in the price of Mwh across the four countries, electricity is regarded as a homogenous good, etc.
- Yet prices are extremely high in unusually cold winters; why?
  - Price that a local distributor of electricity pays to a generator.
- Because, for most firms, supply becomes really steep after exceeding its normal production level.
  - Aggregate supply curve is very steep, and an increase in demand on cold days produces a very significant ΔP.

Long-Run Supply



- Similar to short-run, but now there are no fixed or sunk costs:
- Now all costs are *avoidable*, since the size of the plant, K, acts like variable, i.e., it can be varied.

Long-run PC Markets

- **Long-run competitive equilibrium:** The market price and quantity at which supply equals demand, established firms have no incentive to exit the industry, and prospective firms have no incentive to enter the industry.

1. No entry, no exit
2. Each firm maximizes long-run profits, π, changing Q and K decisions
3. Economic profits are zero, since p = min AC
4. Market Demand = Market Supply

(Note: These four properties hold in the long-run, although properties 1 and 3 are equivalent)

Example

N firms in the industry, each with:

Consider the following information:

$AC(Q) = 40 – Q + 0.01Q^2$

$MC(Q) = 40 – 2Q + 0.03Q^2$

$D(p) = 25{,}000 – 1{,}000p$ ← This is the aggregate demand

<u>Equilibrium in a P.C. market:</u>

We know that in a P.C. market the following 3 conditions must hold:

$p^* = MC(Q^*) = 40 – 2Q^* + 0.03(Q^*)^2$ (profit maximizing)

$p^* = AC(Q^*) = 40 – Q^* + 0.01(Q^*)^2$ (zero profit)

$D(p^*) = n^* \times Q^* \rightarrow 25{,}000 – 1{,}000p^* = nQ^*$ (market demand = market supply)

Example (cont.)

From the first two equations, p=MC and p=AC, we obtain MC=AC:

1) $40 – 2Q^* + 0.03(Q^*)^2 = 40 – Q^* + 0.01(Q^*)^2$

Rearranging, $0.02\,(Q^*)^2 = 2Q^* - Q^*$

$0.02\,(Q^*)^2 = Q^*$

$0.02\,Q^* = 1$

$Q^* = 1/0.02 = 50$ units

(The individual supply in equilibrium

With this equality, we make MC=AC, finding the min of the AC, which occurs where MC and AC intersect

Going back to the first equation (p=MC), and plugging Q*=50, we obtain…

2) $p^* = 40 – 2Q^* + 0.03(Q^*)^2 = 40 - 2\times 50 + 0.03\times (50)^2 = \$15$

(This is the equilibrium price)

Example (cont.)

Now we know the equilibrium price, p*=$15, as well as the individual supply for every firm, Q*=50 units

3)Plugging p*=15 into the demand function, we obtain

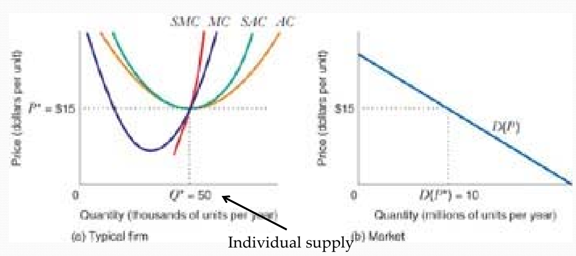
$D(p^*) = 25{,}000 – 1{,}000\times 15 = 10{,}000$

4)Then, from condition $D(p^*) = n^*\, Q^*$, i.e., market demand = market supply, we find that

$10{,}000 = n\times 50$ ➔ $n = 10{,}000/50 = 200$ firms in equilibrium

Let us depict these results on the next slide

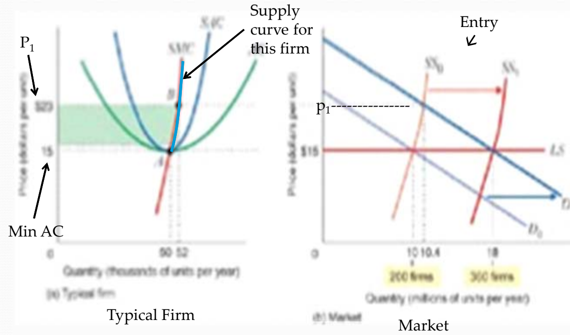
Long-run equilibrium in a perfectly competitive market



Empirical Application of *n**

- For a given individual supply provided by individual firms, the larger the demand, the larger the number of firms (in this application, internet service providers, ISPs) in a local market.
  - That is, *n*=Demand* / *Output by each firm*
- Empirical evidence:
  - A) Market with less than 74,000 hab. (Pullman and Moscow) →1-5 ISPs
  - B) Market with more than 943,000 hab. (Chicago) →21 or more ISPs

Long-run Supply Curve



Explanation on the next slide…

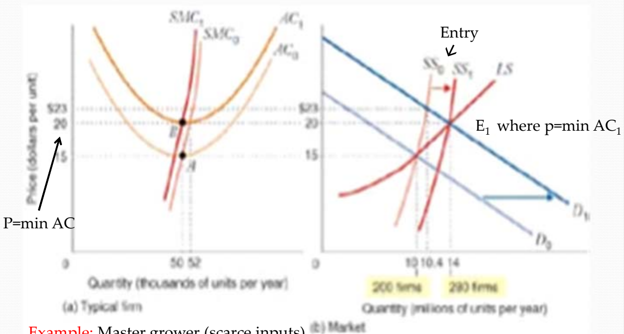
Sequential Presentation of the Previous Figure

- Demand shifts from D_0 to D_1
- Price increases from p_0 to p_1 (e.g. from $15 to $23)
- Large profits, since p_1 > SRAC in the left panel (shaded area)
- This induces the entry of new firms, from SS_0 to SS_1 in the right panel
- Equilibrium, in the long run, happens to be at p_0 = min AC
- No entry or exit of additional firms
- Long-run supply curve is a flat line at p = min AC

[This is the case of constant cost industry where ΔQ from new firms doesn't affect input prices, i.e., doesn't affect firms' cost curves]

- So far entry did not affect input prices, but… What if it does?
- More firms in the industry can make inputs more expensive.
  - Example: Scarce input, such a master grower in the rose industry, leads to an increase in the price of this input
- More firms can also make inputs cheaper.
  - Example: Computer chips as inputs (smartphones); price drops when the smartphone industry expands.

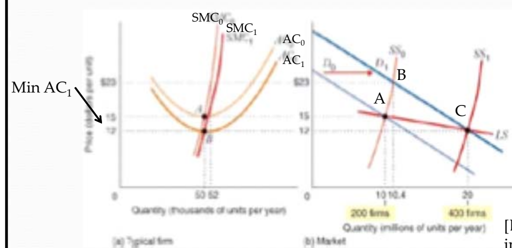
Long-run supply with increasing costs



Example: Master grower (scarce inputs)

[Δ in costs as a result of entry]

Long-run supply curve with decreasing costs



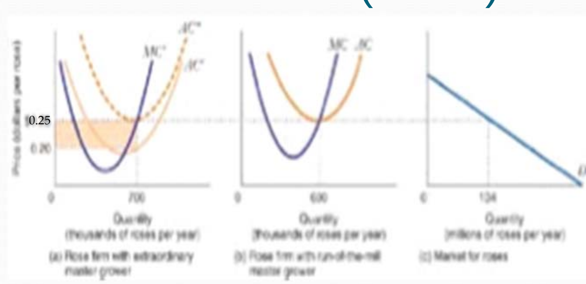
Example: industry that uses a specific chip extensively

[Entry induces the input providers to increase scale, lowering prices of chips.]

Economic Rent

- **Economic Rent:** The economic return that is attributable to extraordinarily productive inputs whose supply is scarce.
  - *Alternative definition of Economic Rent*:
  - Maximum amount that a firm is willing to pay for services of an input, also referred to as the input's reservation rule

Economic Rent (cont.)



Rose firm with an extraordinary master grower (lower AC curve)

Rose firm with a run-of-the-mill master grower

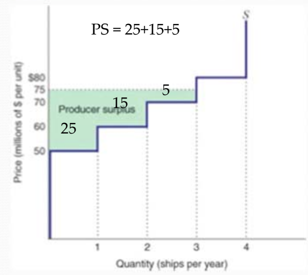
Market for roses

Economic Rent (Cont.)

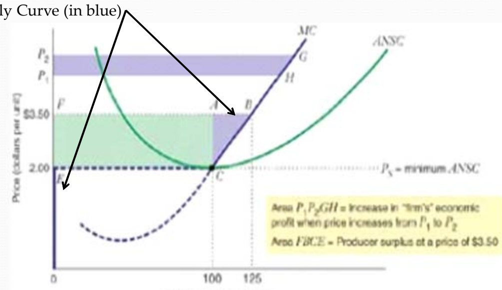
- Firm 1→ AC` and MC` in left-hand side due to extraordinary master grower who receives a low salary as regular master grower
- Firm 2→ MC and AC in right-hand side since they use run-of-the-mill master grower who receives a low salary as regular master grower, their costs are higher.
- If P.C. p* = 0.25, then *firm 1* profits are larger (shaded area)
- Competition for such a valuable (talented) master grower makes firm 2 offer him from 70,000 to 105,000. A similar argument applies to Firm 1.
- As a consequence, the economic rent will be 105,000-70,000=35,000, which is entirely captured by the extraordinary master grower.

Producer Surplus

- **Producer Surplus:**
- A measure of monetary benefit that producers derive from producing a good at a particular price.



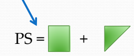
Supply Curve (in blue)



F.A.C.E. → Producer surplus from the first 100 units when p=$3.50
ABC → Additional producer surplus from the last 25 units (from 100 to 125)

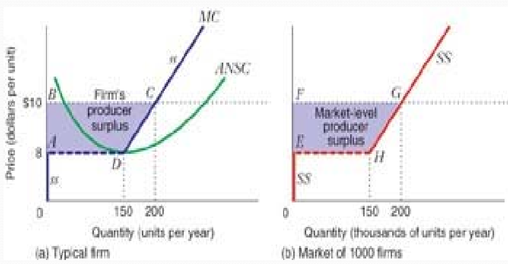
Producer Surplus

- Difference between what a producer actually receives for selling one unit and the minimum price he must receive in order to be willing to supply that unit, i.e., its MC.
- This definition applies both in the case of individual firms and market supply.
- Note that with linear supply curves…



Producer Surplus

(For each individual firm, and at the market-level)

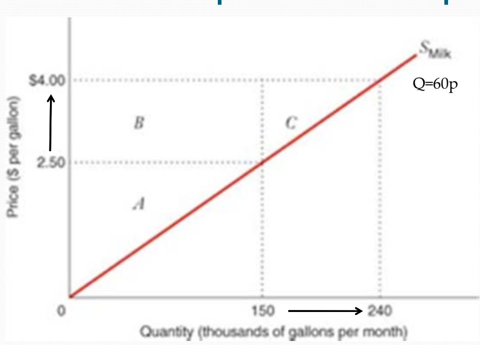


Producer Surplus - Example

- Consider a linear market supply Q=60p (in thousands)
- Equilibrium price is $2.50.
- What is producer surplus at this price?
  - At p=$2.50, equilibrium output is Q=60*(2.5)=150,000
  - Therefore, producer surplus is given by the area of triangle *A* in the following figure.

$$PS = \frac{1}{2} \times 150{,}000 \times \$2.50 = \$187{,}500$$

Producer Surplus - Example



Producer Surplus – Example (Cont.)

What if p increases to $4.00; how does PS grow?

Producer surplus grows in areas B + C, where

- Area B= (4 – 2.5) × 150,000 = 225,000, and
- Area C is $\frac{1}{2}$×(4 – 2.5)×(240-150) = 67,500,
  - where note that, at a price of p = $4, output becomes Q = 60×4 = 240
- Hence, when p increases from p=2.5 to p=4,
  Producer surplus grows in:
  (B) + (C) = 225,000 + 67,500 = 292,500