Lecture 14

Firm and Industry Supply

Overview

- **Last lecture: the derivation of cost functions and cost curves**

  (i.e. given technology and an output level, how firms minimize their costs)

- **Today: 1) the derivation of firms' supply curves from their cost functions; 2) the derivation of industry supply from individual firm supply**

Market Environments

- **Are there many other firms, or just a few?**
- **Do other firms' decisions affect our firm's payoffs?**

Market Environments

- **Monopoly**: Just one seller that determines the quantity supplied and the market-clearing price.

  垄断者

- **Oligopoly**: A few firms, the decisions of each influencing the payoffs of the others.

  寡头

Market Environments

- **Dominant Firm**: Many firms, but one much larger than the rest. The large firm's decisions affect the payoffs of each small firm. Decisions by any one small firm do not noticeably affect the payoffs of any other firm.

  市场主导者

Market Environments

- **Monopolistic Competition**: Many firms each making a slightly different product. Each firm's output level is small relative to the total.

  垄断竞争

- **Pure Competition**: Many firms, all making the same product. Each firm's output level is small relative to the total.

  完全竞争

Market Environments

- **Later chapters examine monopoly, oligopoly, and the dominant firm.**
- **This chapter explores only pure competition.**

Pure Competition

- **A firm in a perfectly competitive market knows it has no influence over the market price for its product. The firm is a market price-taker.**

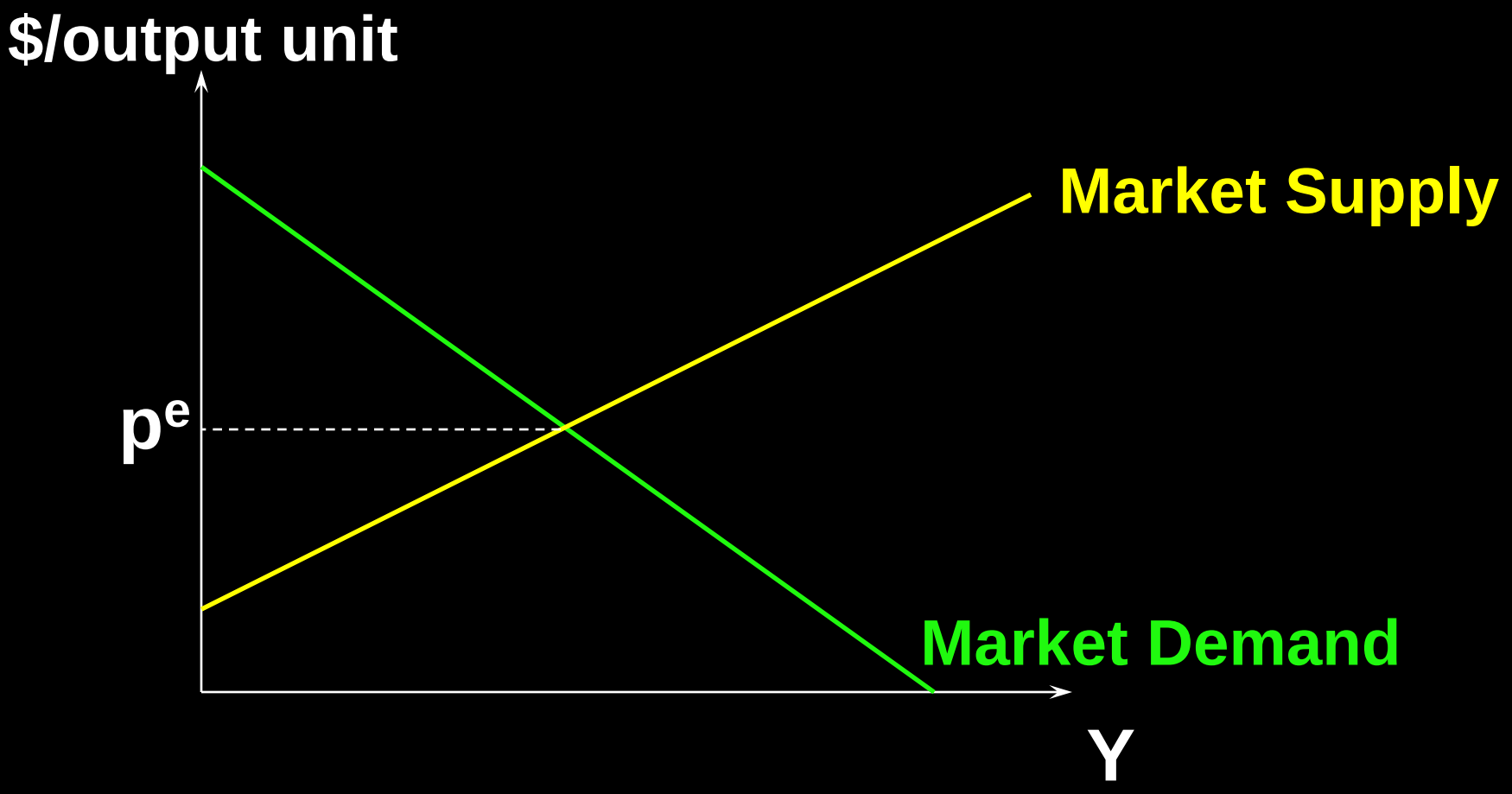
Pure Competition

- **The firm is free to vary its own price.**
- **If the firm sets its own price above the market price then the quantity demanded from the firm is zero.**
- **If the firm sets its own price below the market price then the quantity demanded from the firm is the entire market quantity-demanded.**

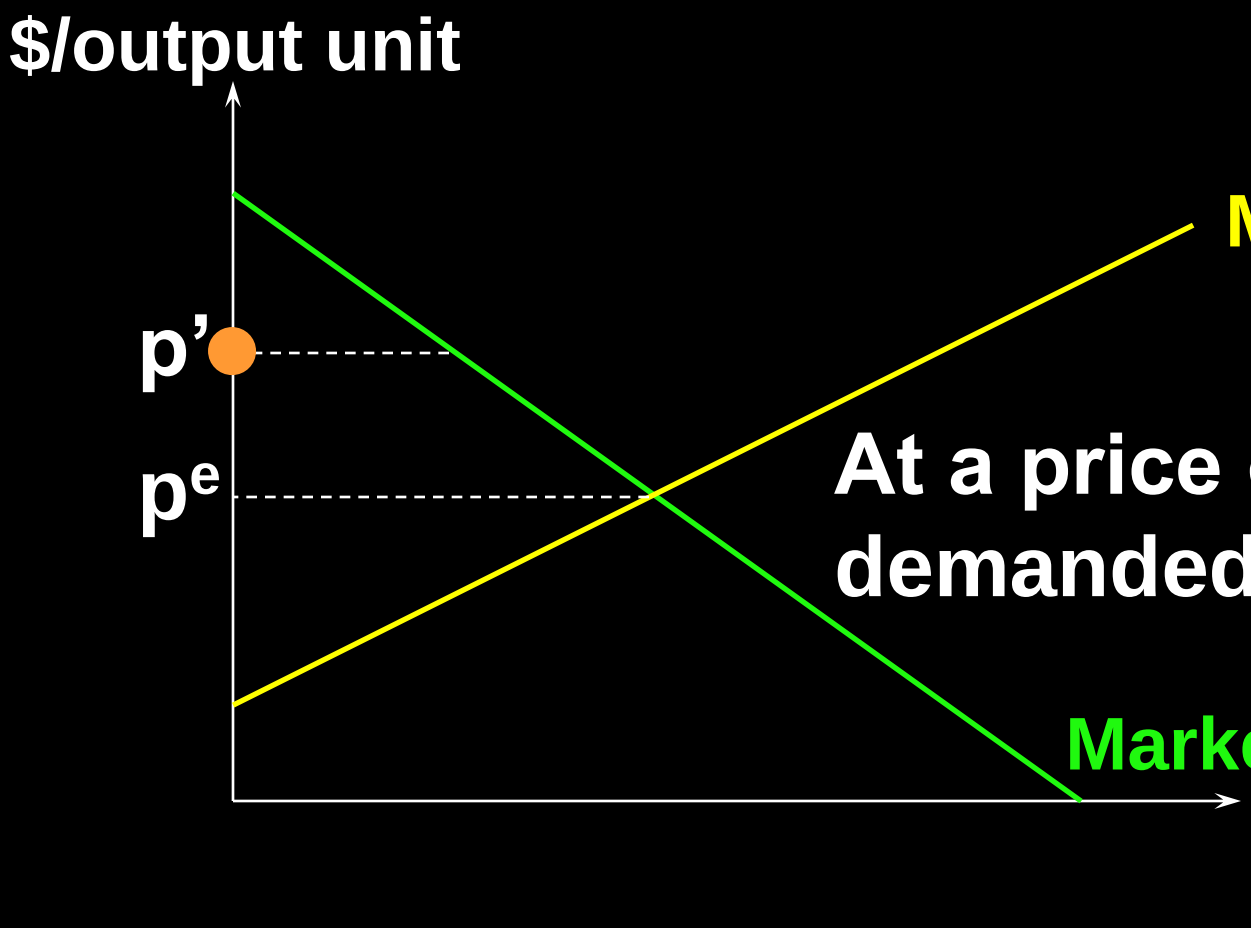
Pure Competition

- **So what is the demand curve faced by the individual firm?**

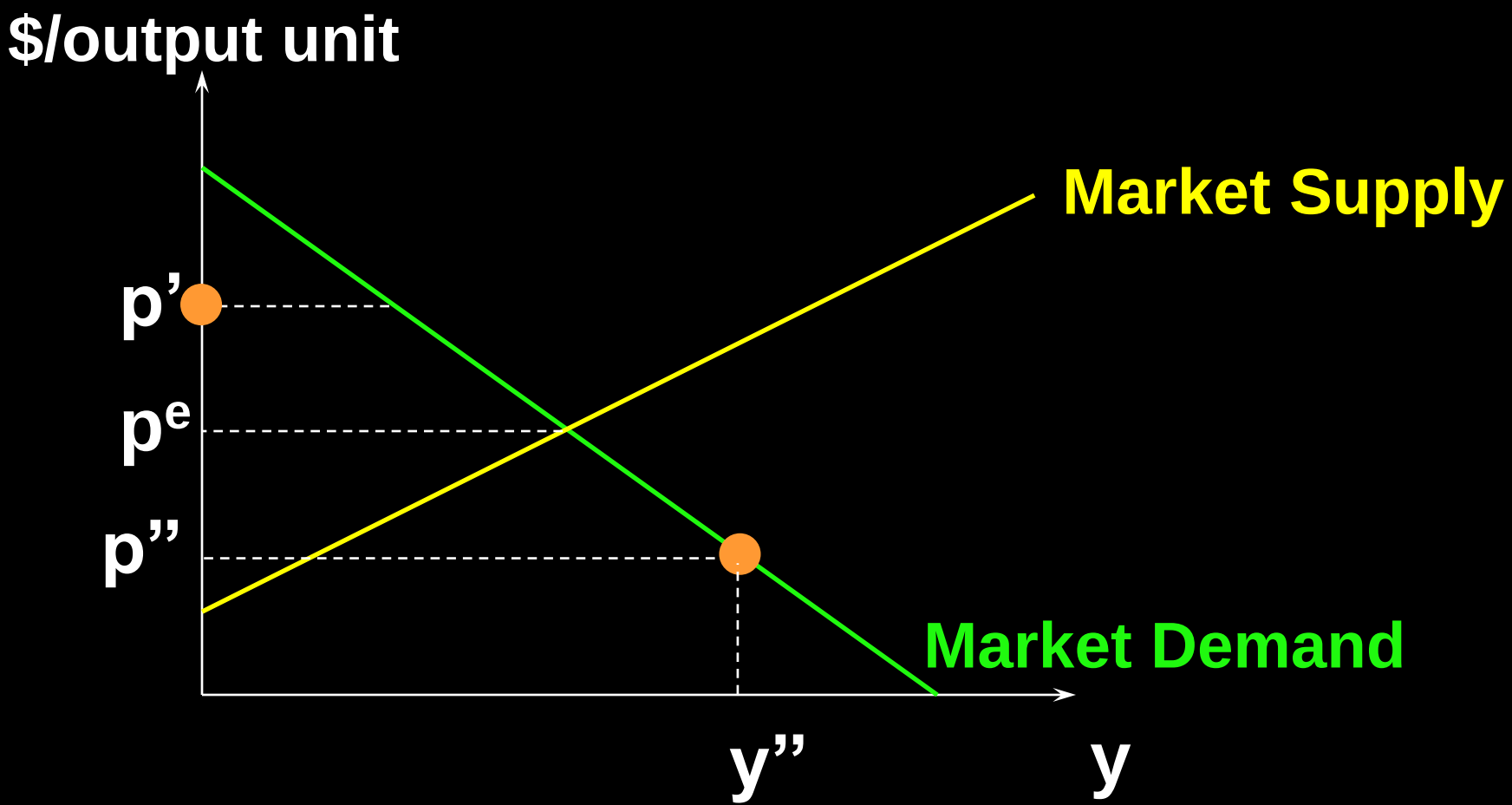
Pure Competition



Pure Competition

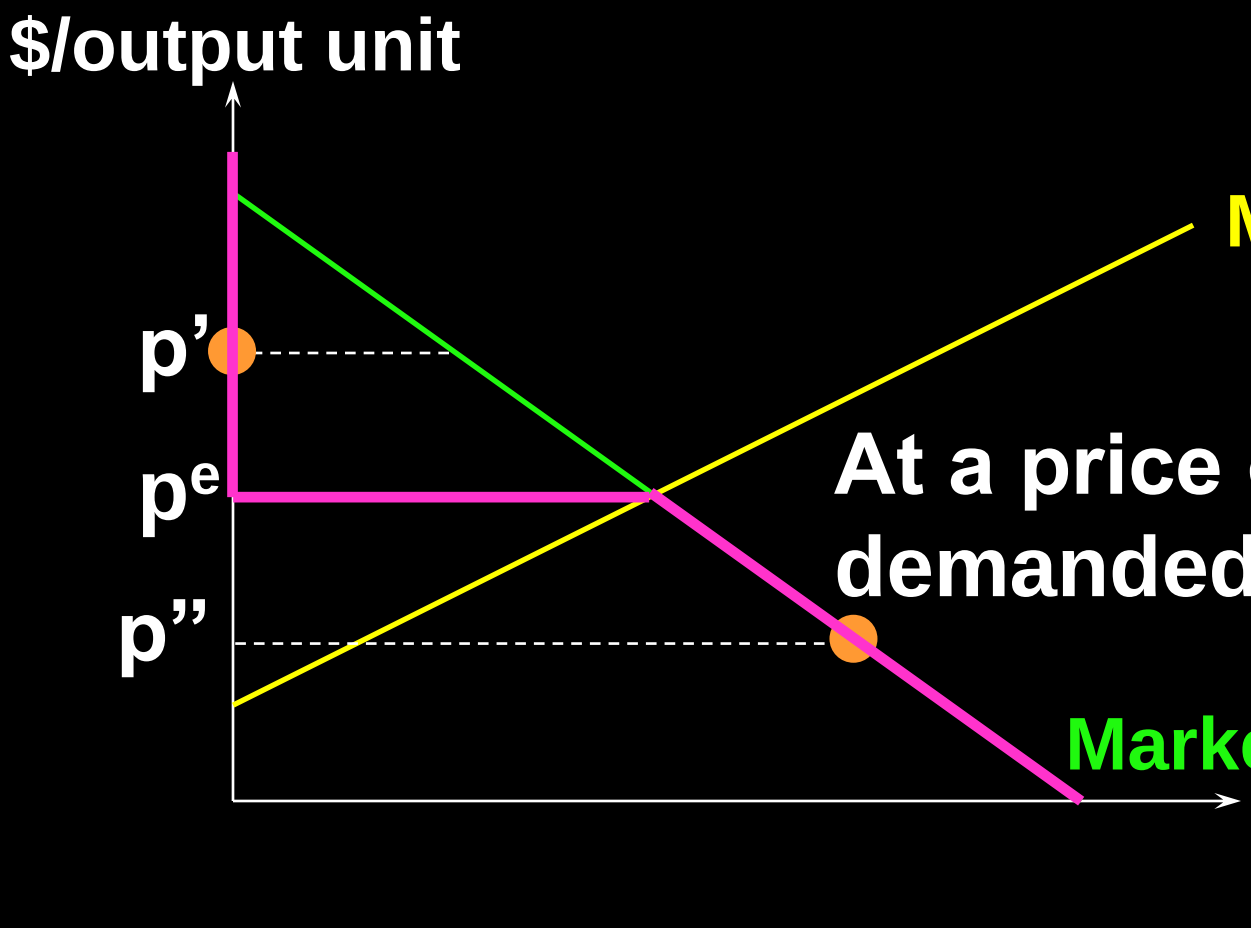


Pure Competition



At a price of p'' the firm faces the **entire market demand.**

Pure Competition



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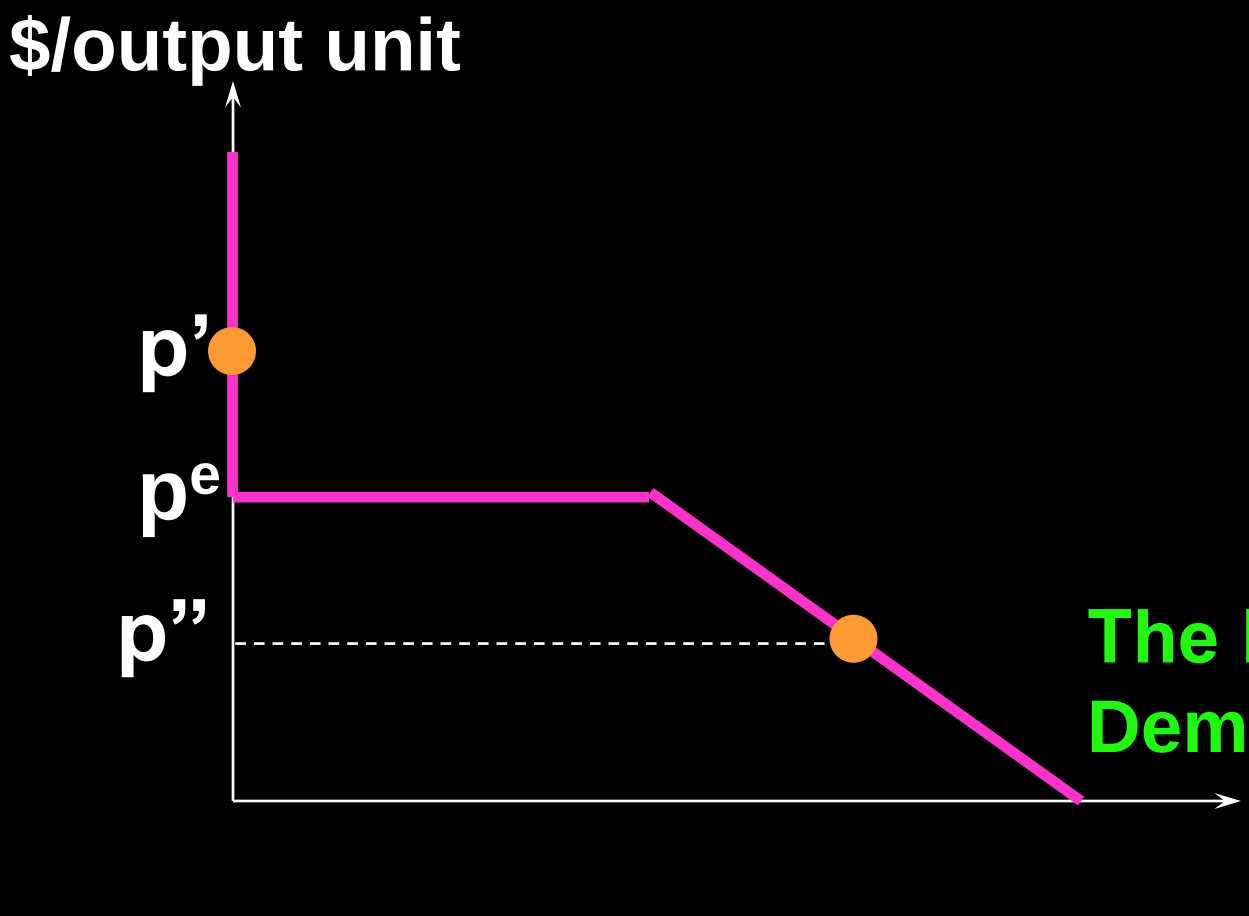
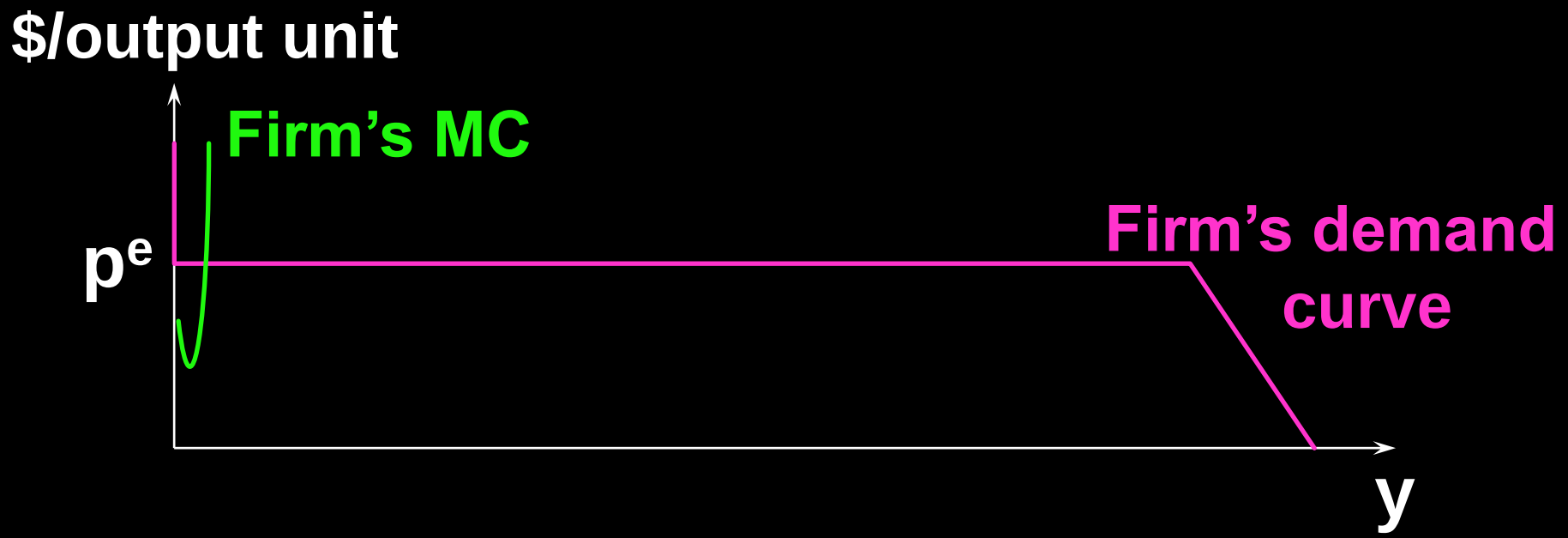


市场需求曲线描述的是价格与总需求量之间的关系，而厂商面临的需求曲线描述的是价格与该企业产品被需求量之间的关系。

Smallness

- **What does it mean to say that an individual firm is “small relative to the industry”?**

Smallness



The individual firm's technology causes it always to supply only a small part of the total quantity demanded at the market price.

在完全竞争市场中，个体企业的生产量相对于市场总需求量非常之小，所面临的需求近似为水平直线。

The Firm's Short-Run Supply Decision

- **Each firm is a profit-maximizer and is in a short-run.**
- **Q: How does each firm choose its output level?**

The Firm's Short-Run Supply Decision

- Each firm is a profit-maximizer and is in a short-run.
- Q: How does each firm choose its output level?
- A: By solving

$$\max_{y \geq 0} \Pi_s(y) = py - c_s(y).$$

The Firm's Short-Run Supply Decision

$$\max_{y \geq 0} \Pi_s(y) = py - c_s(y).$$

What can the solution y_s^* look like?

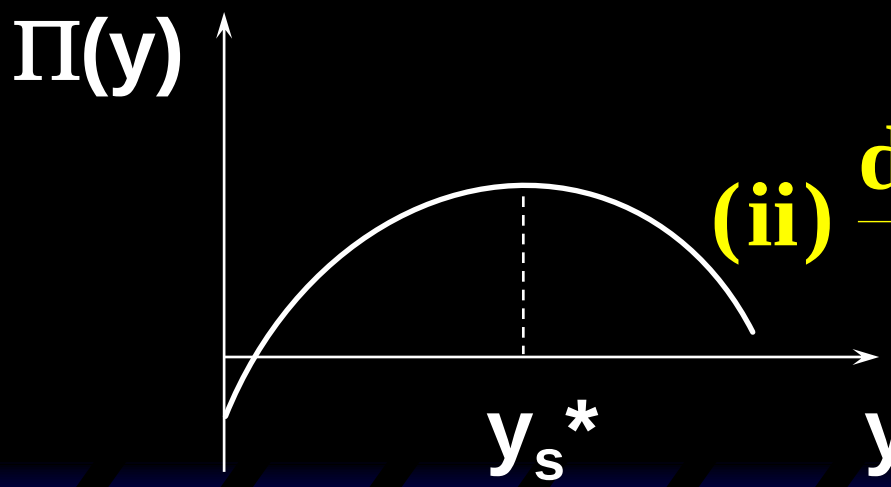
The Firm's Short-Run Supply Decision

$$\max_{y \geq 0} \Pi_s(y) = py - c_s(y).$$

What can the solution y_s^* look like?

$y_s^* > 0$:

$$\text{(i)}\ \frac{d\Pi_s(y)}{dy} = p - MC_s(y) = 0$$



$$\text{(ii)}\ \frac{d^2\Pi_s(y)}{dy^2} < 0 \text{ at } y = y_s^*.$$

The Firm's Short-Run Supply Decision

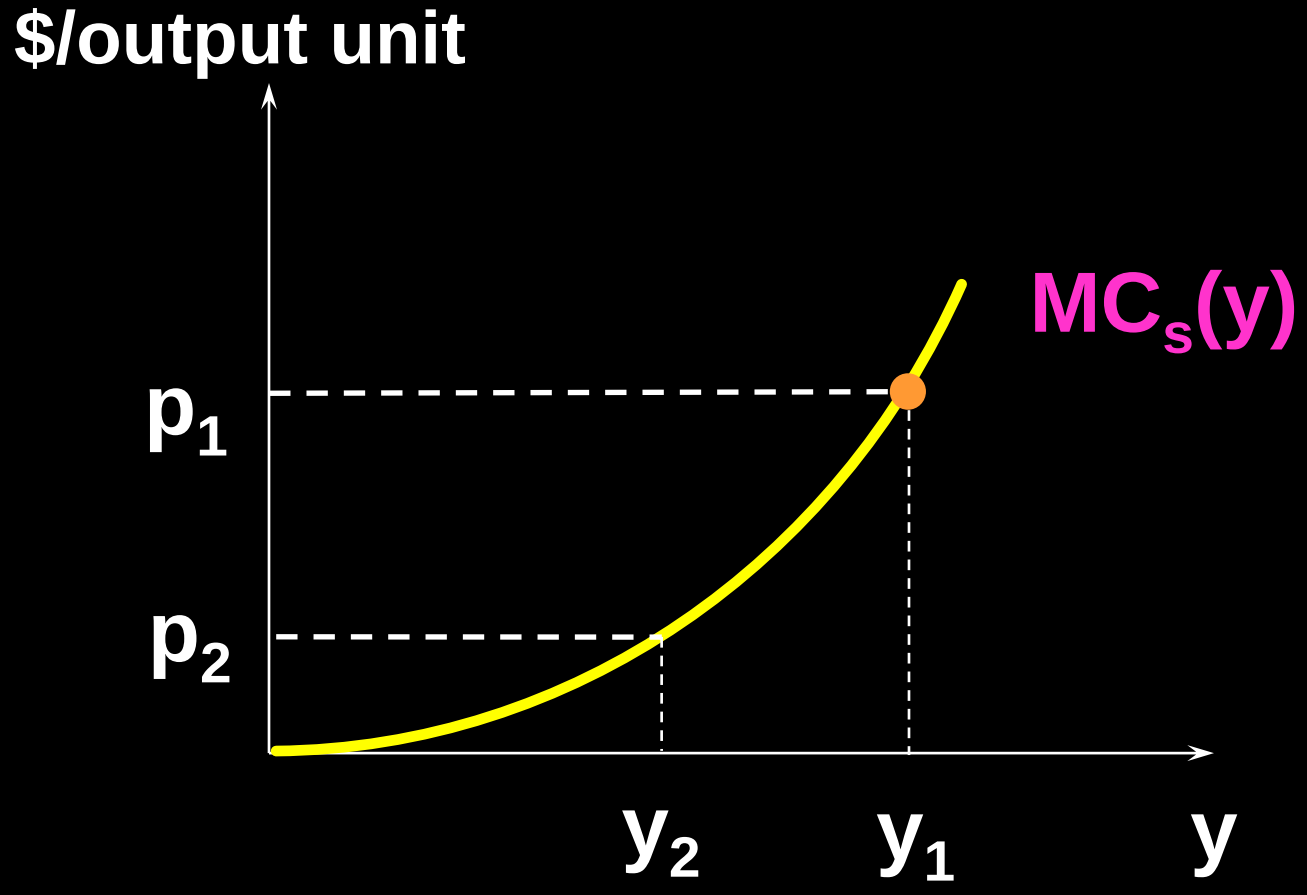
For the interior case of $y_s^* > 0$, the **first-order maximum profit condition** is

$$\frac{d\Pi_s(y)}{dy} = p - MC_s(y) = 0.$$

That is, $p = MC_s(y_s^*)$.

So at a profit maximum with $y_s^* > 0$, the market price p equals the marginal cost of production at $y = y_s^*$.

The Firm's Short-Run Supply Decision



厂商根据 $P = MC_s(y)$ 来决定供给 => 边际成本曲线即为厂商供给曲线

The Firm's Short-Run Supply Decision

For the interior case of $y_s^* > 0$, the **second-order maximum profit condition** is

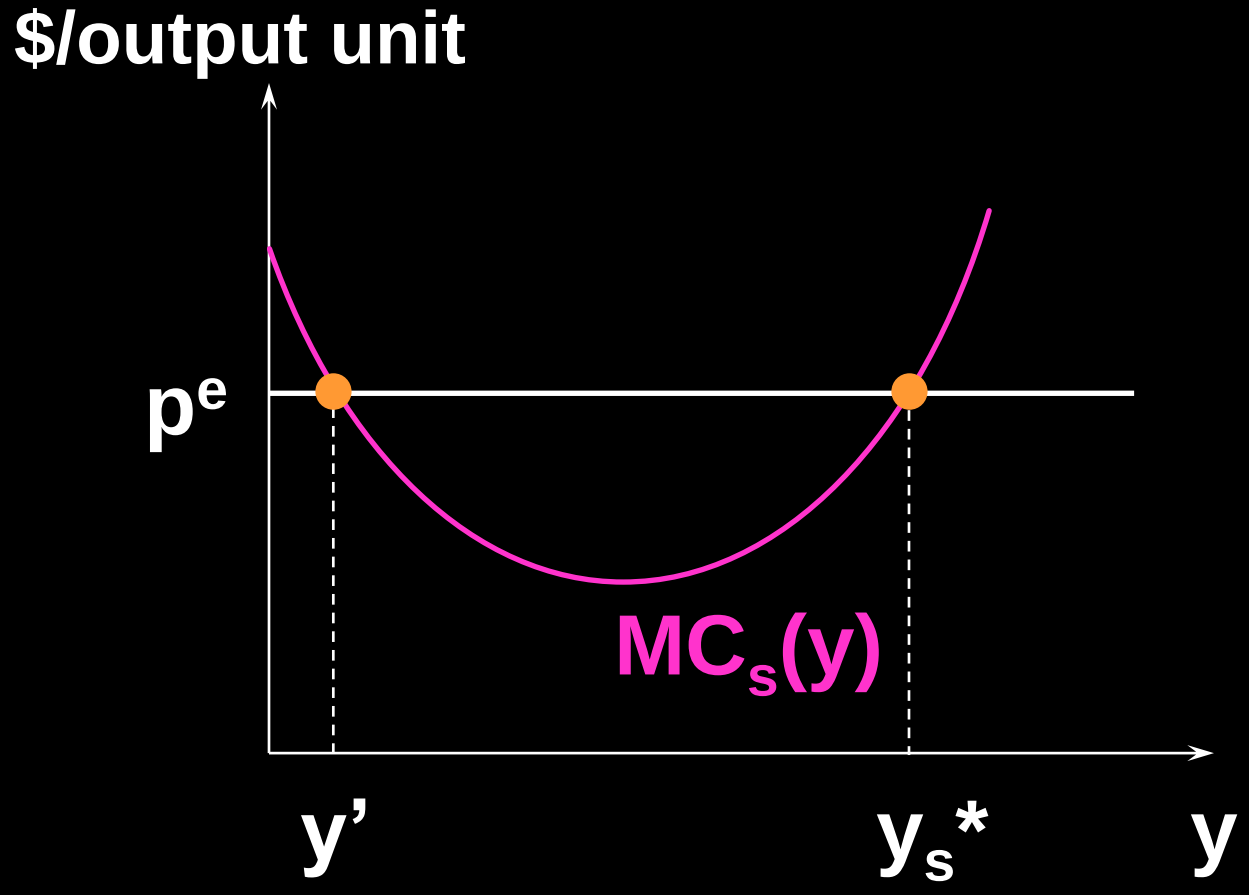
$$\frac{d^2\Pi_s(y)}{dy^2} = \frac{d}{dy}\left(p - MC_s(y)\right) = -\frac{dMC_s(y)}{dy} < 0.$$

That is, $\frac{dMC_s(y_s^*)}{dy} > 0.$

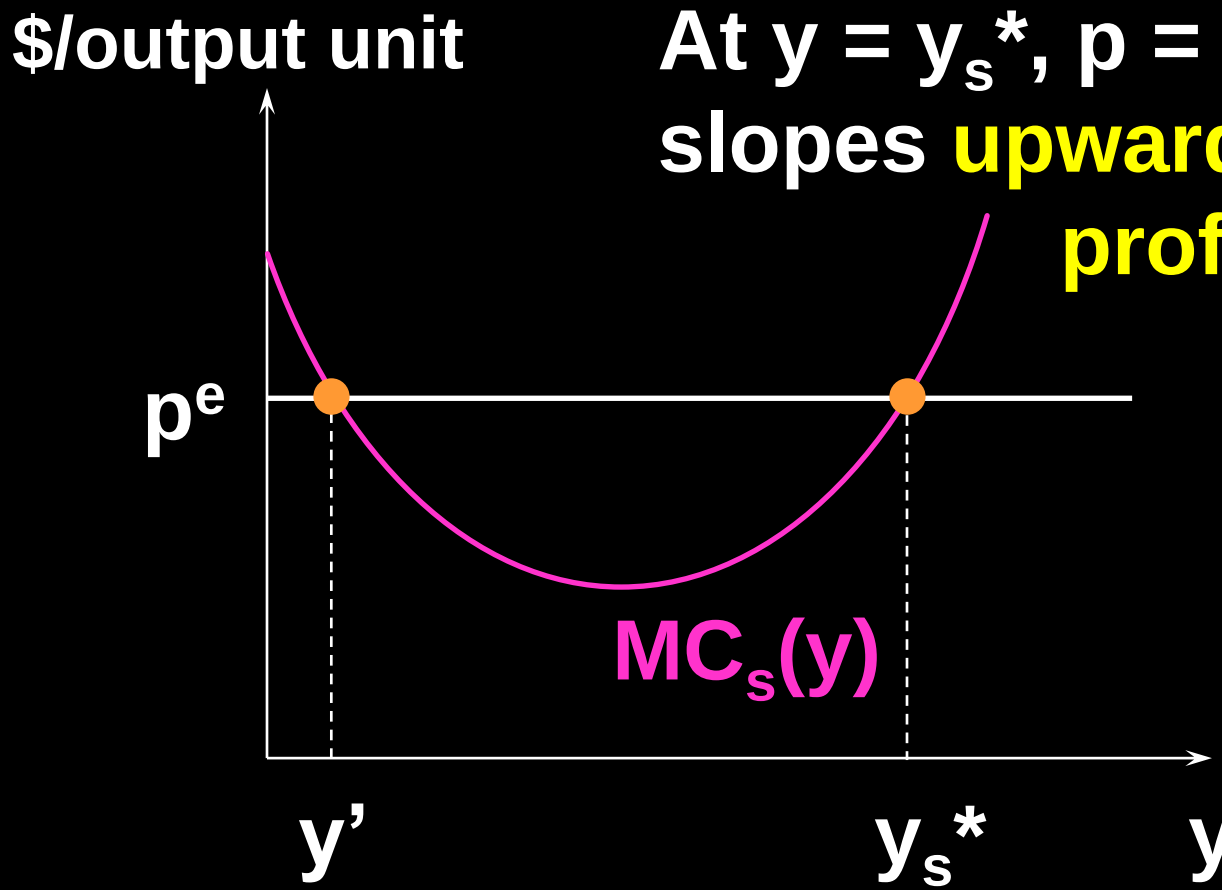
So at a profit maximum with $y_s^* > 0$, the firm's MC curve must be upward-sloping.

由二阶条件:利润最大化时MC(y)是随y单增的（向上倾斜）。

The Firm's Short-Run Supply Decision



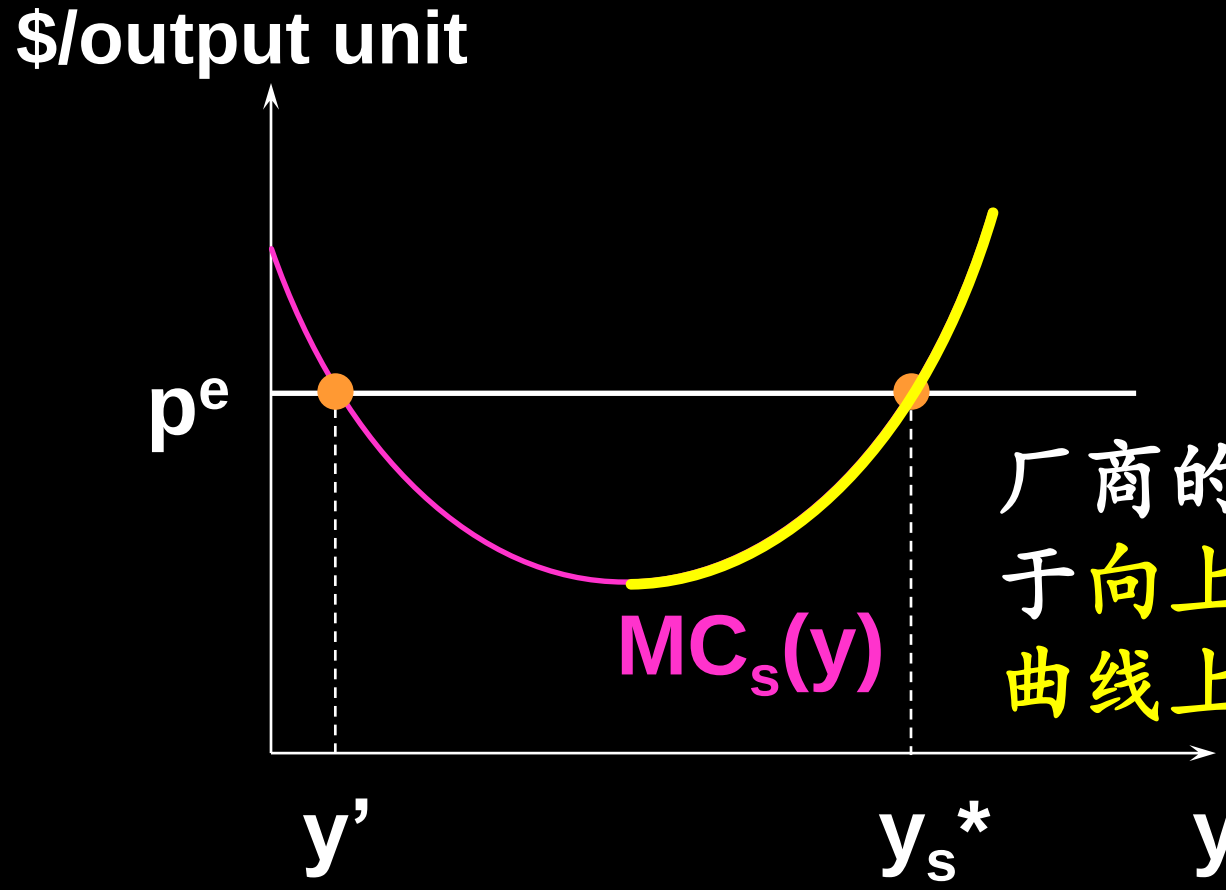
The Firm's Short-Run Supply Decision



At $y = y_s^*$, p = MC and MC slopes **upwards**. $y = y_s^*$ is **profit-maximizing**.

At y = y', p = MC and MC slopes **downwards**. y = y' is profit-minimizing.

The Firm's Short-Run Supply Decision



厂商的供给曲线一定位于向上倾斜的那一段MC曲线上

The Firm's Short-Run Supply Decision

- But not every point on the upward-sloping part of the firm's MC curve represents a profit-maximum.
- The firm's profit function is

$$\Pi_s(y) = py - c_s(y) = py - F - c_v(y).$$

- If the firm chooses y = 0 then its profit is

$$\Pi_s(y) = 0 - F - c_v(0) = -F.$$

The Firm's Short-Run Supply Decision

- So the firm will choose an output level y > 0 only if

$$\Pi_s(y) = py - F - c_v(y) \geq -F.$$

- I.e., only if

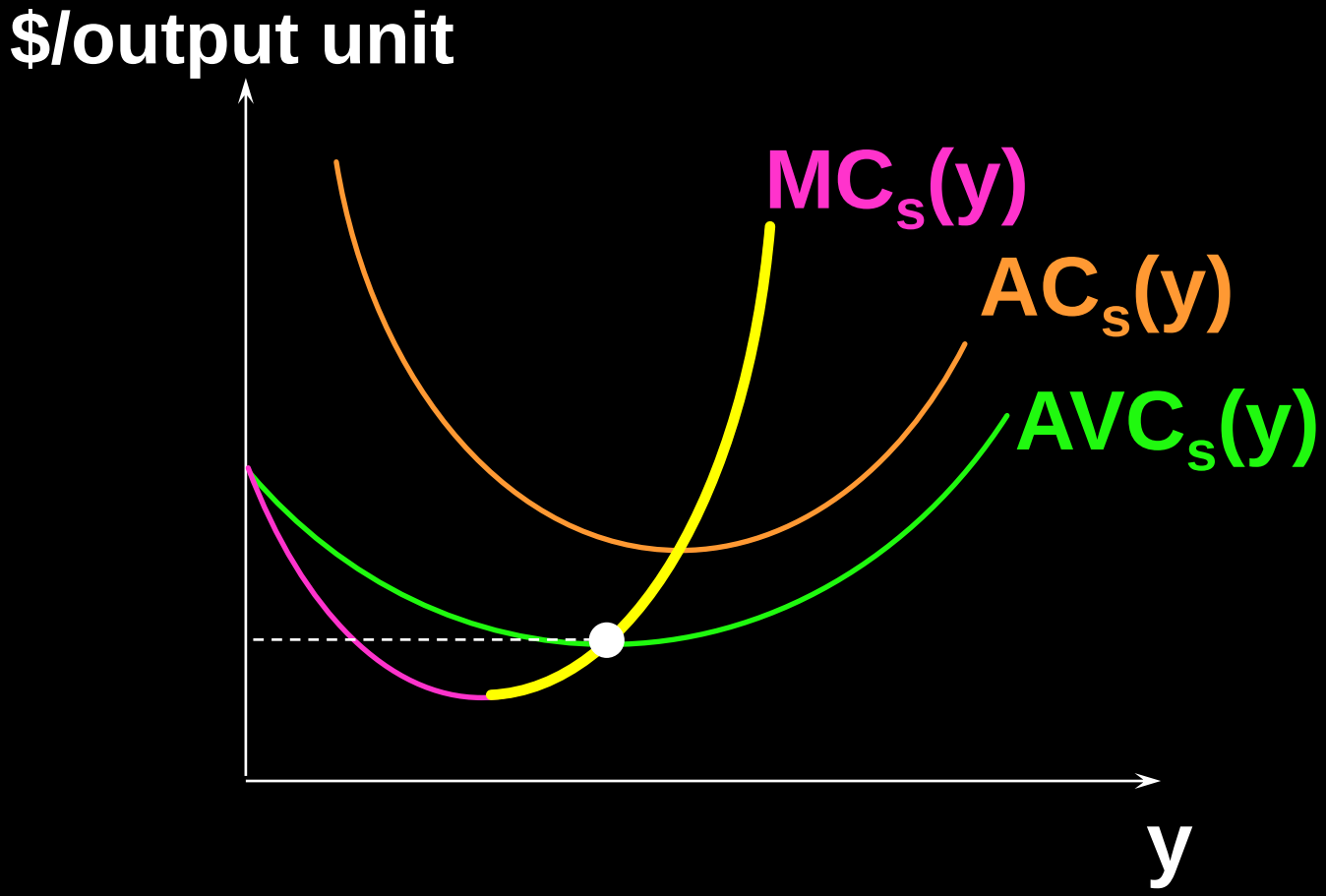
$$py - c_v(y) \geq 0$$

Equivalently, only if

$$p \geq \frac{c_v(y)}{y} = AVC_s(y).$$

当价格低于AVC时，企业的最优产量是0；当价格高于AVC时，企业才愿意供应一个正的产量

The Firm's Short-Run Supply Decision

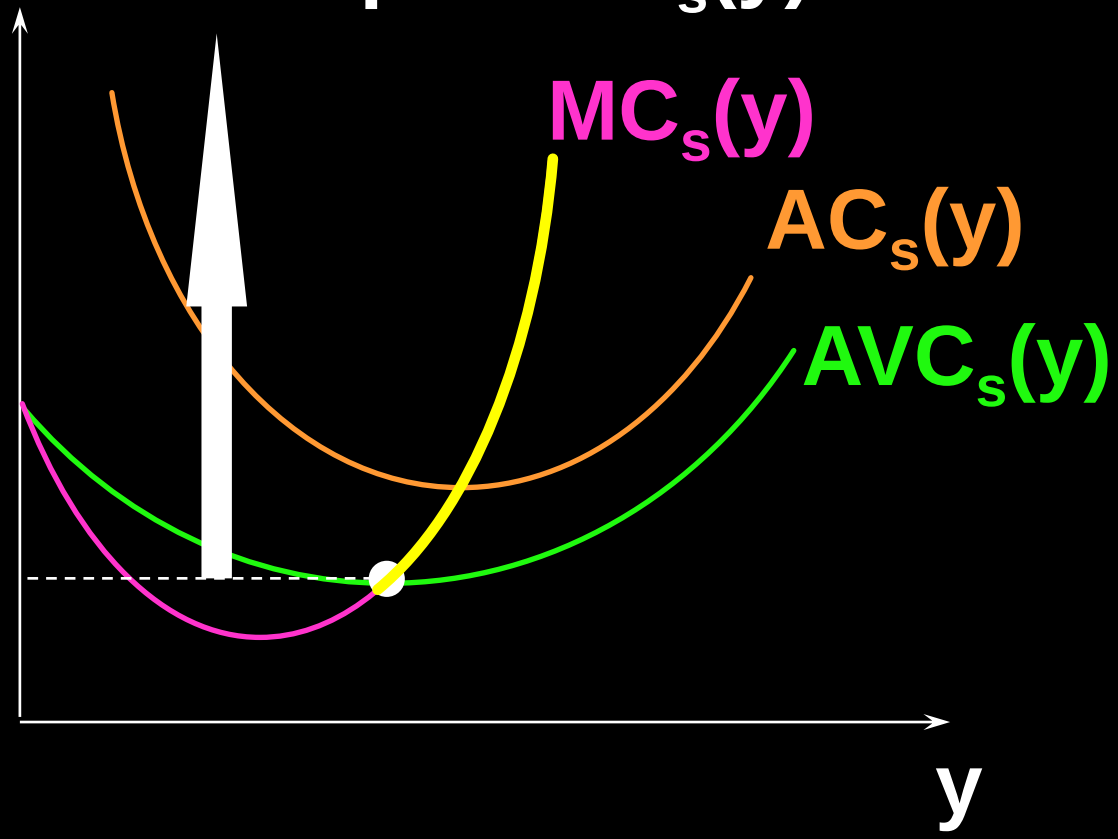


厂商的供给曲线一定位于向上倾斜的那一段MC曲线上

The Firm's Short-Run Supply Decision

$/output unit

$p > AVC_s(y) \Rightarrow y_s^* > 0.$



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The Firm's Short-Run Supply Decision

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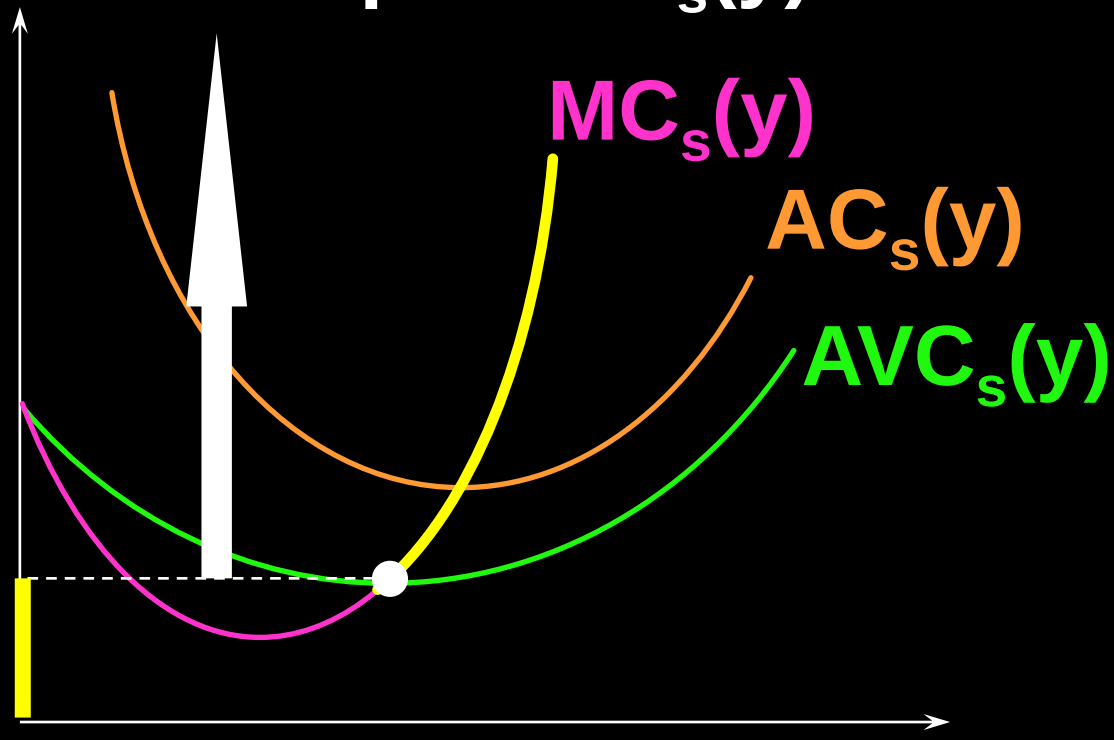

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The Firm's Short-Run Supply Decision

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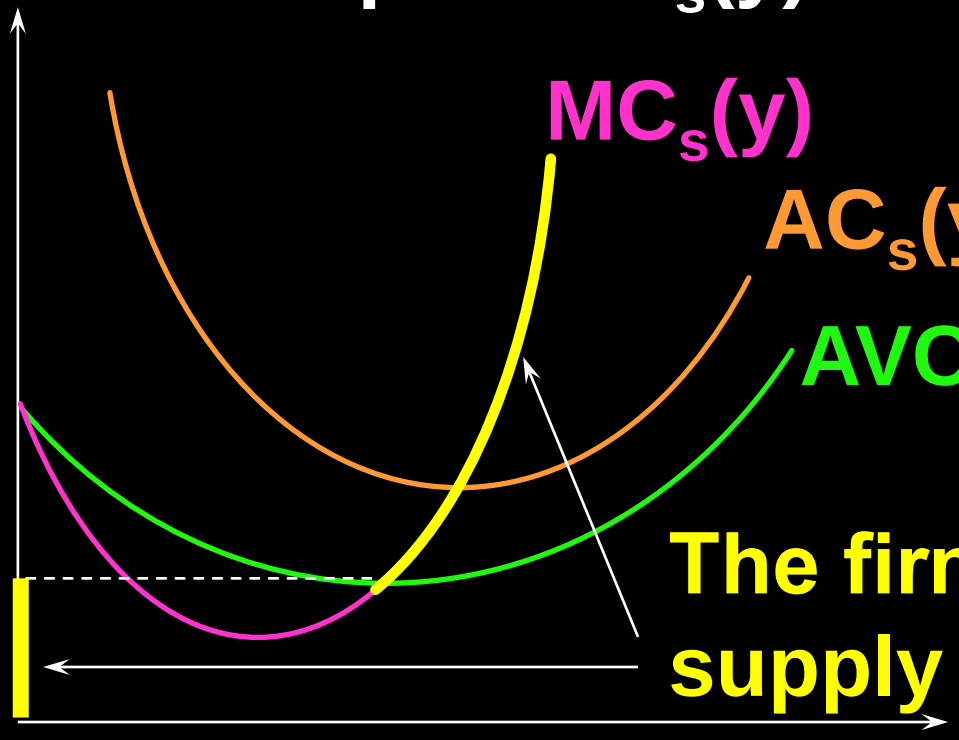

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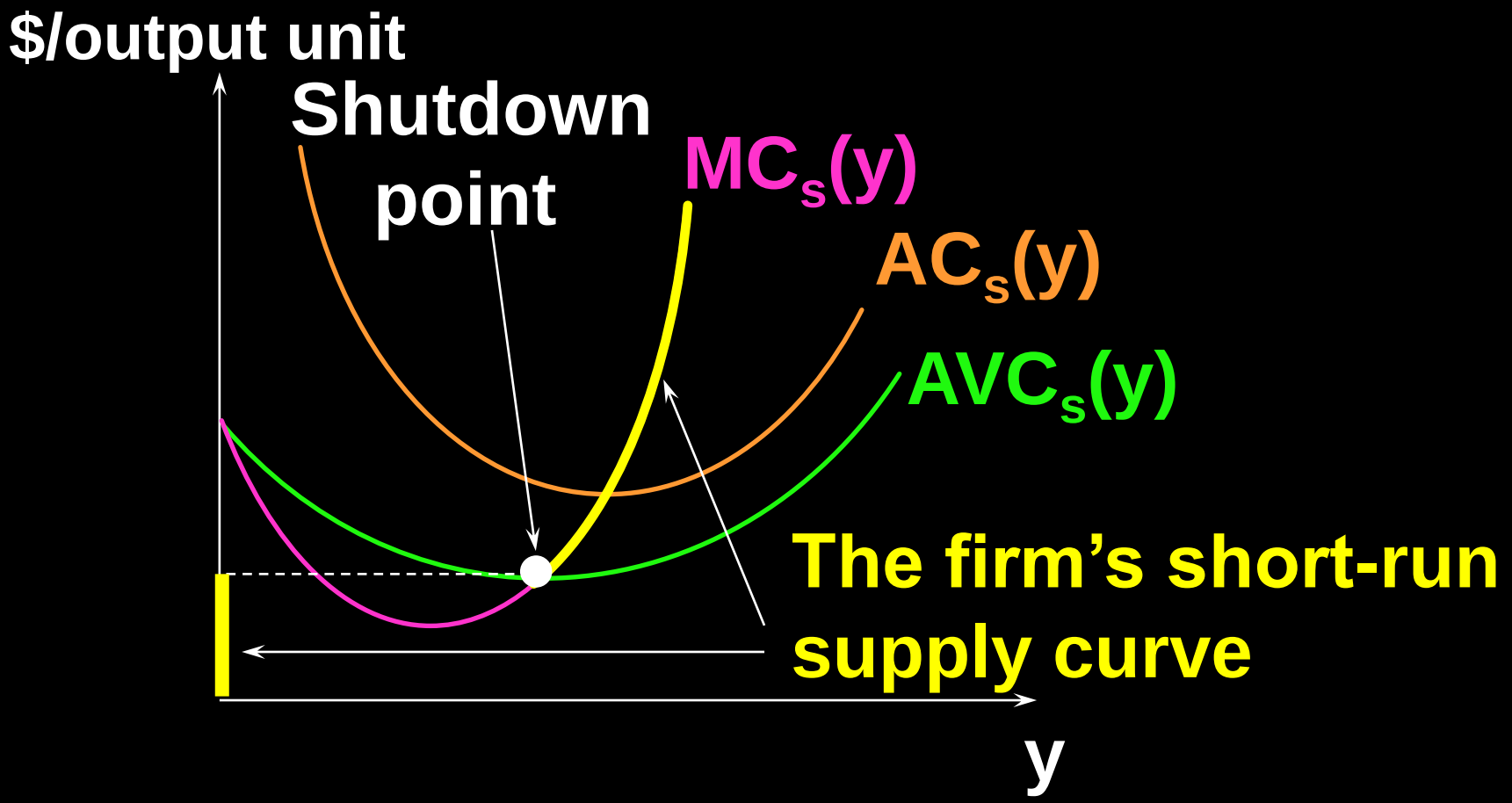
The Firm's Short-Run Supply Decision



The Firm's Short-Run Supply Decision

- 供给曲线是位于平均可变成本AVC曲线以上的、向上倾斜的那部分边际成本曲线。当价格低于AVC时，停产可以得到更多的利润（减少损失）。

The Firm's Short-Run Supply Decision

- **Shut-down is not the same as exit.**

  停产不同于退出市场，停产是短期行为且仍需支付固定成本（利润 = −F）
- **Shutting-down means producing no output (but the firm is still in the industry and suffers its fixed cost).**
- **Exiting means leaving the industry, which the firm can do only in the long-run.**

The Firm's Long-Run Supply Decision

- **The long-run is the circumstance in which the firm can choose amongst all of its short-run circumstances.**
- **How does the firm's long-run supply decision compare to its short-run supply decisions?**

The Firm's Long-Run Supply Decision

- A competitive firm's long-run profit function is

$$\Pi(y) = py - c(y).$$

- The long-run cost c(y) of producing y units of output consists only of variable costs since all inputs are variable in the long-run.

The Firm's Long-Run Supply Decision

- The firm's long-run supply level decision is to

$$\max_{y \geq 0} \Pi(y) = py - c(y).$$

- The 1st and 2nd-order maximization conditions are, for $y^* > 0$,

$$p = MC(y) \text{ and } \frac{dMC(y)}{dy} > 0.$$

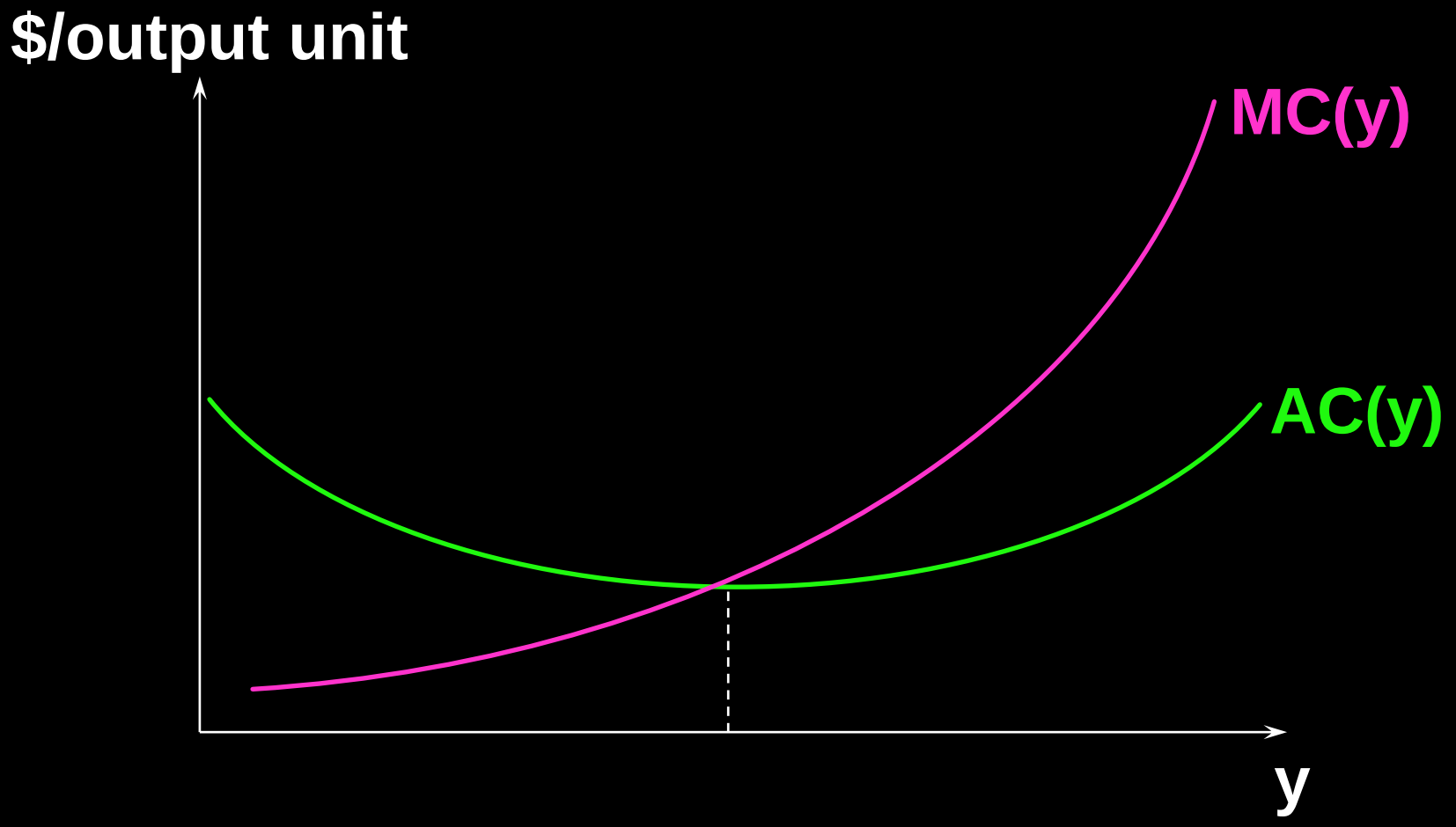
The Firm's Long-Run Supply Decision

- **Additionally, the firm's economic profit level must not be negative since then the firm would exit the industry. So,**

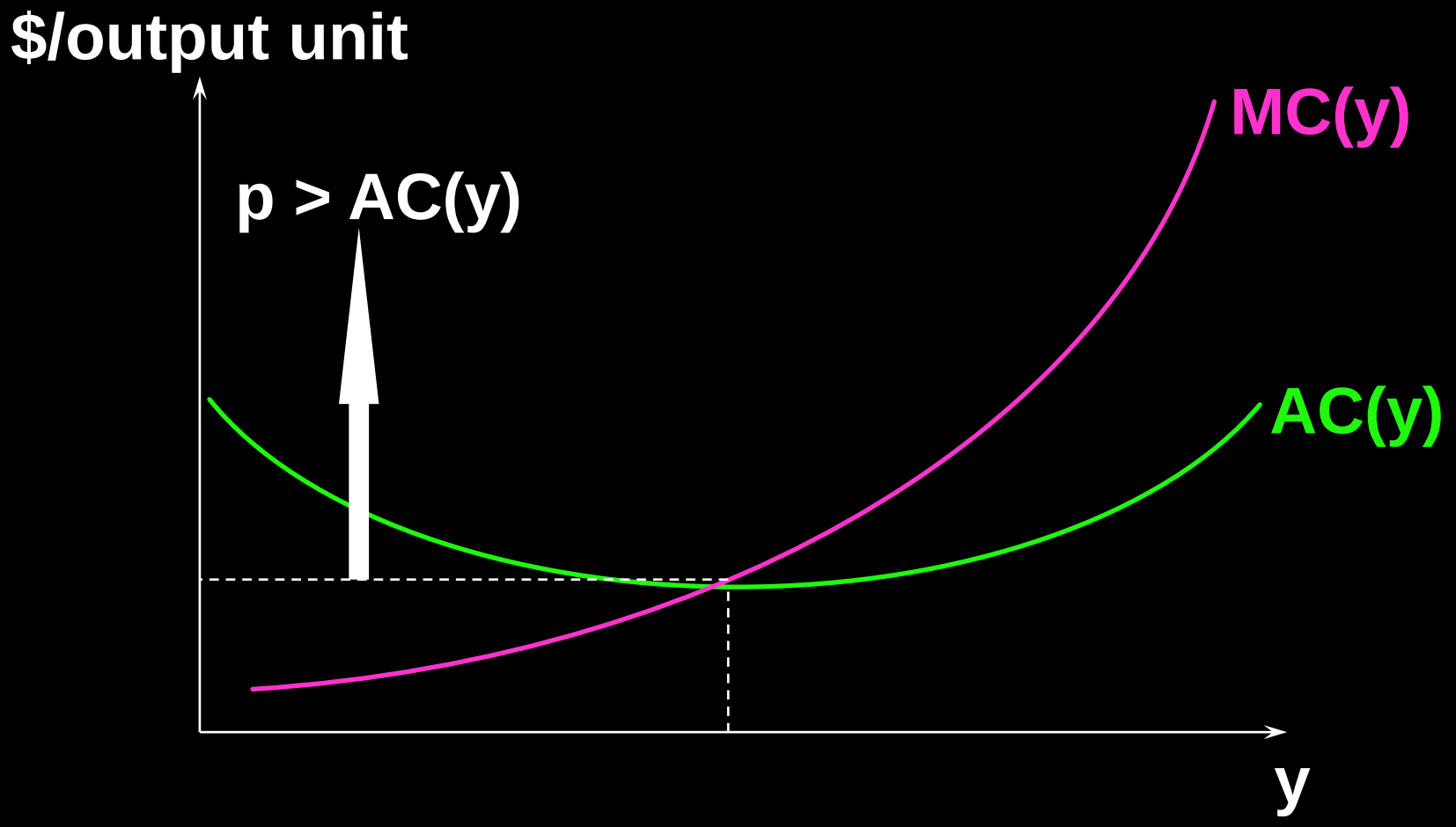
$$\Pi(y) = py - c(y) \geq 0$$

$$\Rightarrow \quad p \geq \frac{c(y)}{y} = AC(y).$$

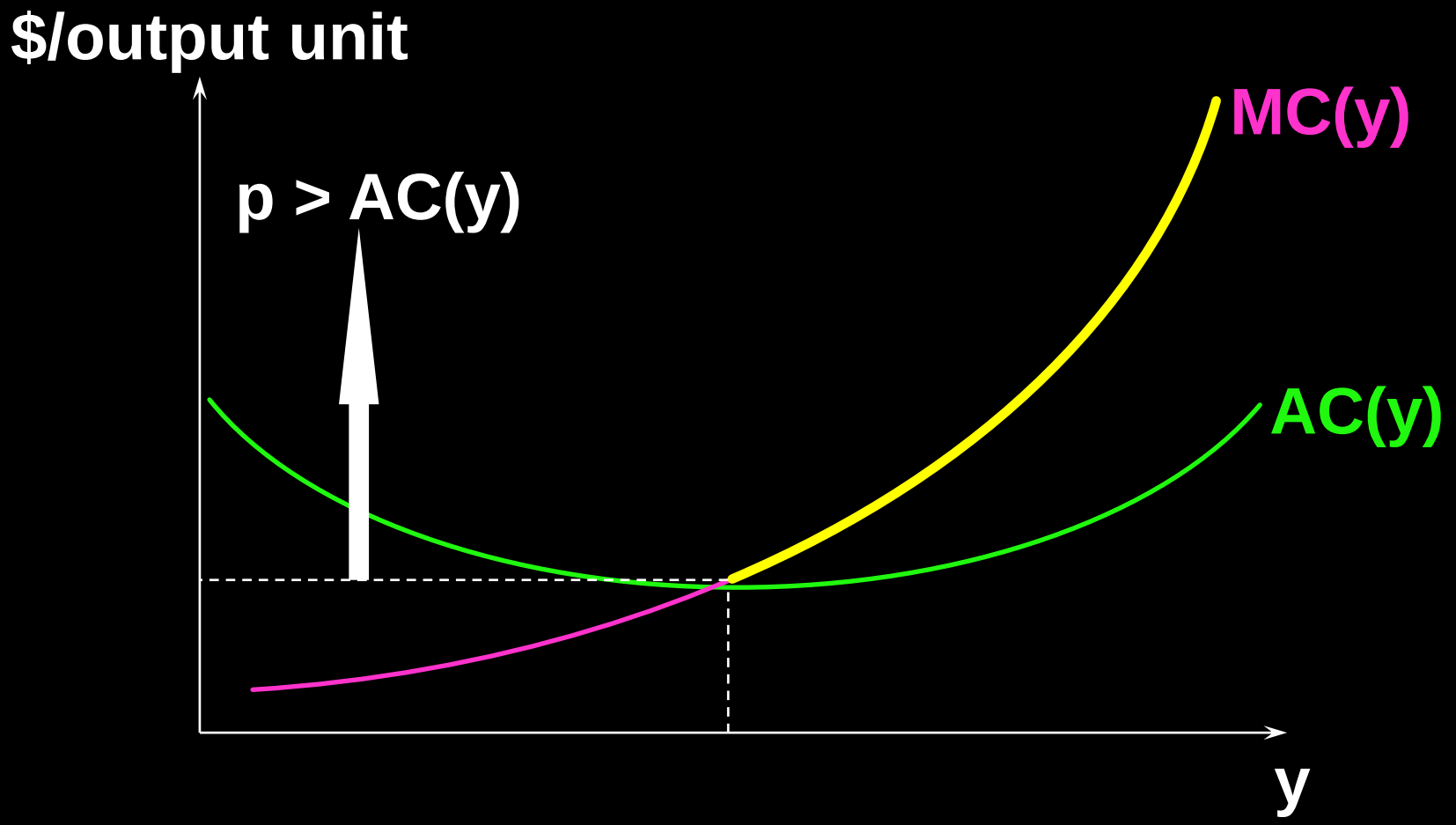
The Firm's Long-Run Supply Decision



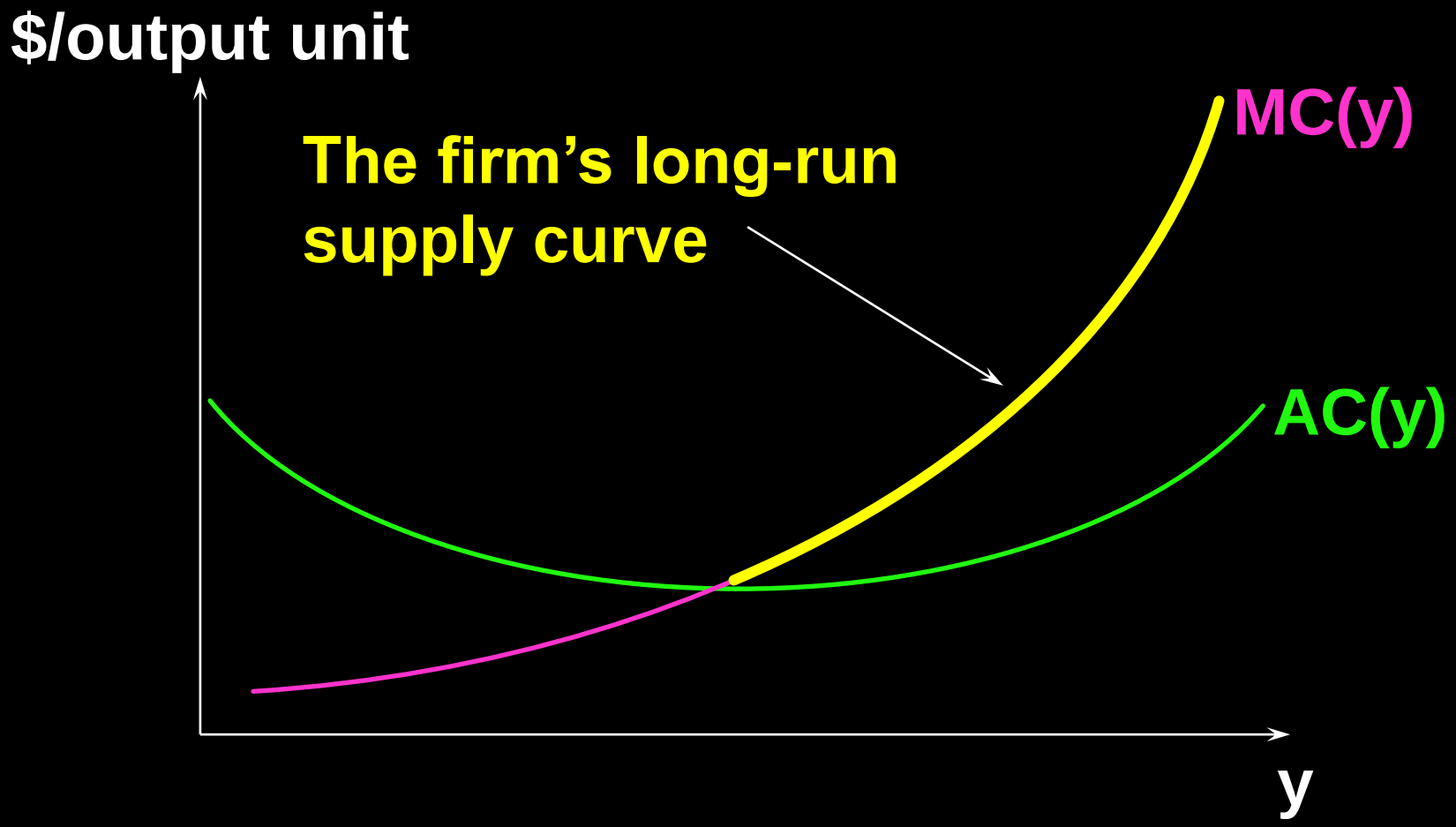
The Firm's Long-Run Supply Decision



The Firm's Long-Run Supply Decision



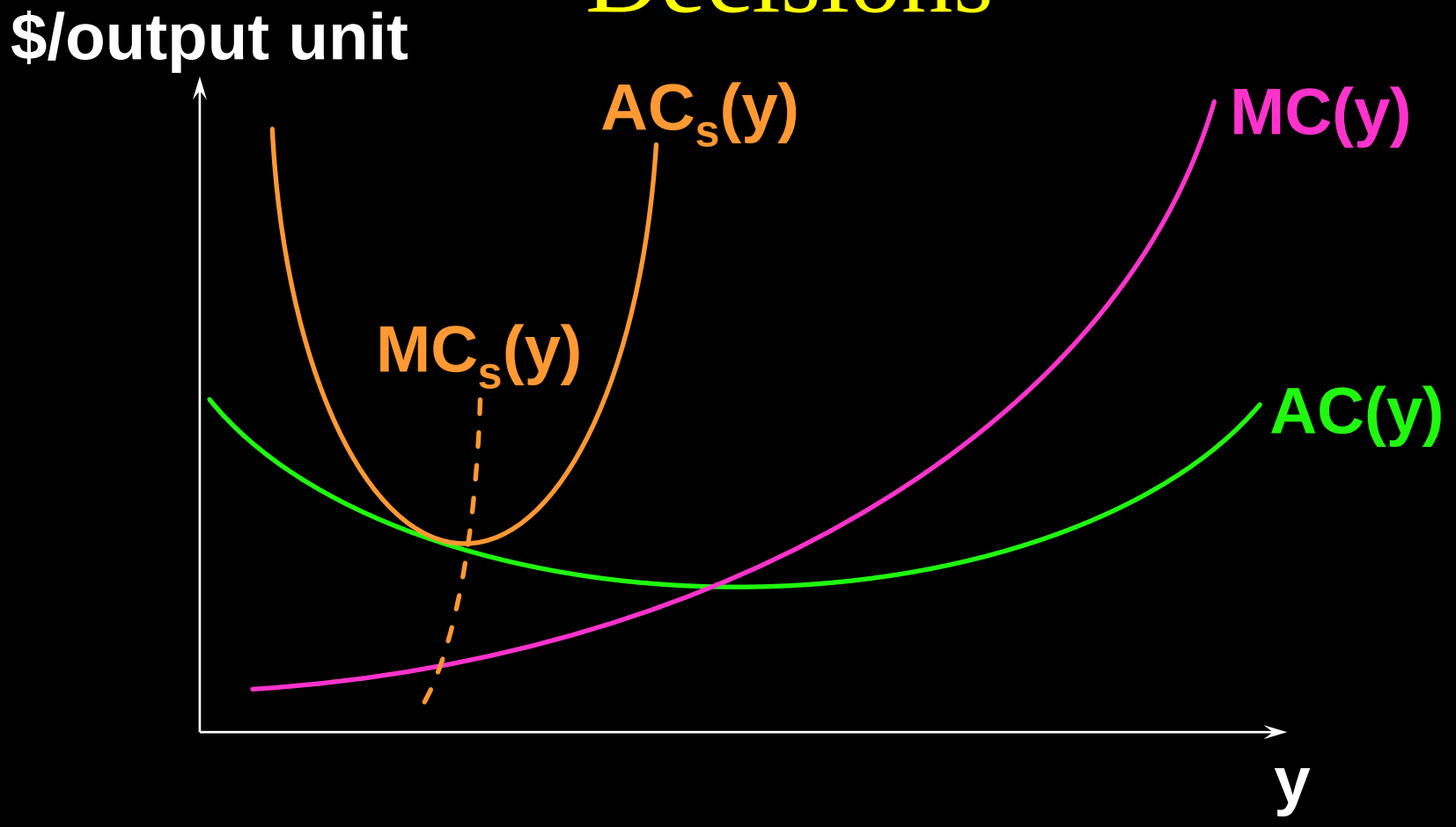
The Firm's Long-Run Supply Decision



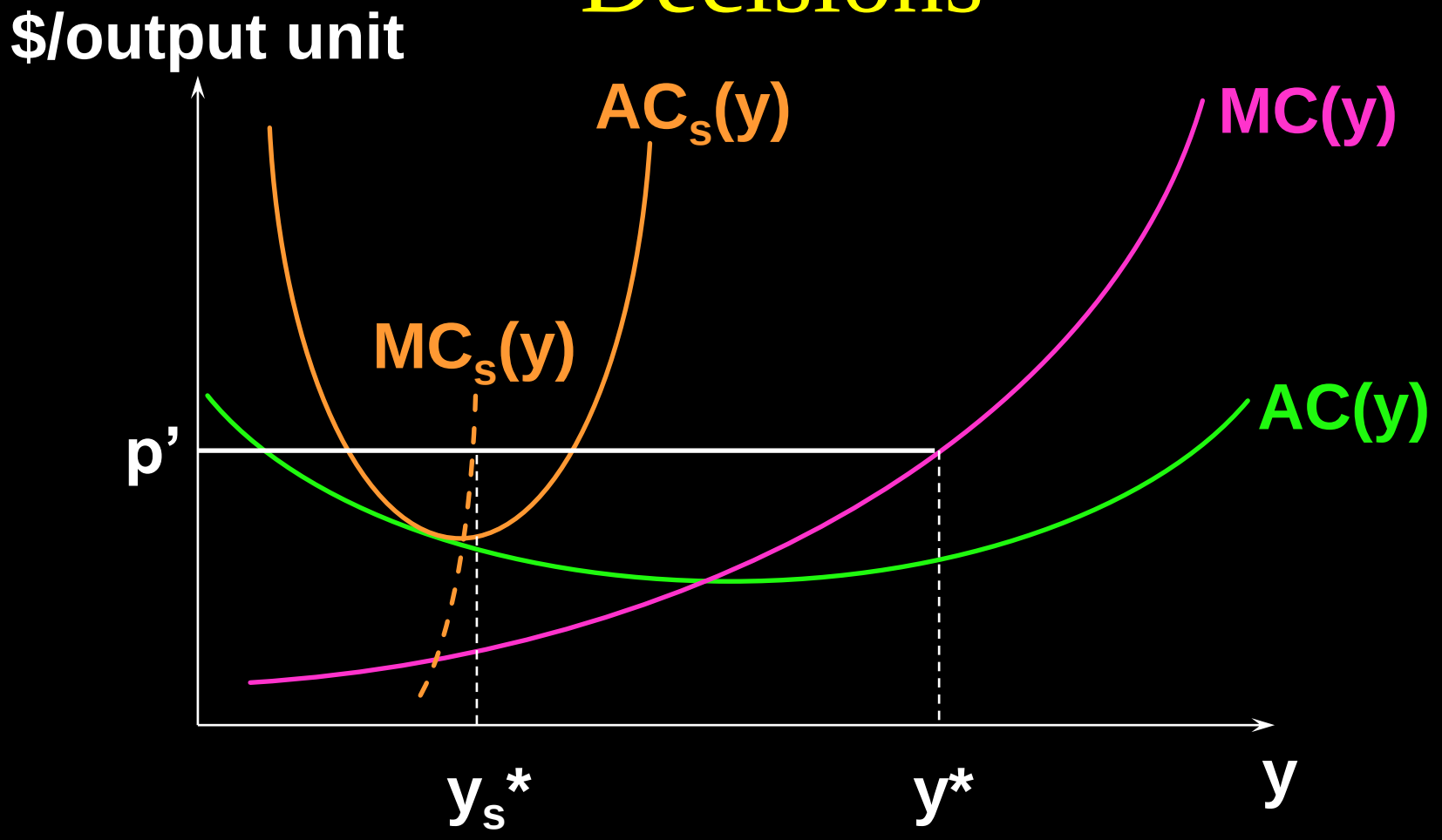
The Firm's Long-Run Supply Decision

- **How is the firm's long-run supply curve related to all of its short-run supply curves?**

The Firm's Long & Short-Run Supply Decisions

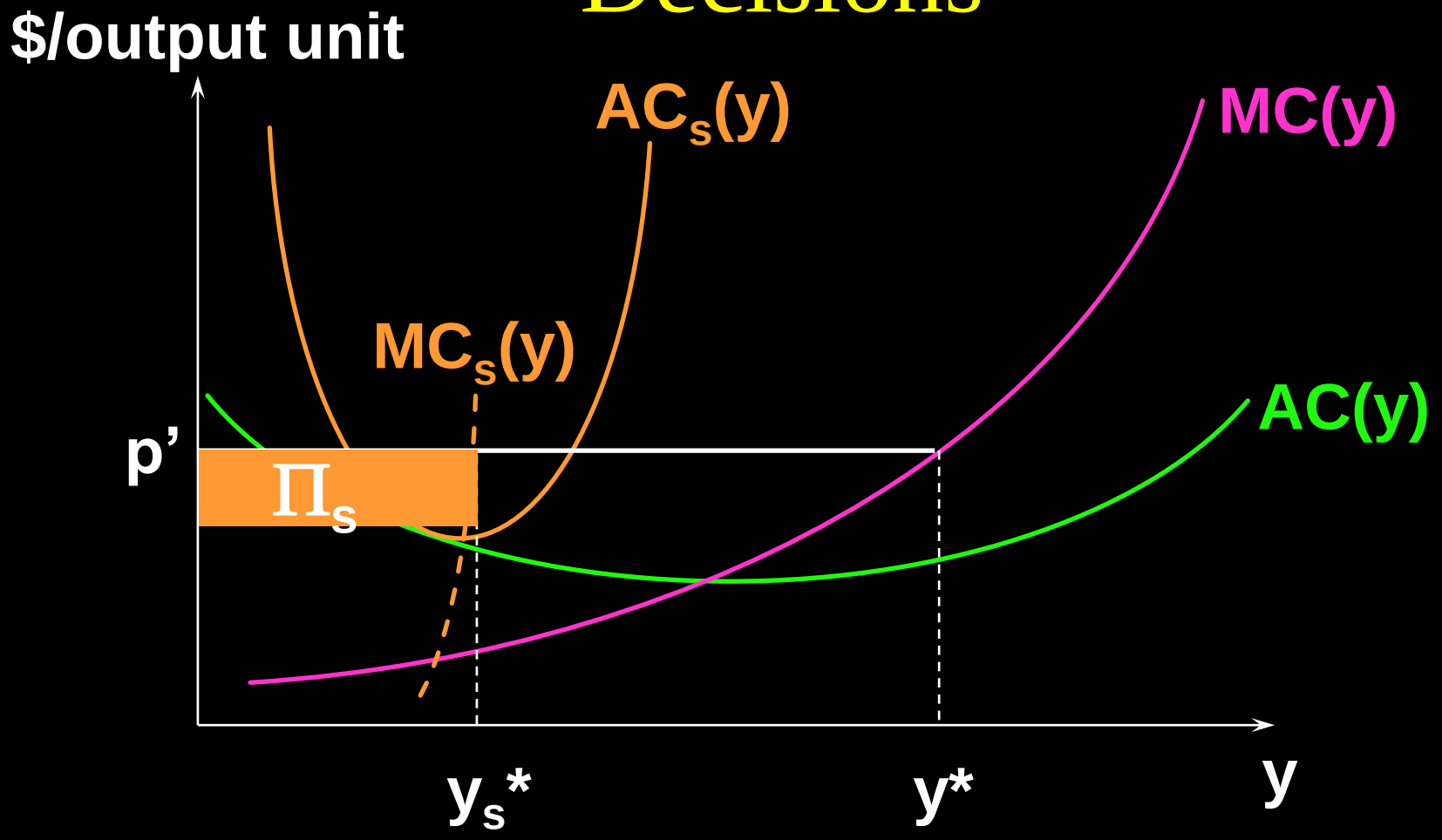


The Firm's Long & Short-Run Supply Decisions



y_s^* is profit-maximizing in this short-run.

The Firm's Long & Short-Run Supply Decisions



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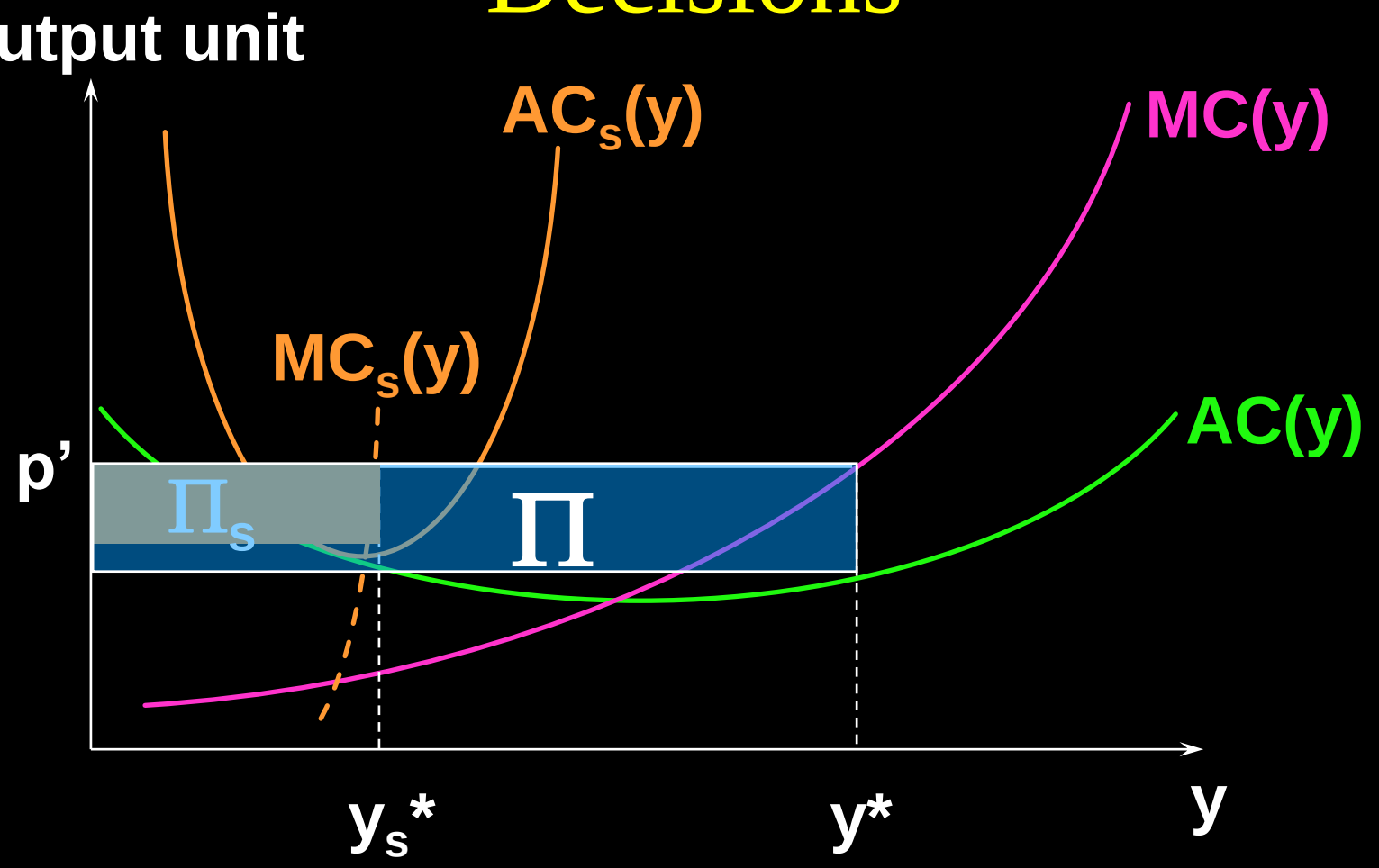
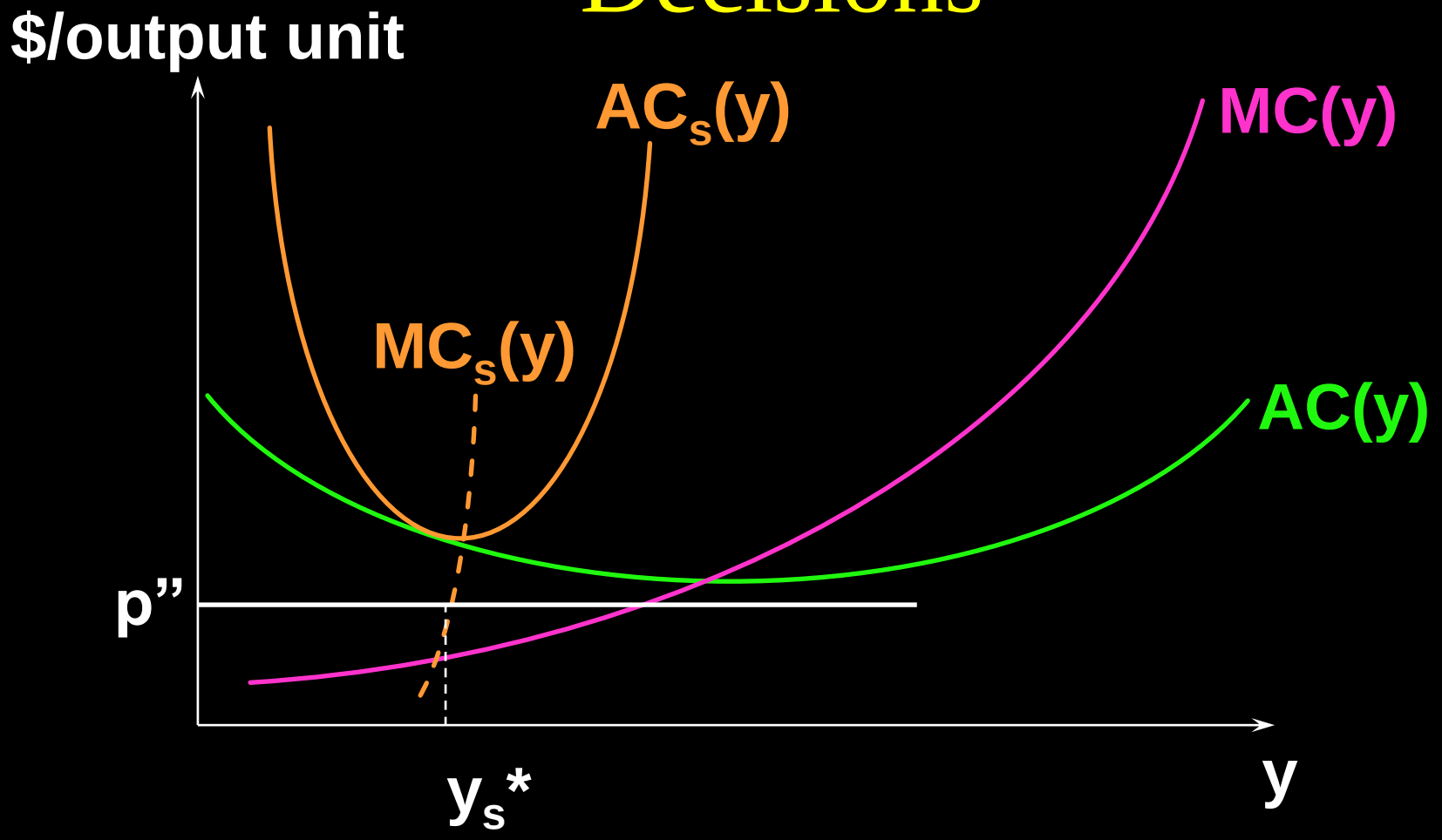
The Firm's Long & Short-Run Supply Decisions



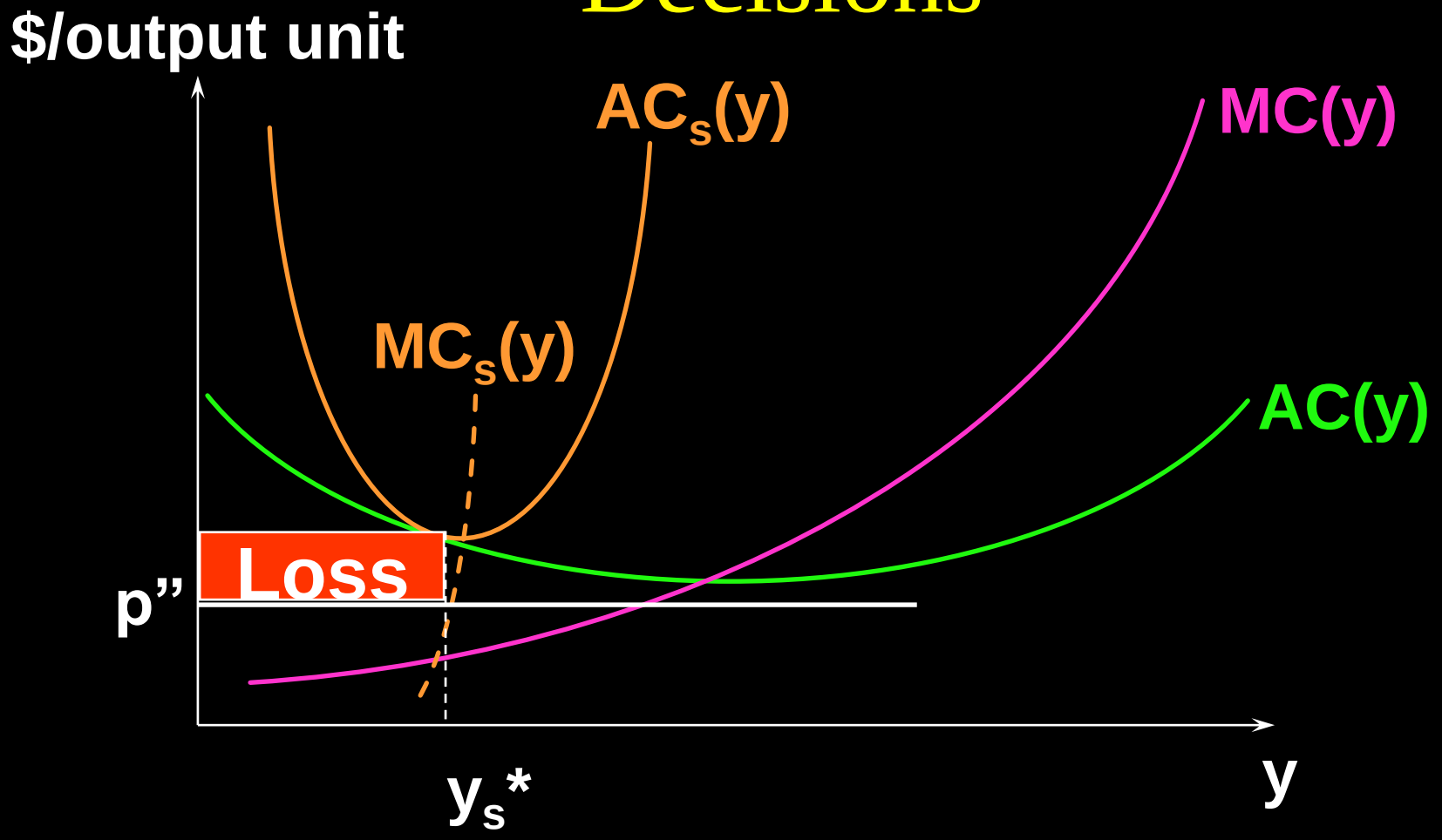
The firm can increase profit by increasing x_2 and producing y* output units.

The Firm's Long & Short-Run Supply Decisions



y_s^* is loss-minimizing in this short-run.

The Firm's Long & Short-Run Supply Decisions



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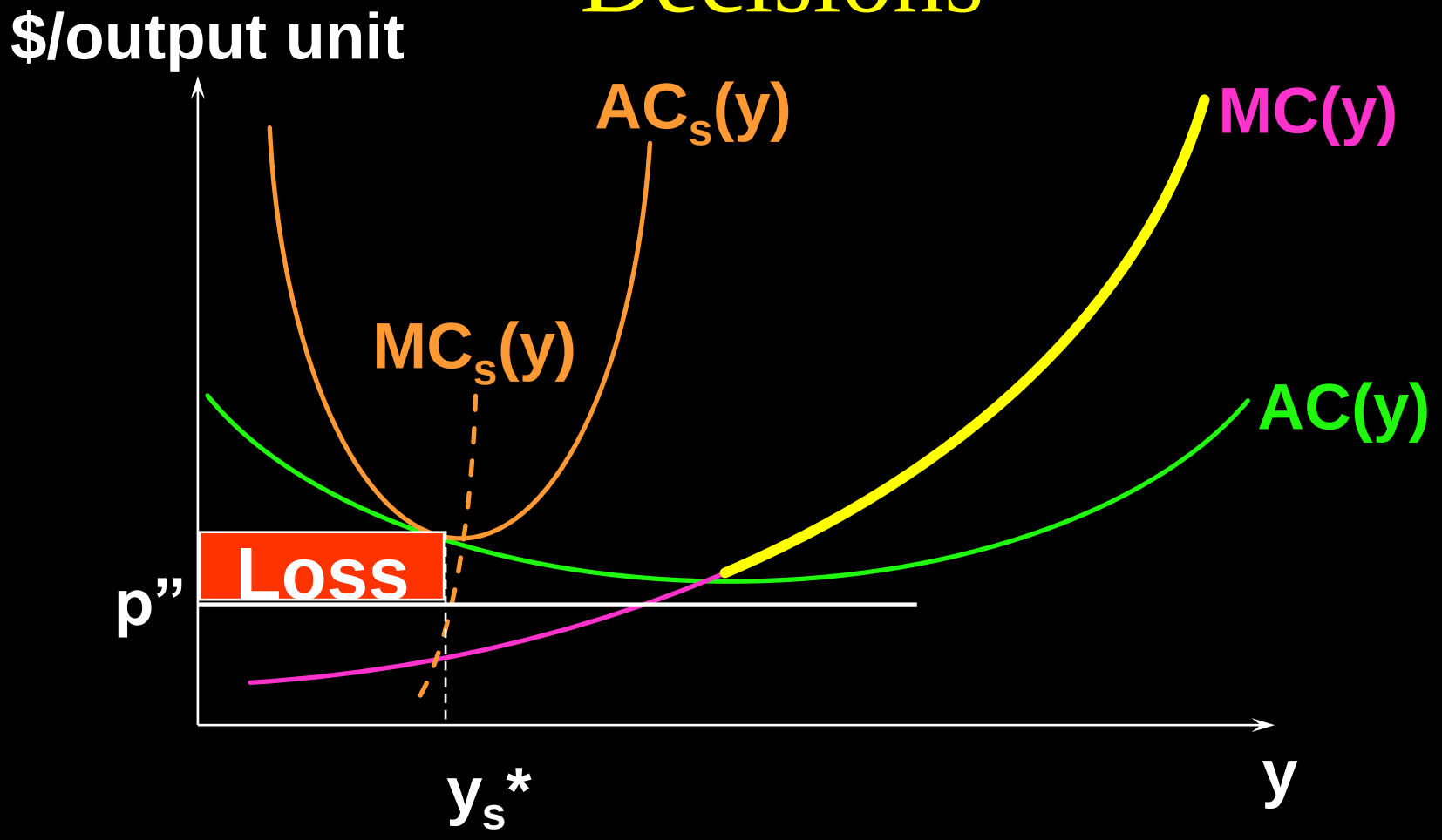
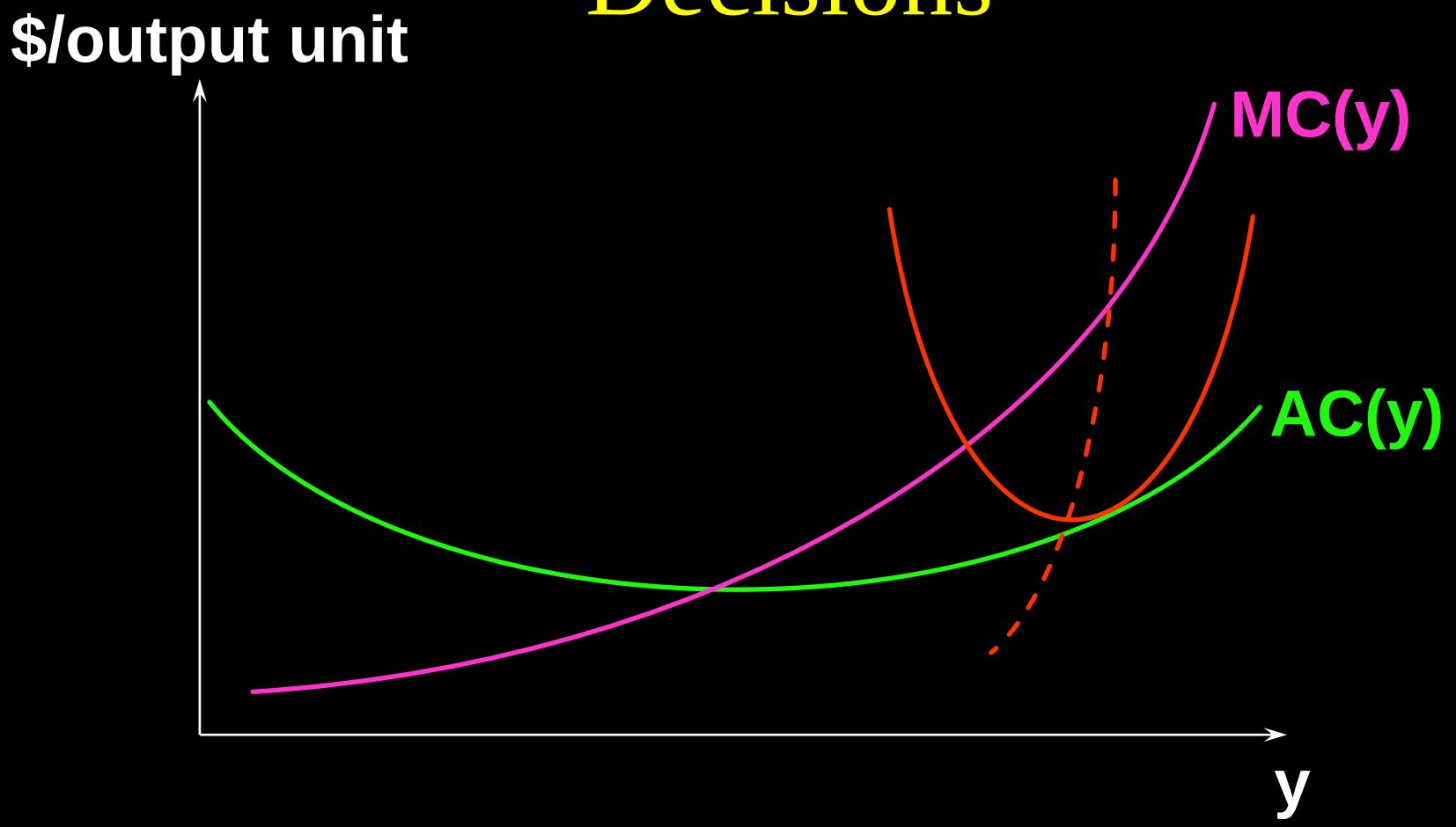
The Firm's Long & Short-Run Supply Decisions

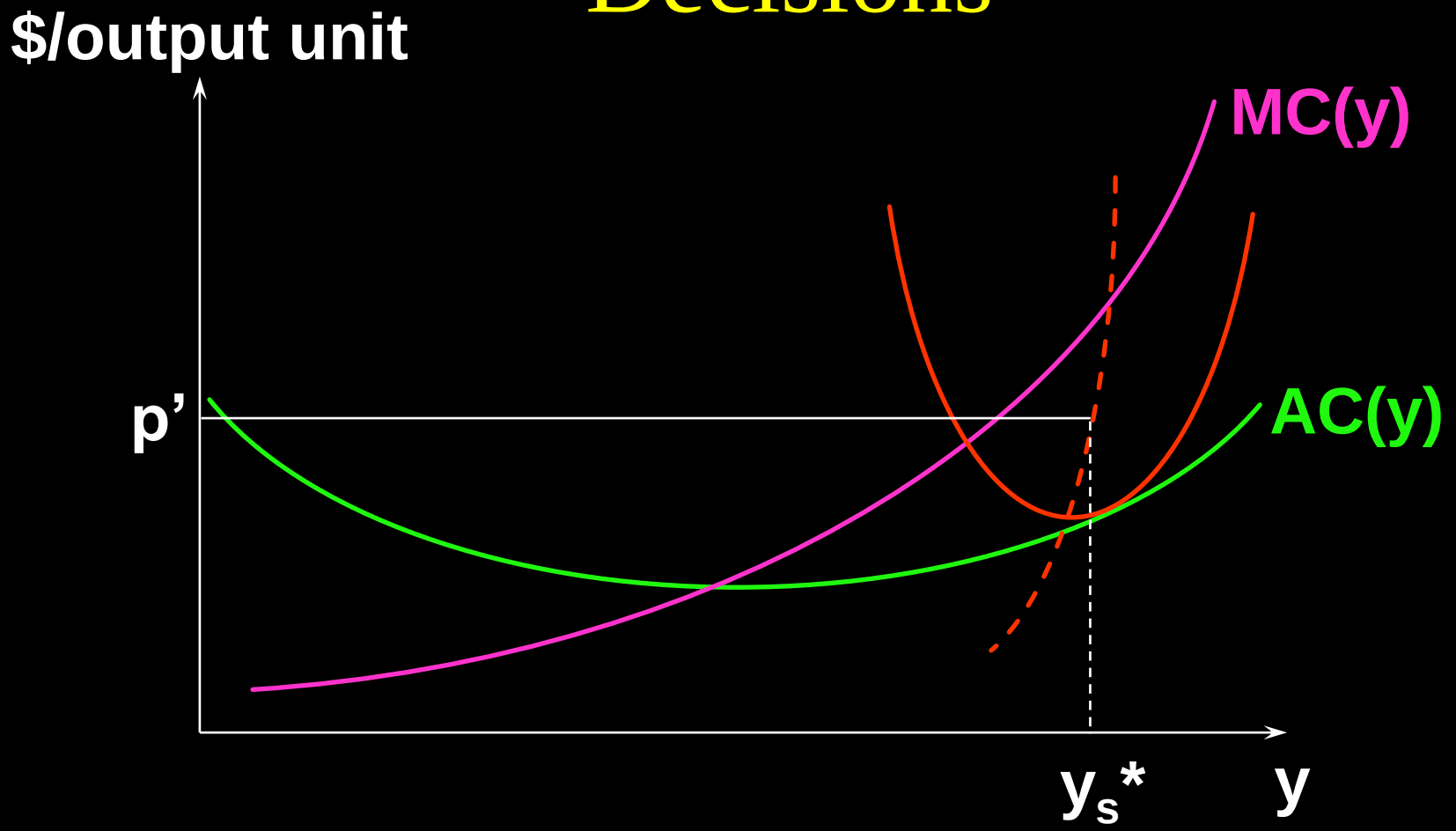


This loss can be eliminated in the long-run by the firm exiting the industry.

The Firm's Long & Short-Run Supply Decisions

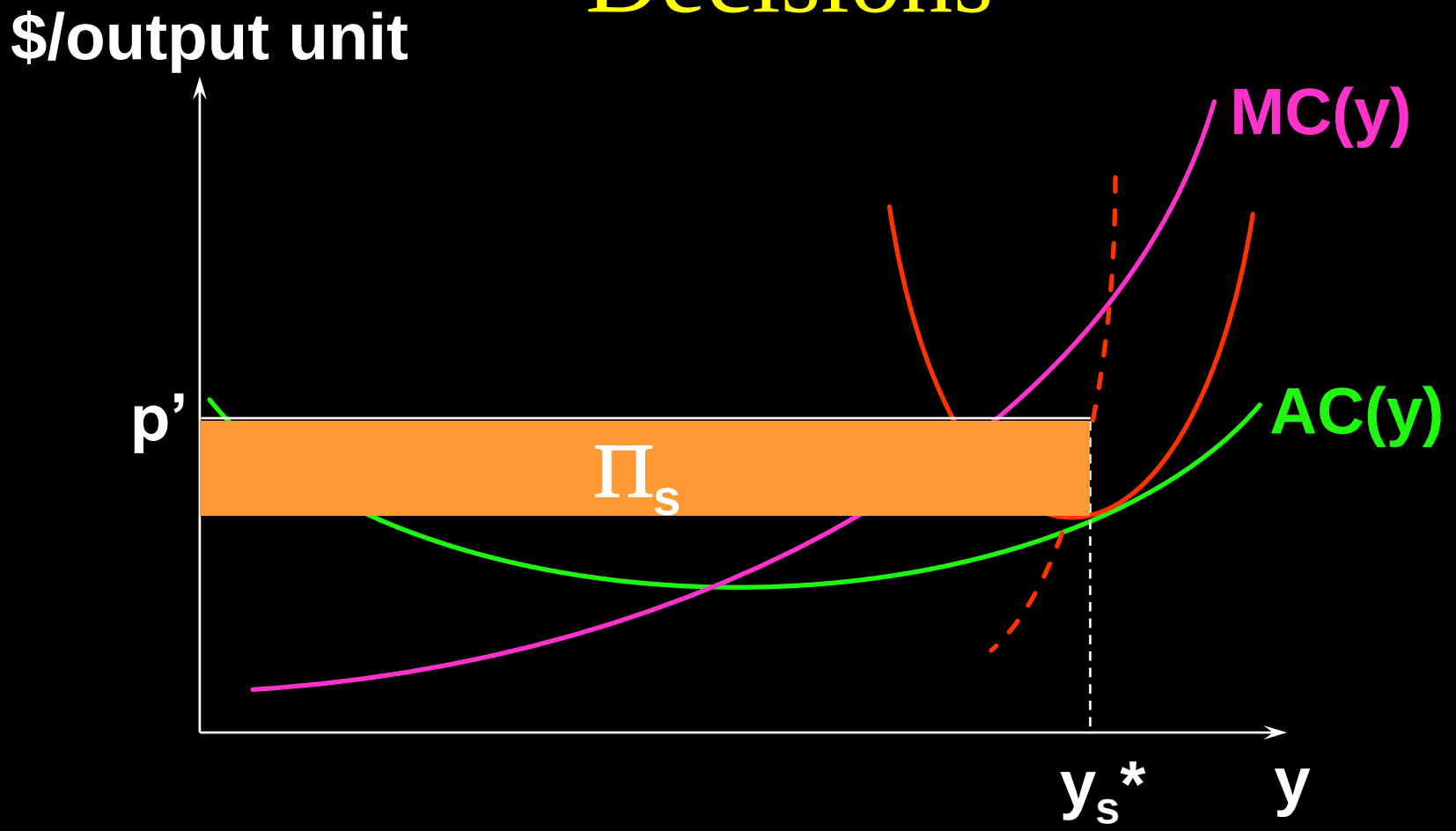


The Firm's Long & Short-Run Supply Decisions



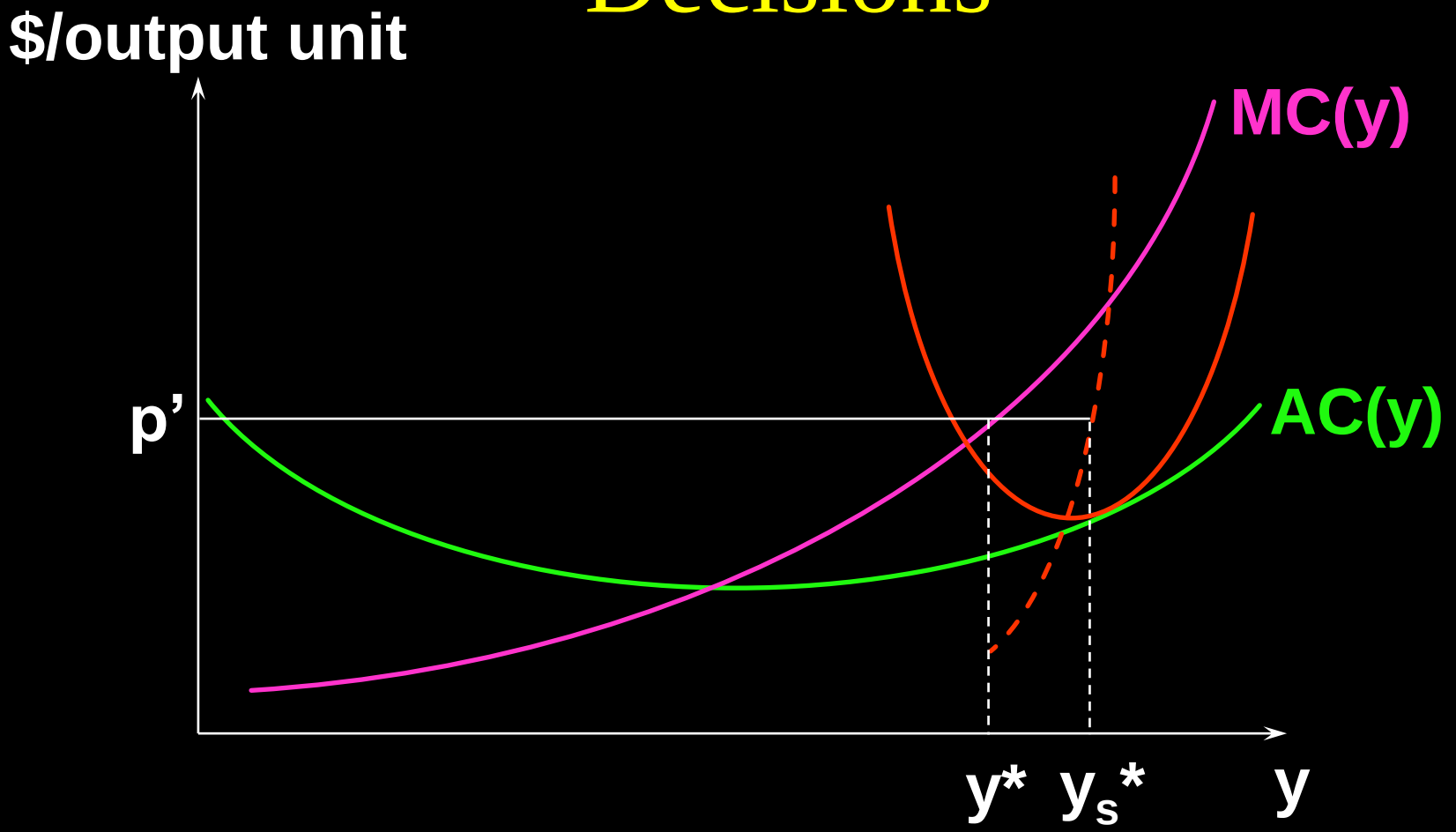
y_s^* is profit-maximizing in this short-run.

The Firm's Long & Short-Run Supply Decisions



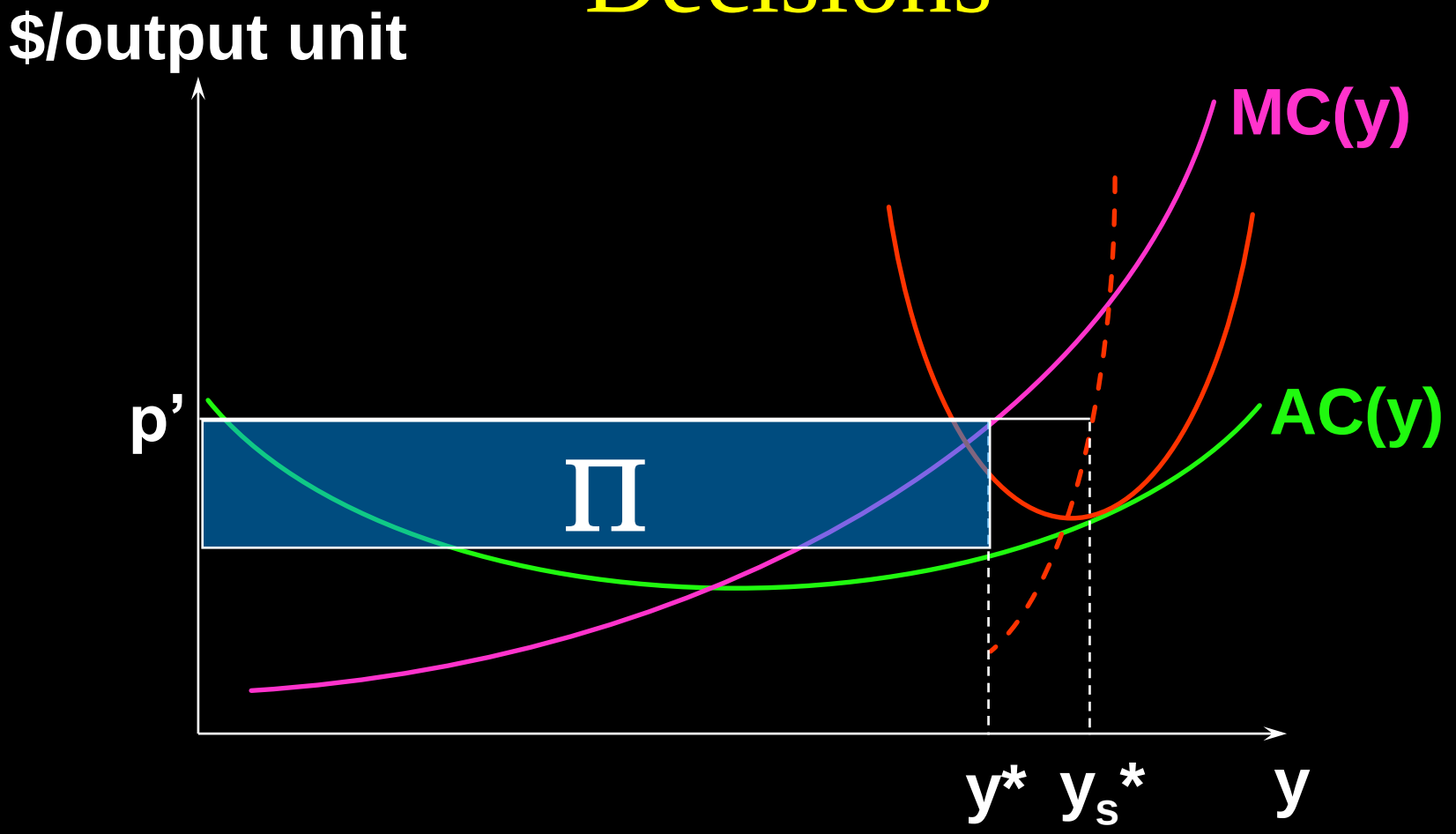
y_s^* is profit-maximizing in this short-run.

The Firm's Long & Short-Run Supply Decisions



y_s* is profit-maximizing in this short-run.
y* is profit-maximizing in the long-run.

The Firm's Long & Short-Run Supply Decisions



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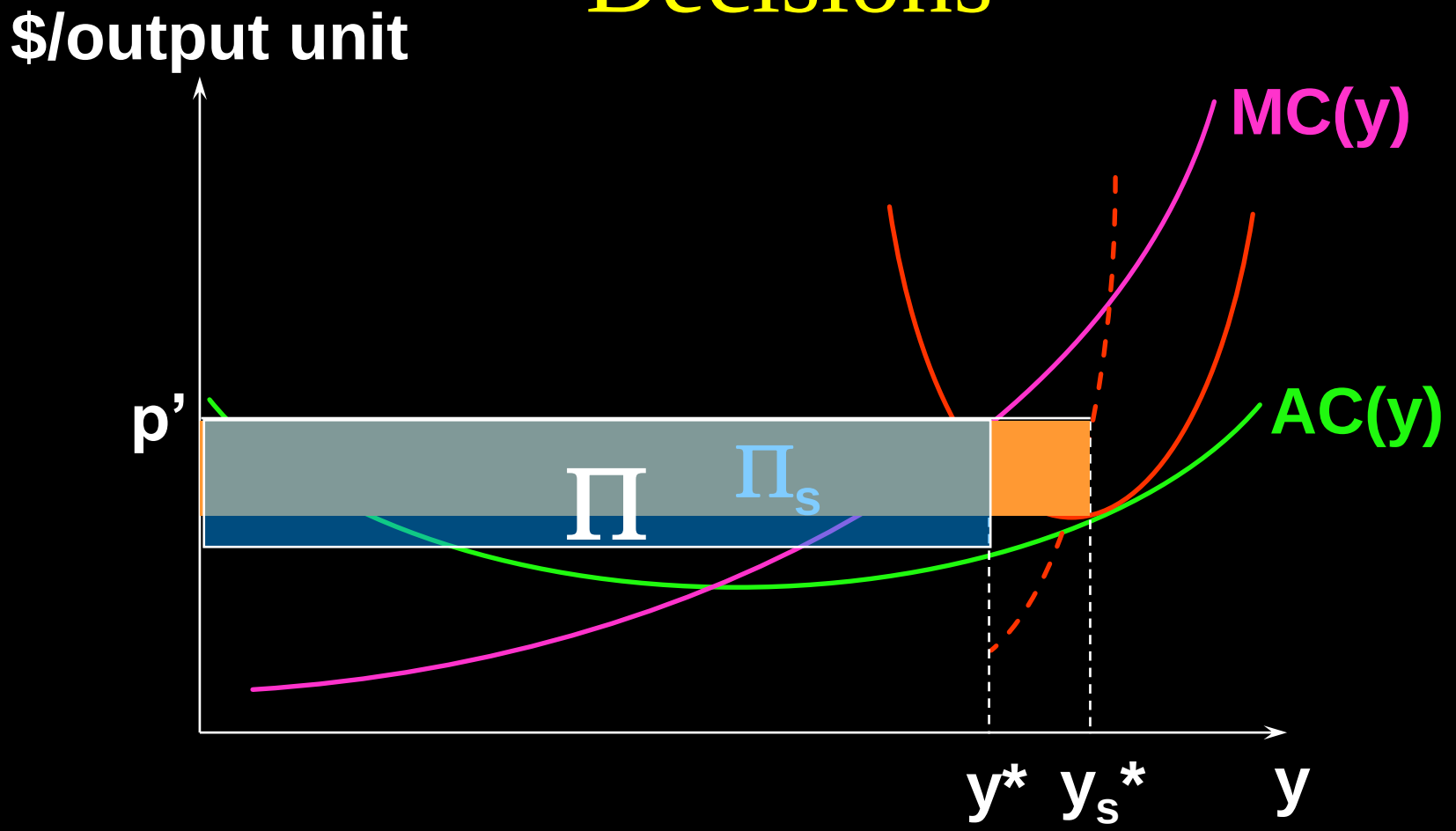
The Firm's Long & Short-Run Supply Decisions



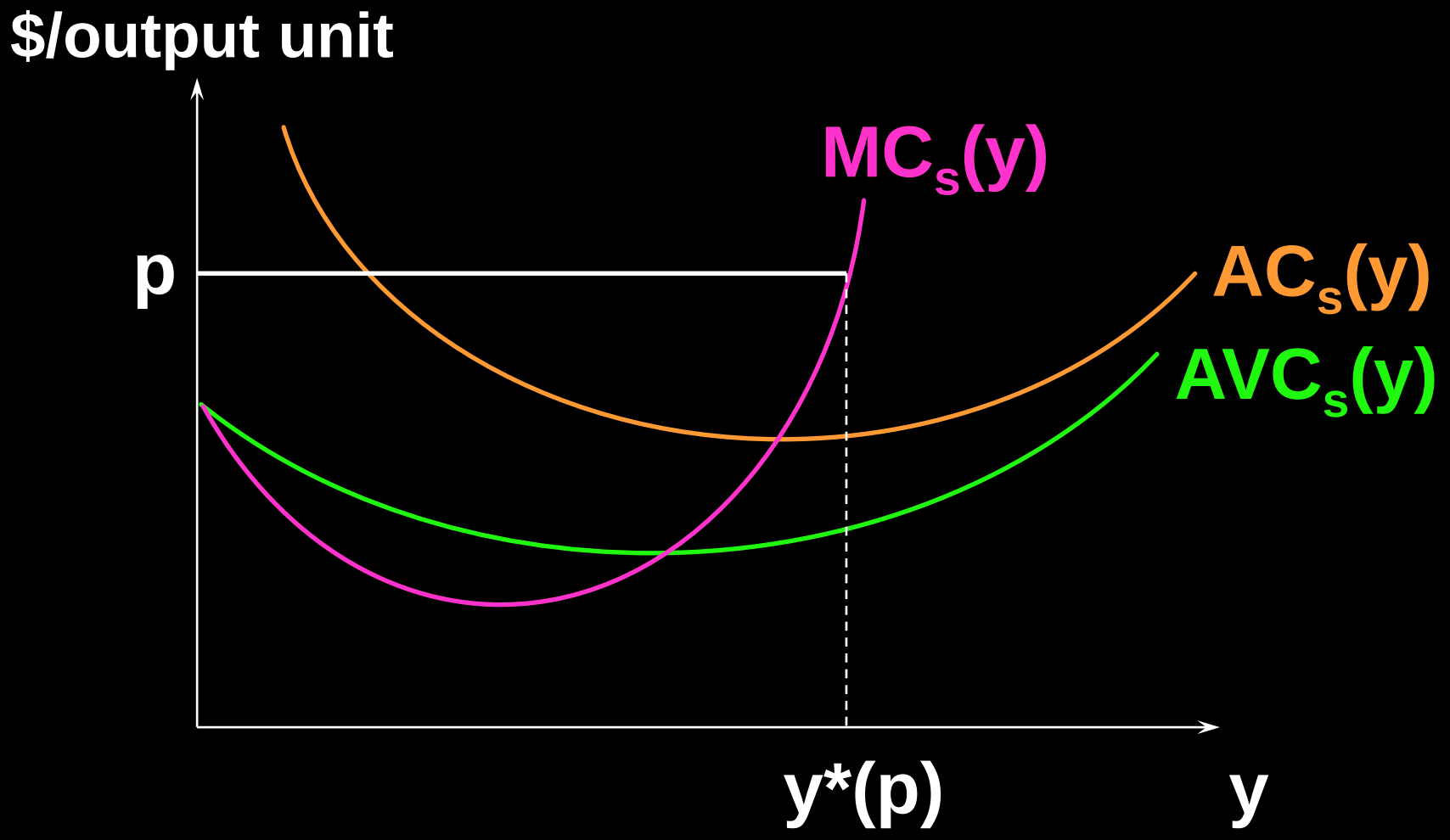
The firm can increase profit by reducing x_2 and producing y* units of output.

Producer's Surplus Revisited

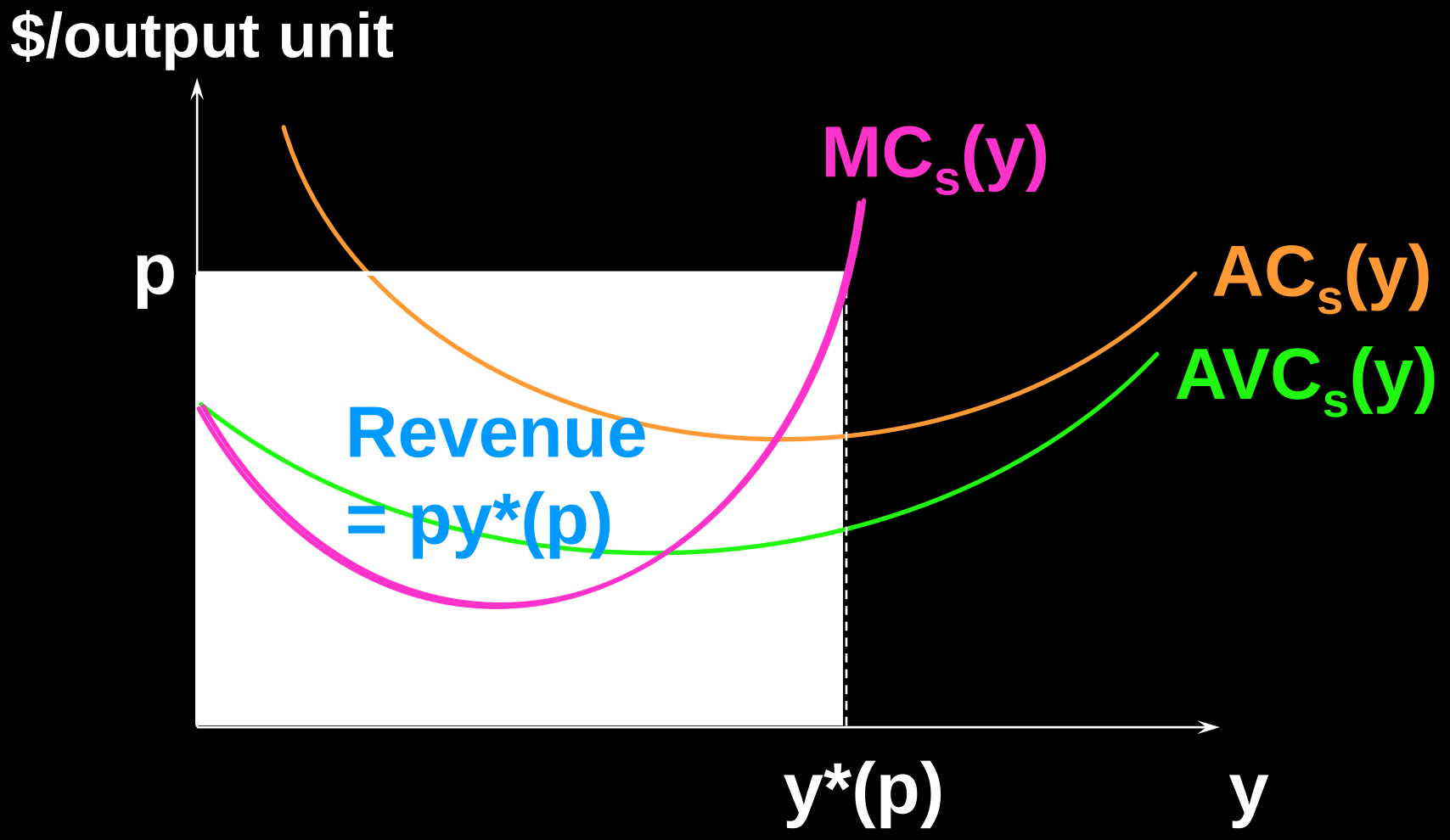
- **The firm's producer's surplus is the accumulation, unit by extra unit of output, of extra revenue less extra production cost.**

  生产者剩余是总收益和总可变成本之差

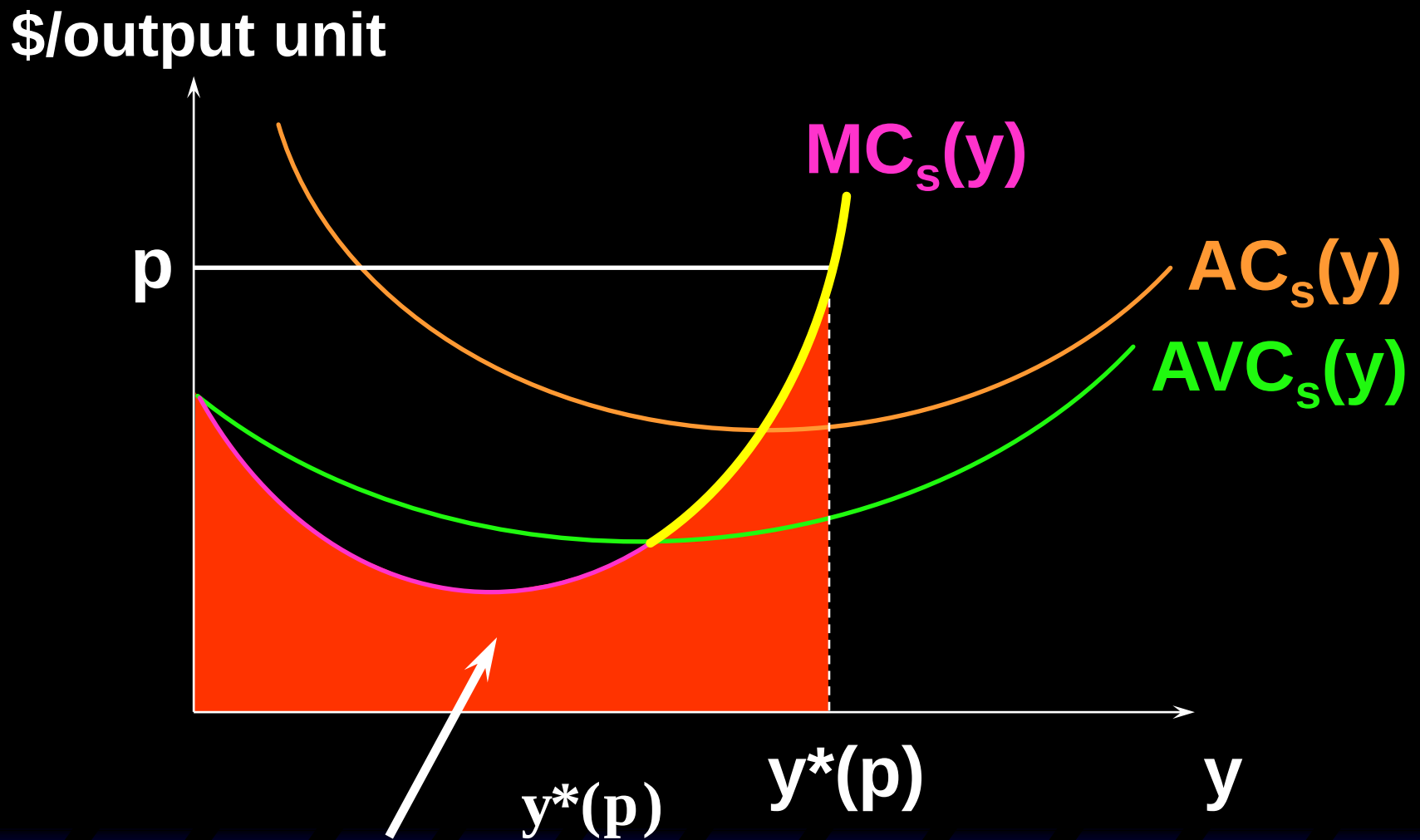
Producer's Surplus Revisited



Producer's Surplus Revisited

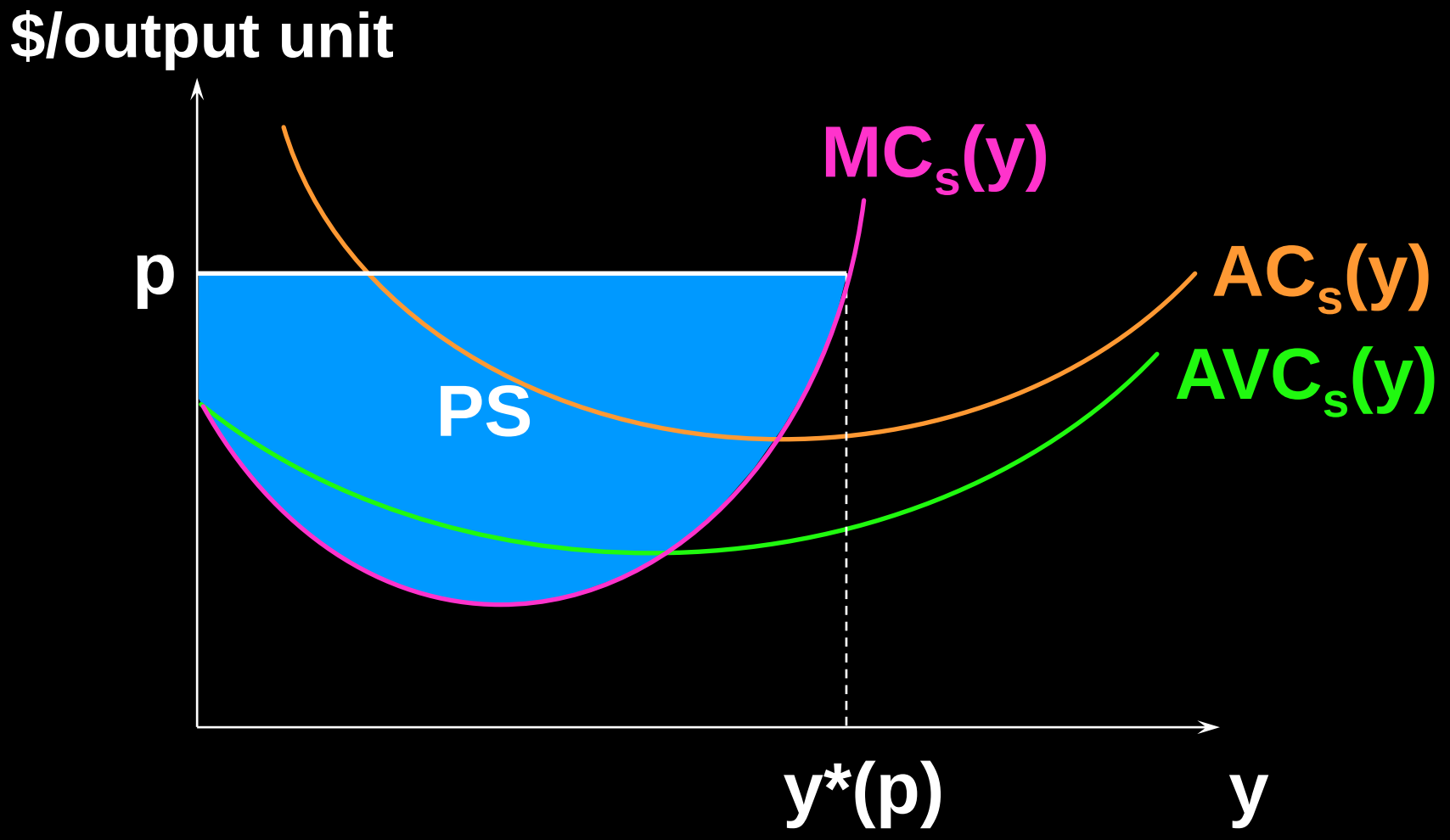


Producer's Surplus Revisited

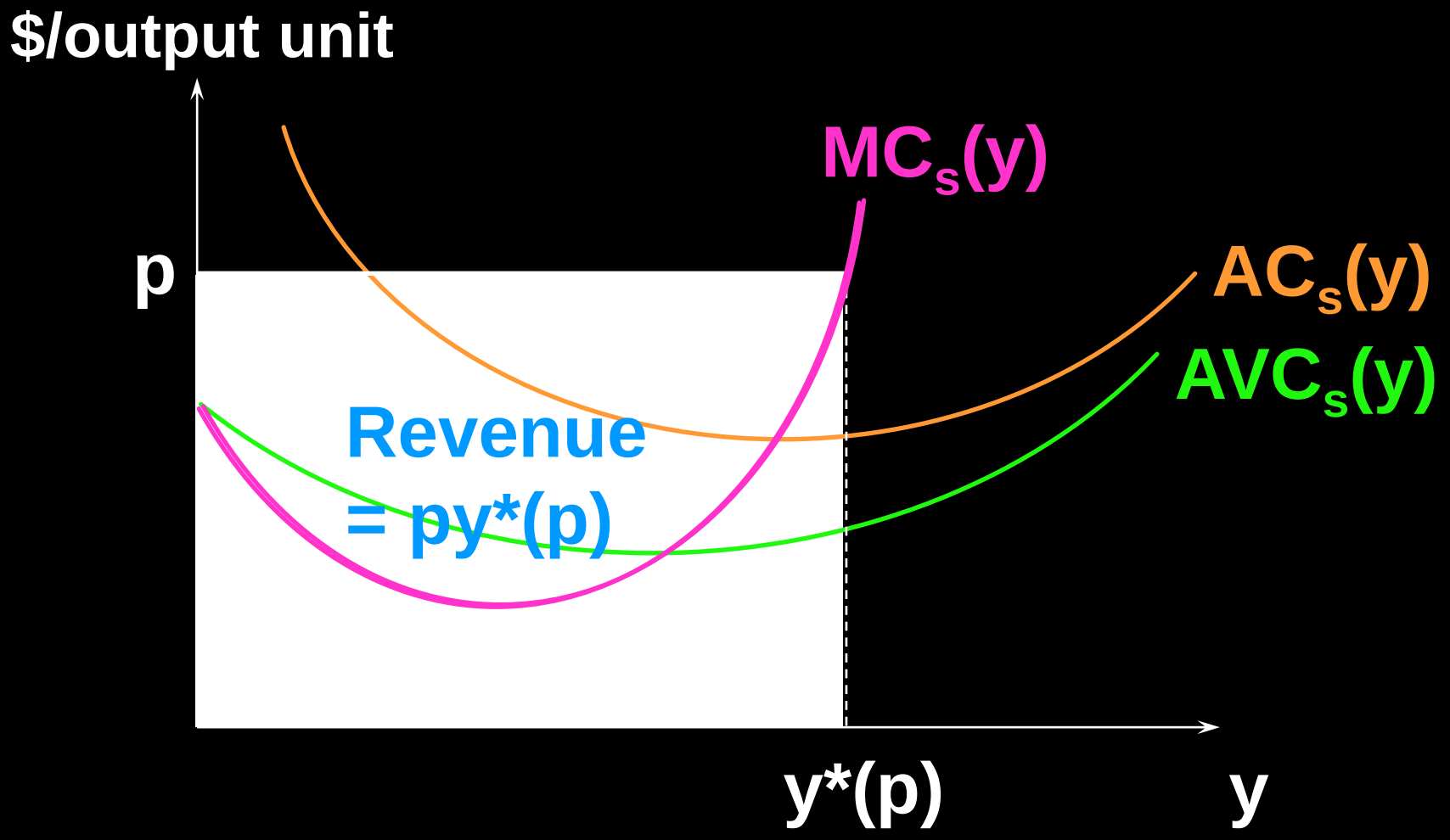


$$c_v(y^*(p)) = \int_0^{y^*(p)} MC_s(z)d(z)$$

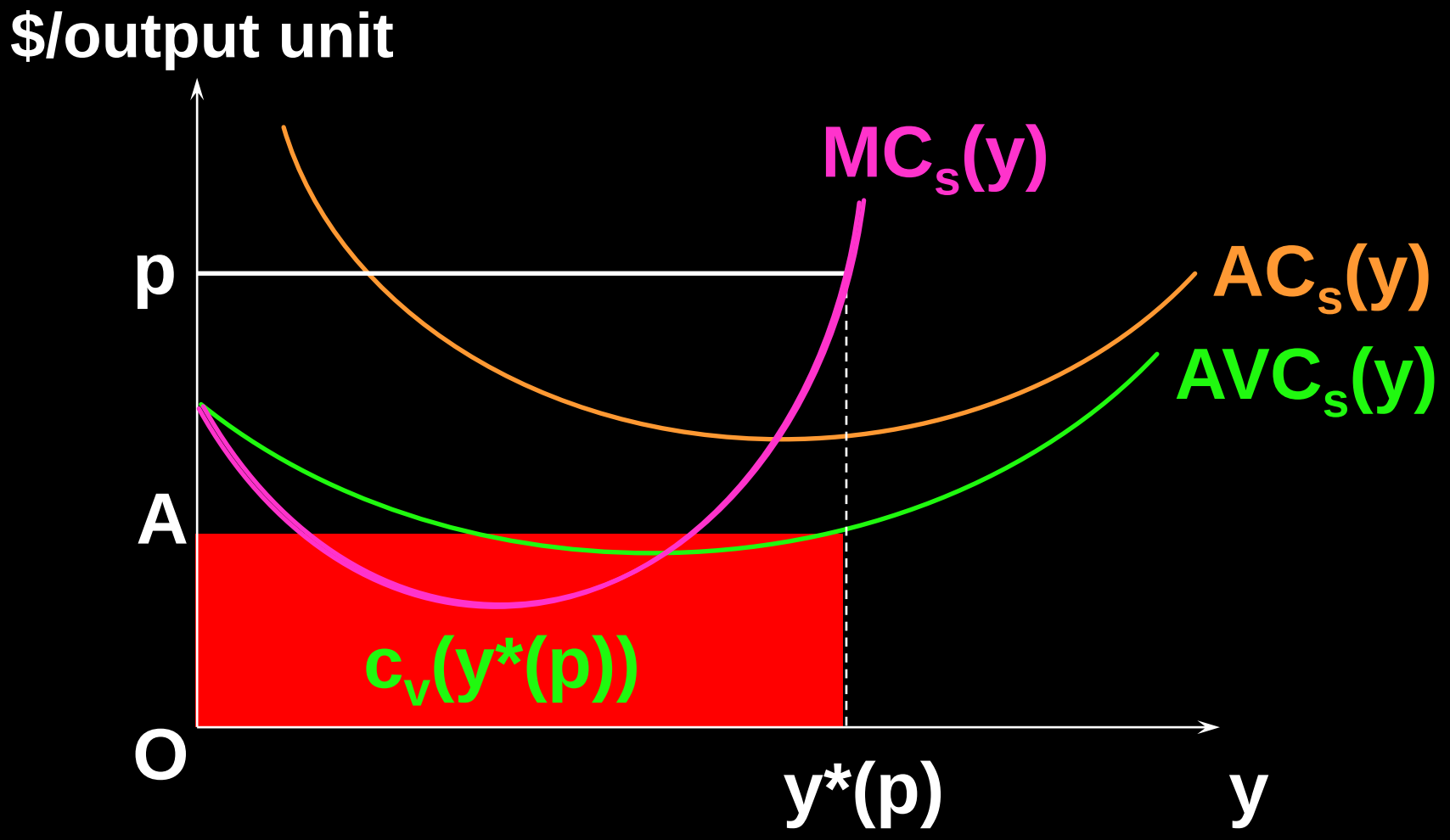
Producer's Surplus Revisited



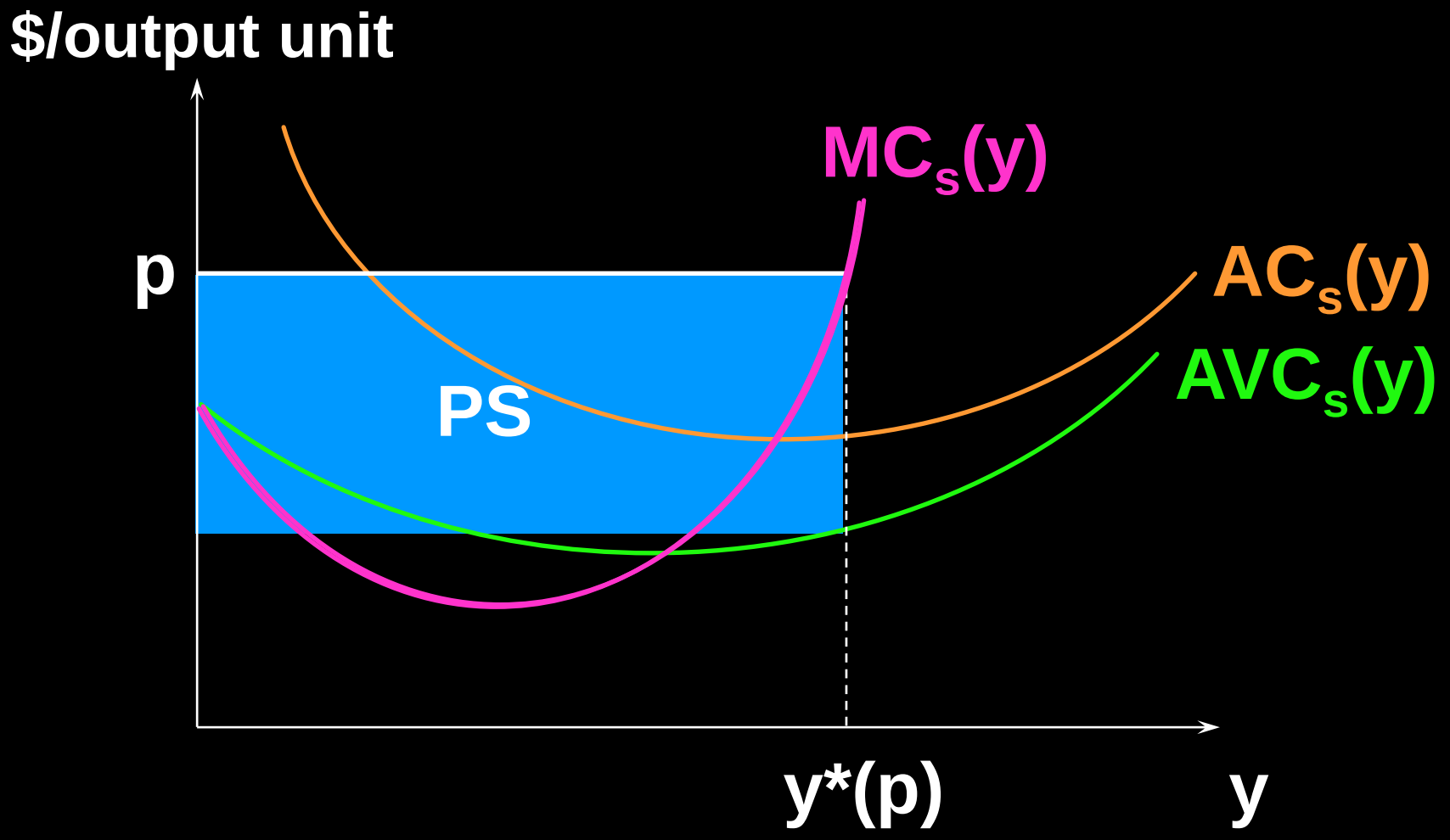
Producer's Surplus Revisited



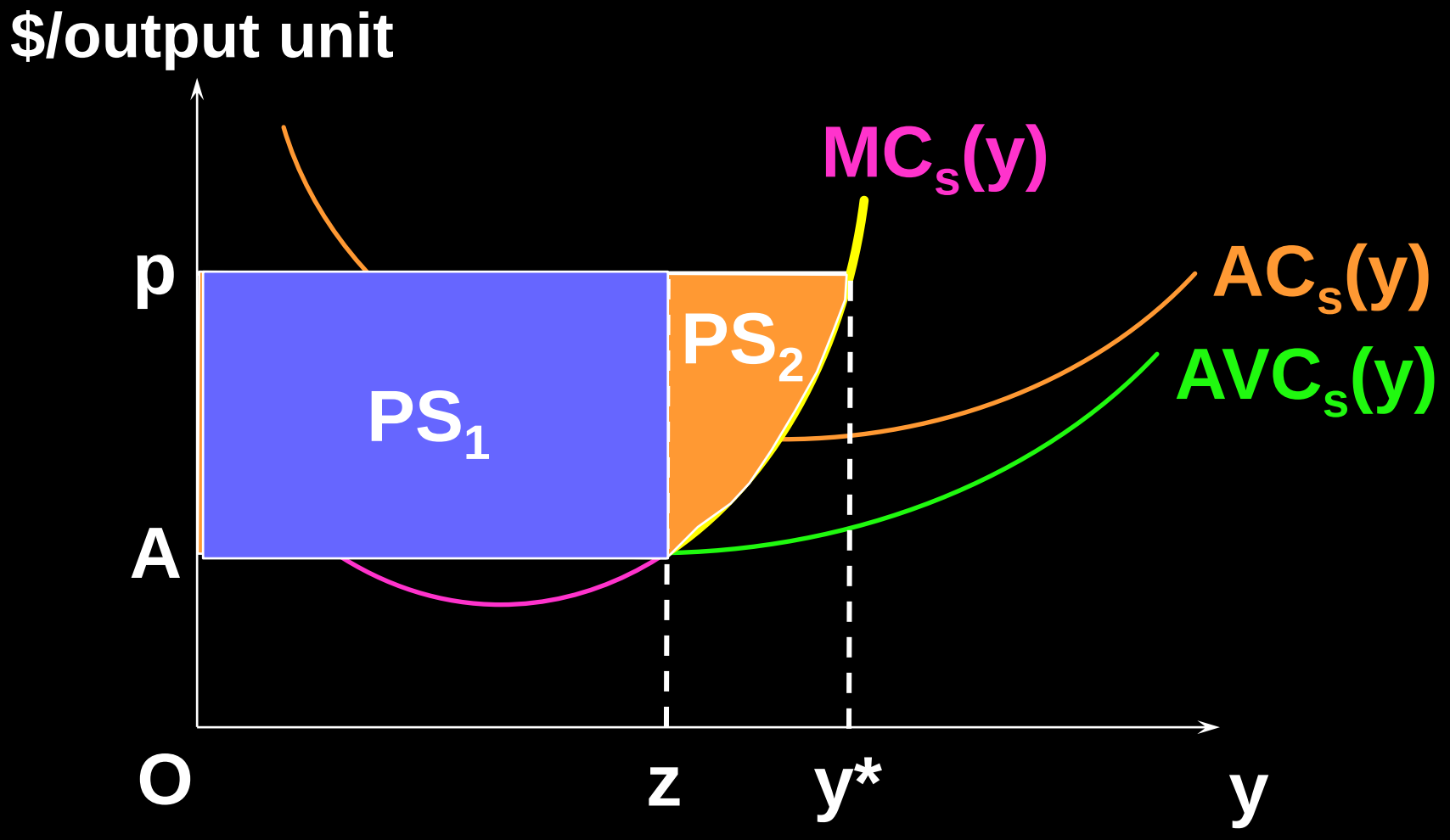
Producer's Surplus Revisited



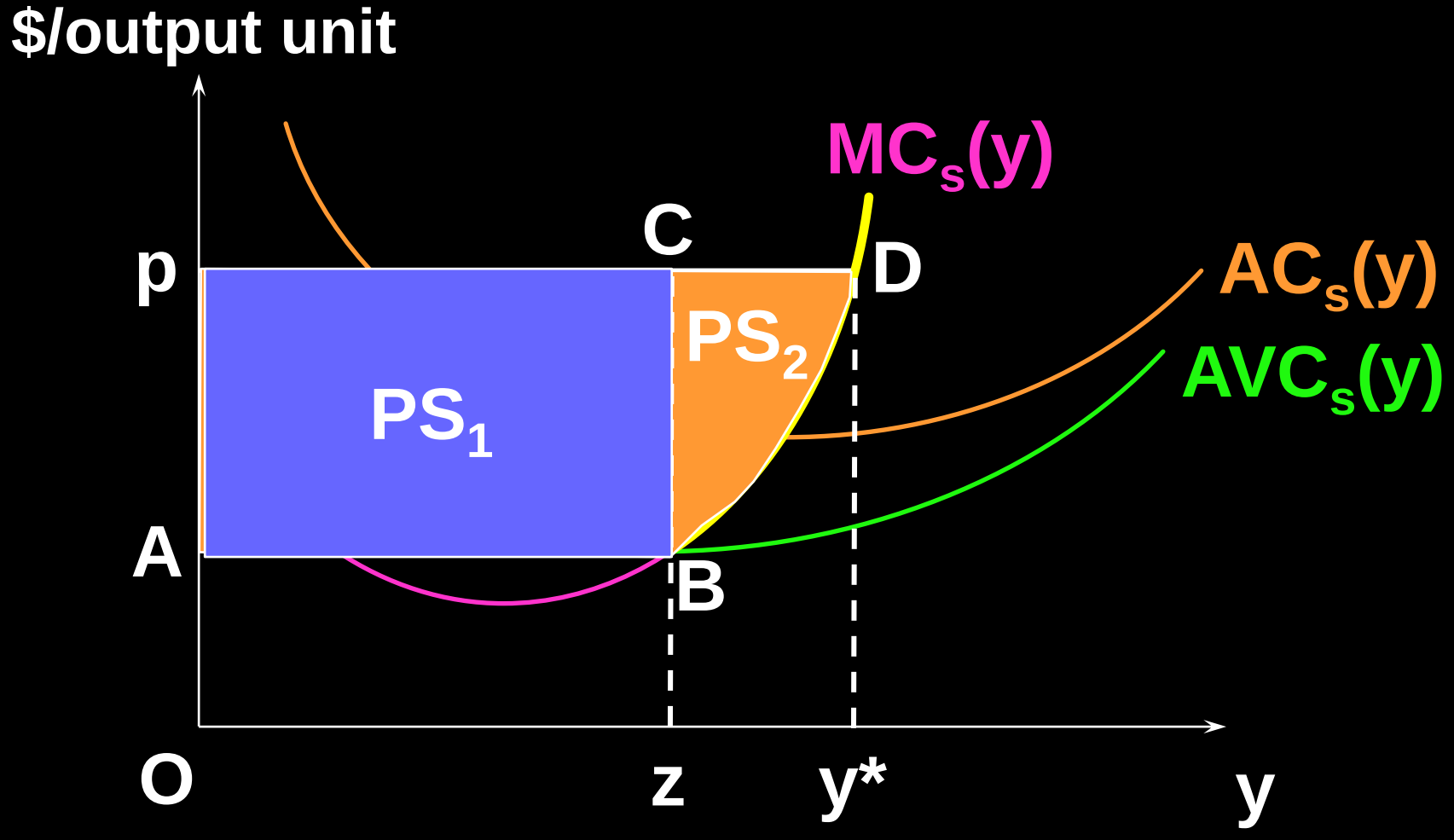
Producer's Surplus Revisited



Producer's Surplus Revisited

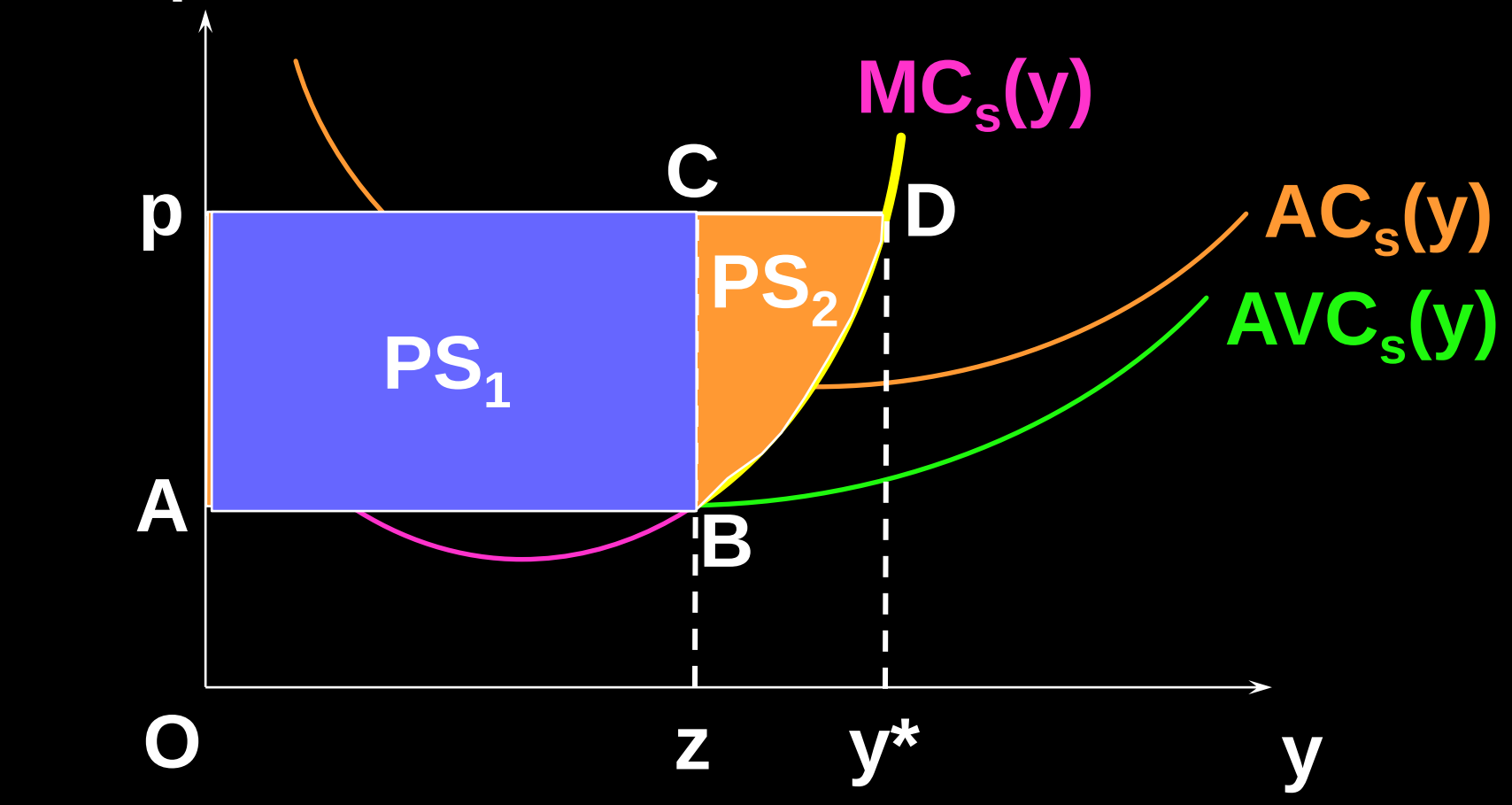


Producer's Surplus Revisited



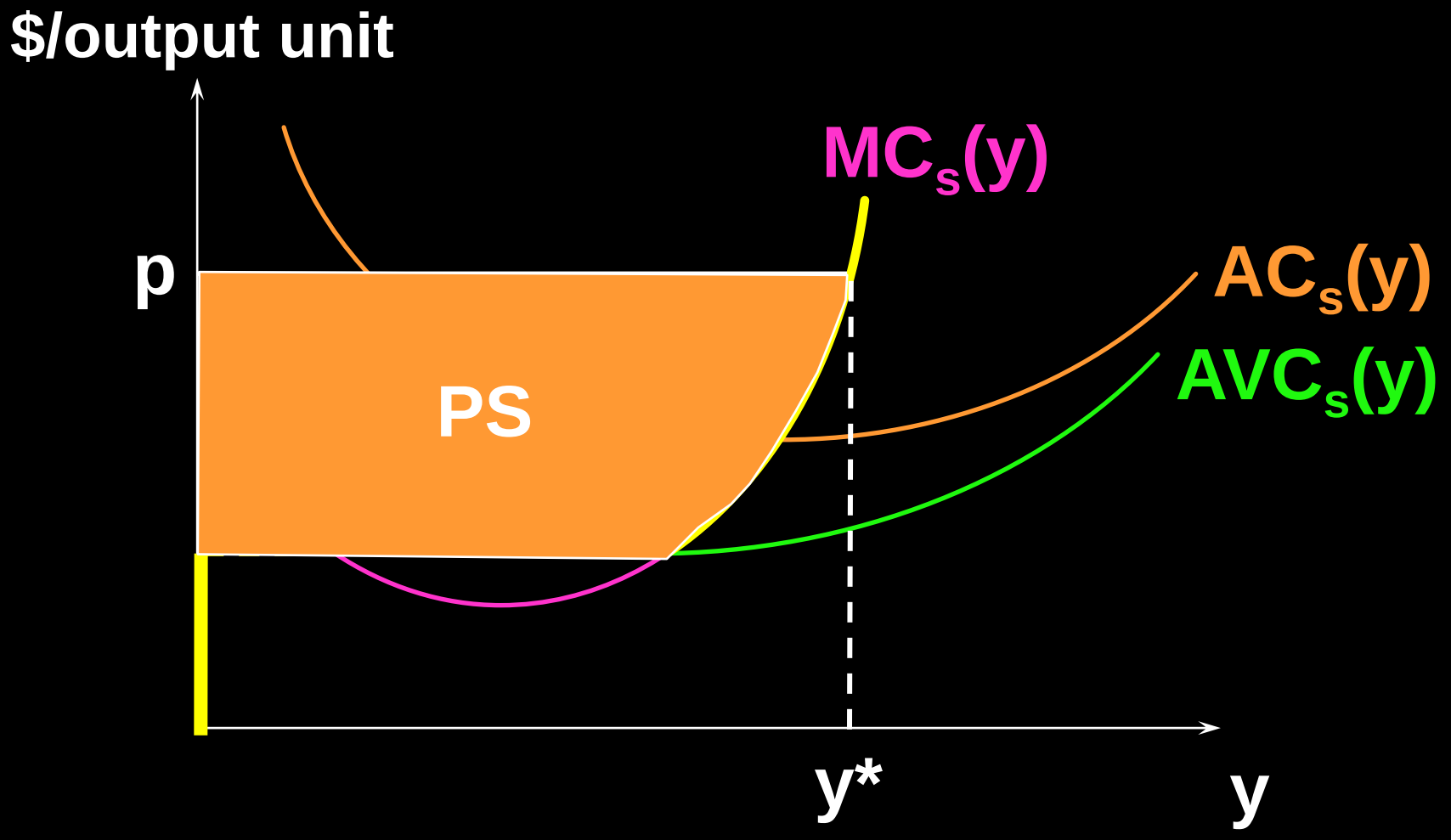
前z单位产出所带来的PS_1是前z单位的收益和可变成本之差

Producer's Surplus Revisited

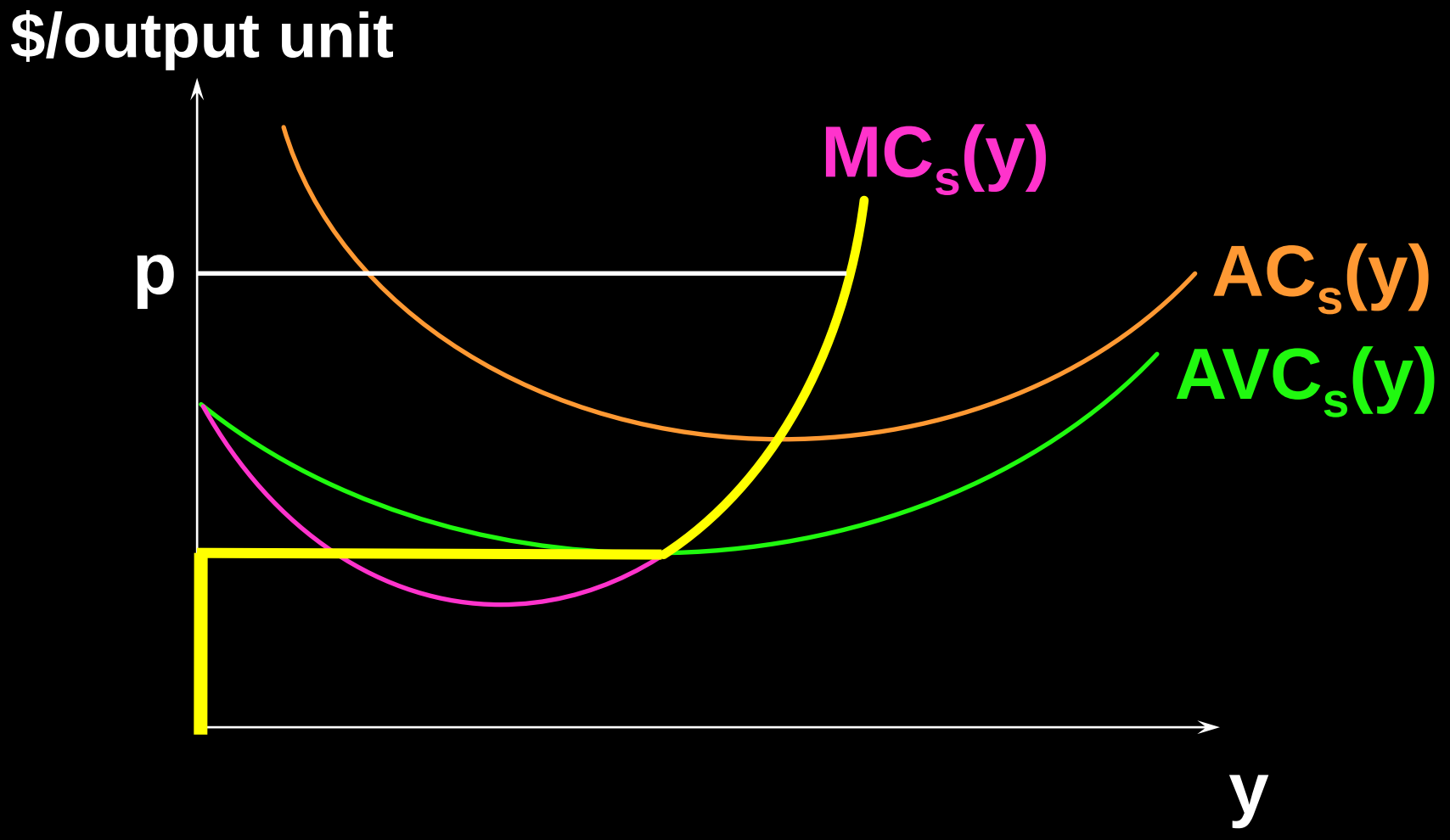


后(y*–z)单位产出所带来的PS_2是也是其收益和可变成本之差

Producer's Surplus Revisited



Producer's Surplus Revisited



生产者剩余还可表示为价格线以下、厂商供给曲线以上的部分

Producer's Surplus Revisited

- **PS = Revenue - Variable Cost.**
- **Profit = Revenue - Total Cost**
  = Revenue - Fixed Cost
  - Variable Cost.
- **So, PS = Profit + Fixed Cost.**
- **Only if fixed cost is zero (the long-run) are PS and profit the same.**

Industry Supply

Supply From A Competitive Industry

- **Since every firm in the industry is a price-taker, total quantity supplied at a given price is the sum of quantities supplied at that price by the individual firms.**

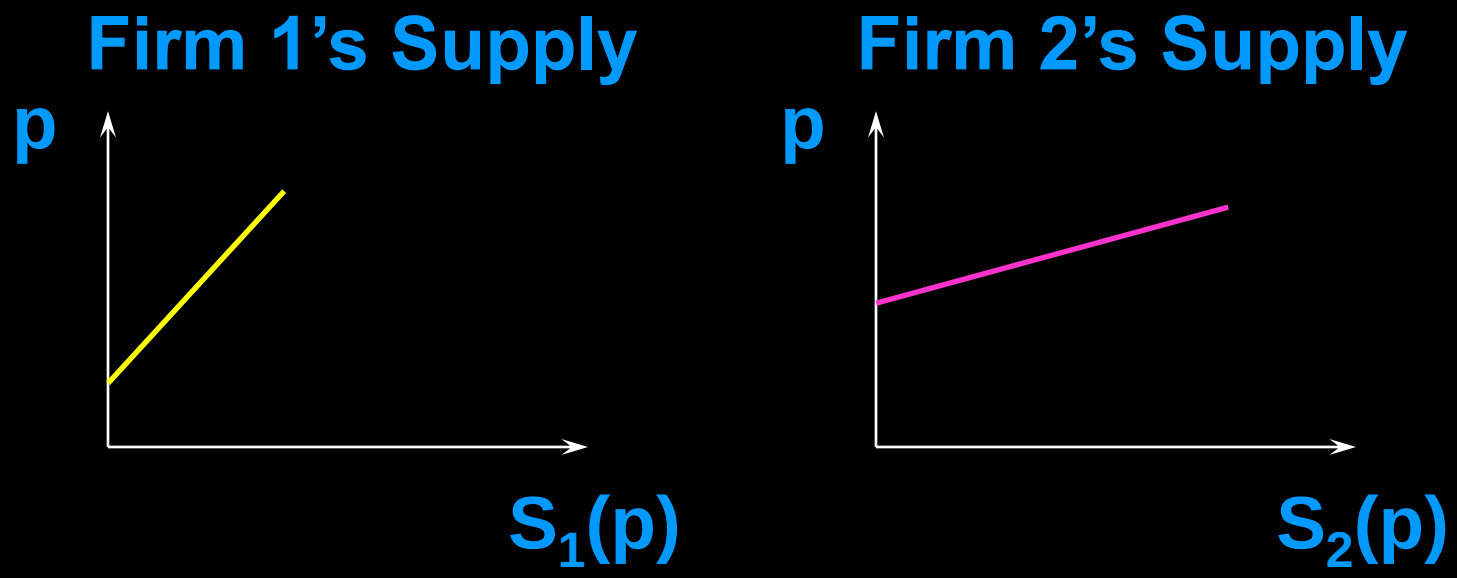
  短期行业供给是企业供给的水平加总

Short-Run Supply

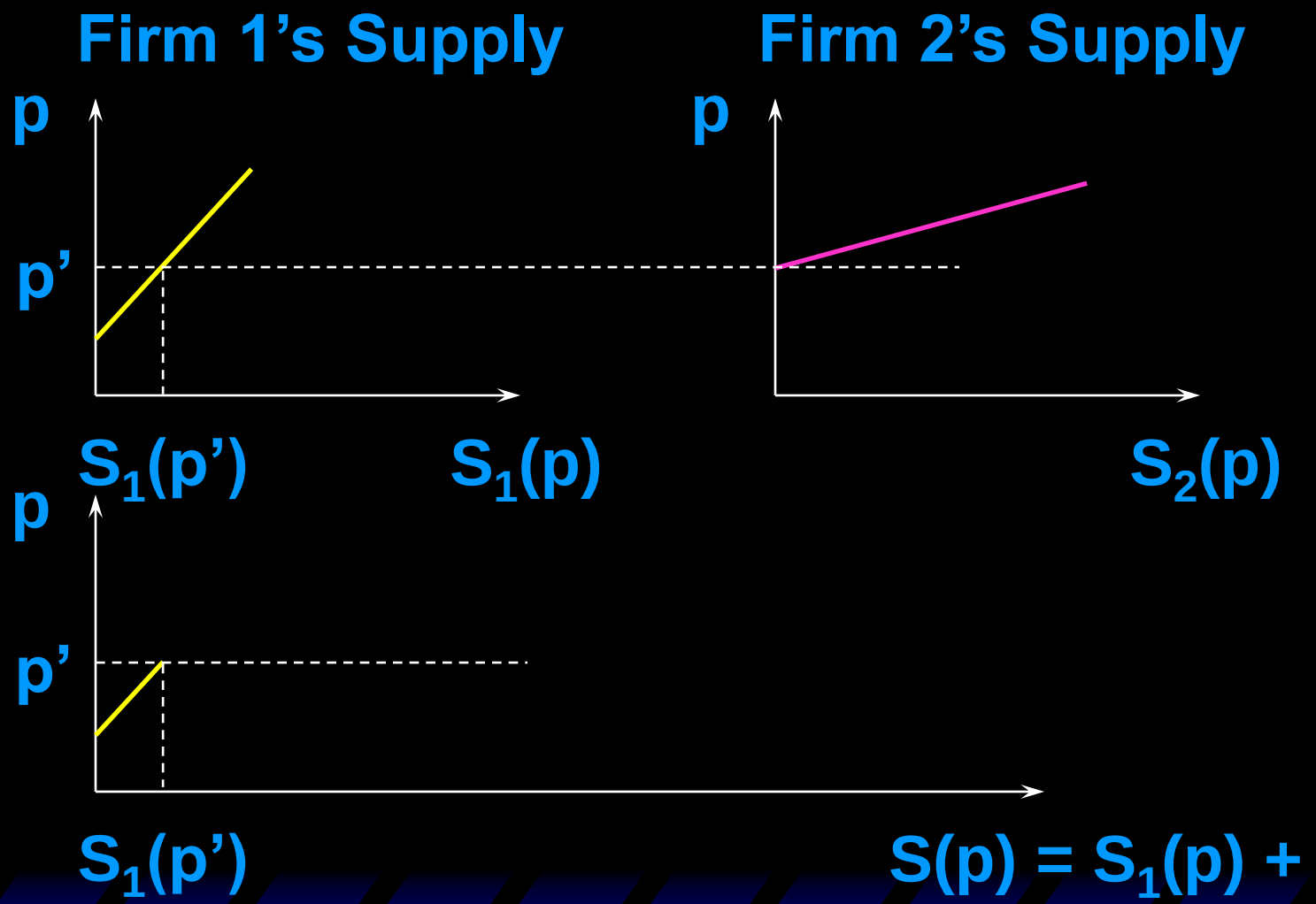
- In a **short-run** the number of firms in the industry is, temporarily, fixed.
- Let **n** be the number of firms; i = 1, … ,n.
- $S_i(p)$ is firm i's supply function.
- The industry's short-run supply function is

$$S(p) = \sum_{i=1}^{n} S_i(p).$$

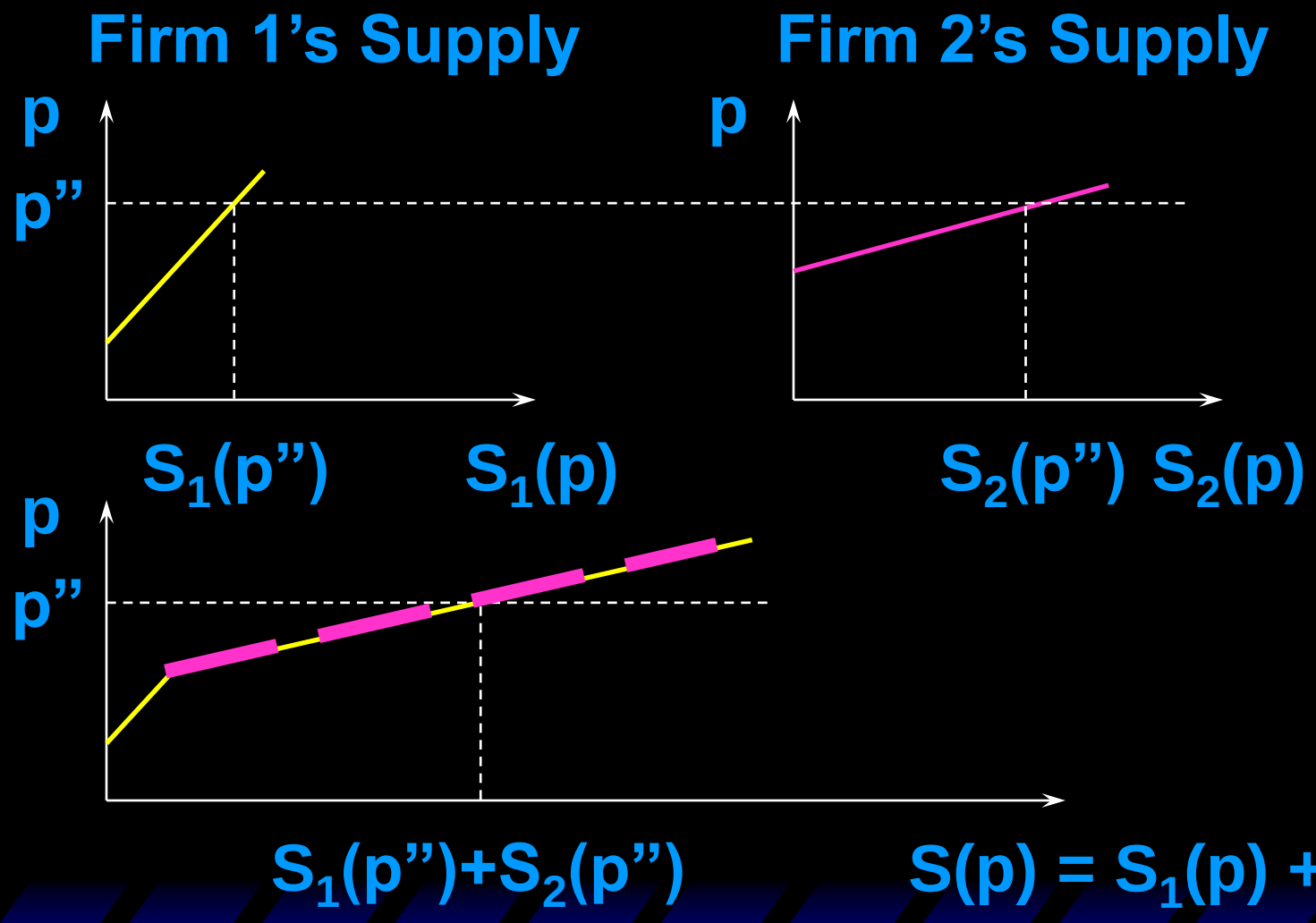
Supply From A Competitive Industry



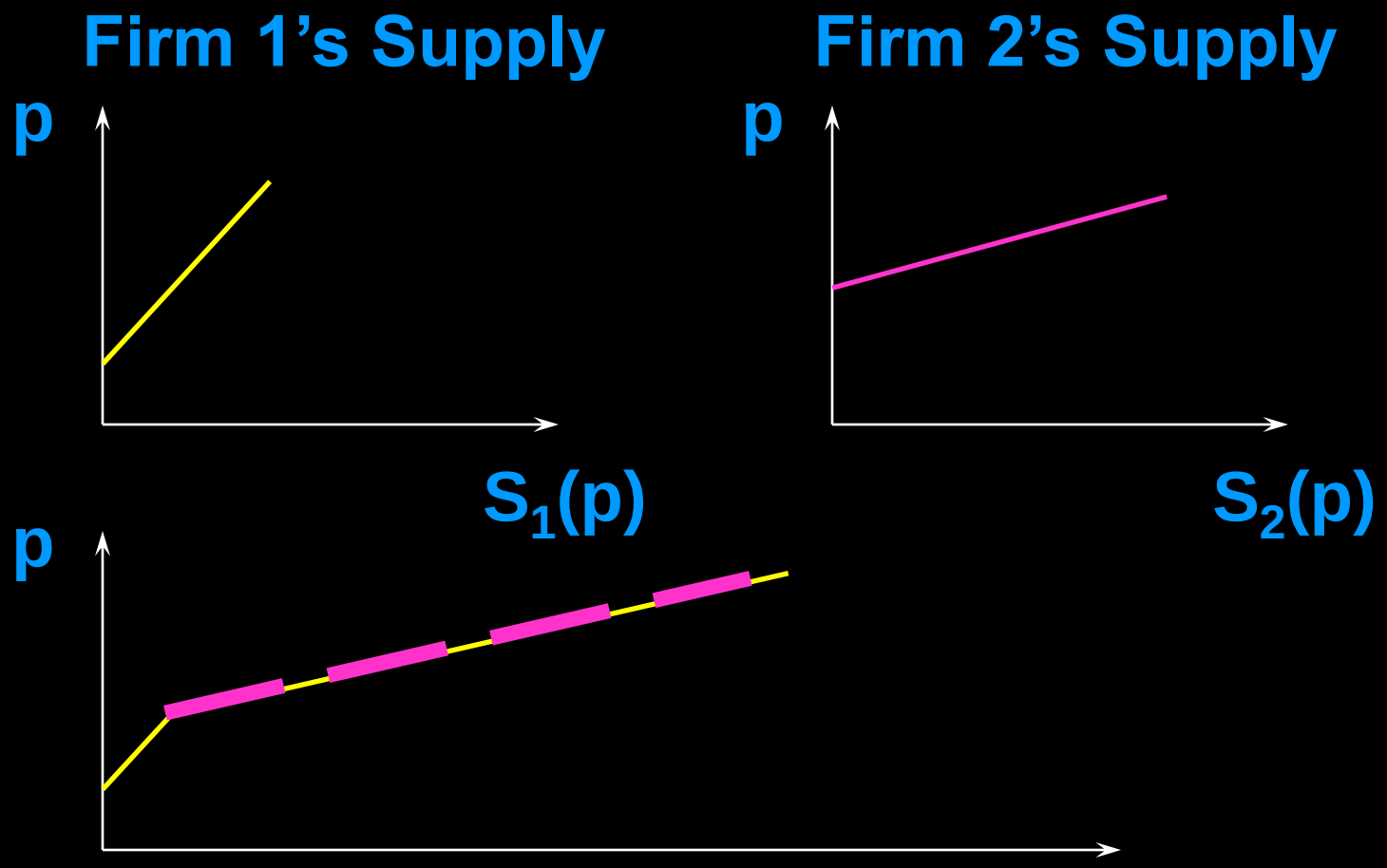
Supply From A Competitive Industry



Supply From A Competitive Industry



Supply From A Competitive Industry



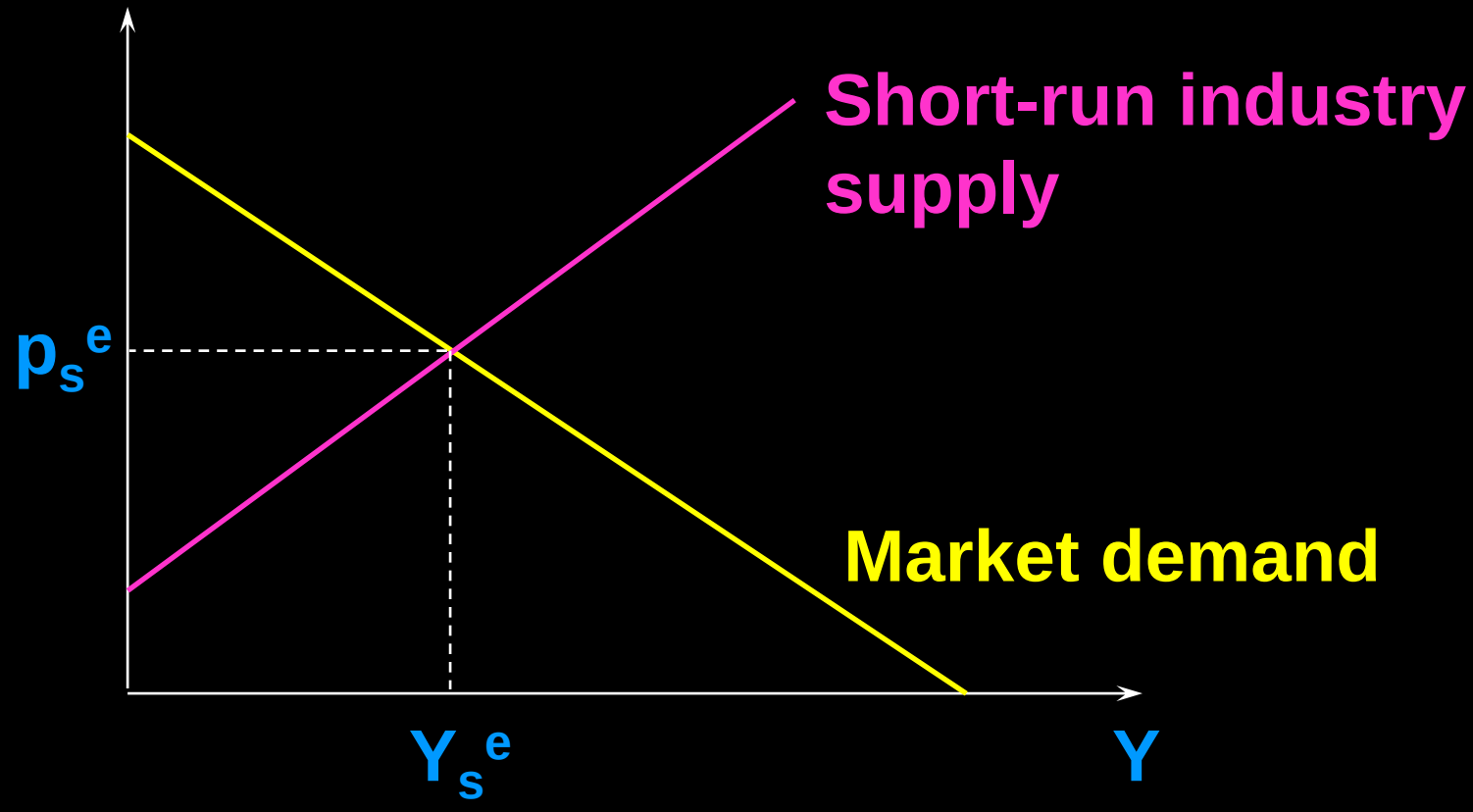
行业供给曲线随企业数量增加而变得平缓

Short-Run Industry Equilibrium

- **In a short-run, neither entry nor exit can occur.**
- **Consequently, in a short-run equilibrium, some firms may earn positive economics profits, others may suffer economic losses, and still others may earn zero economic profit.**

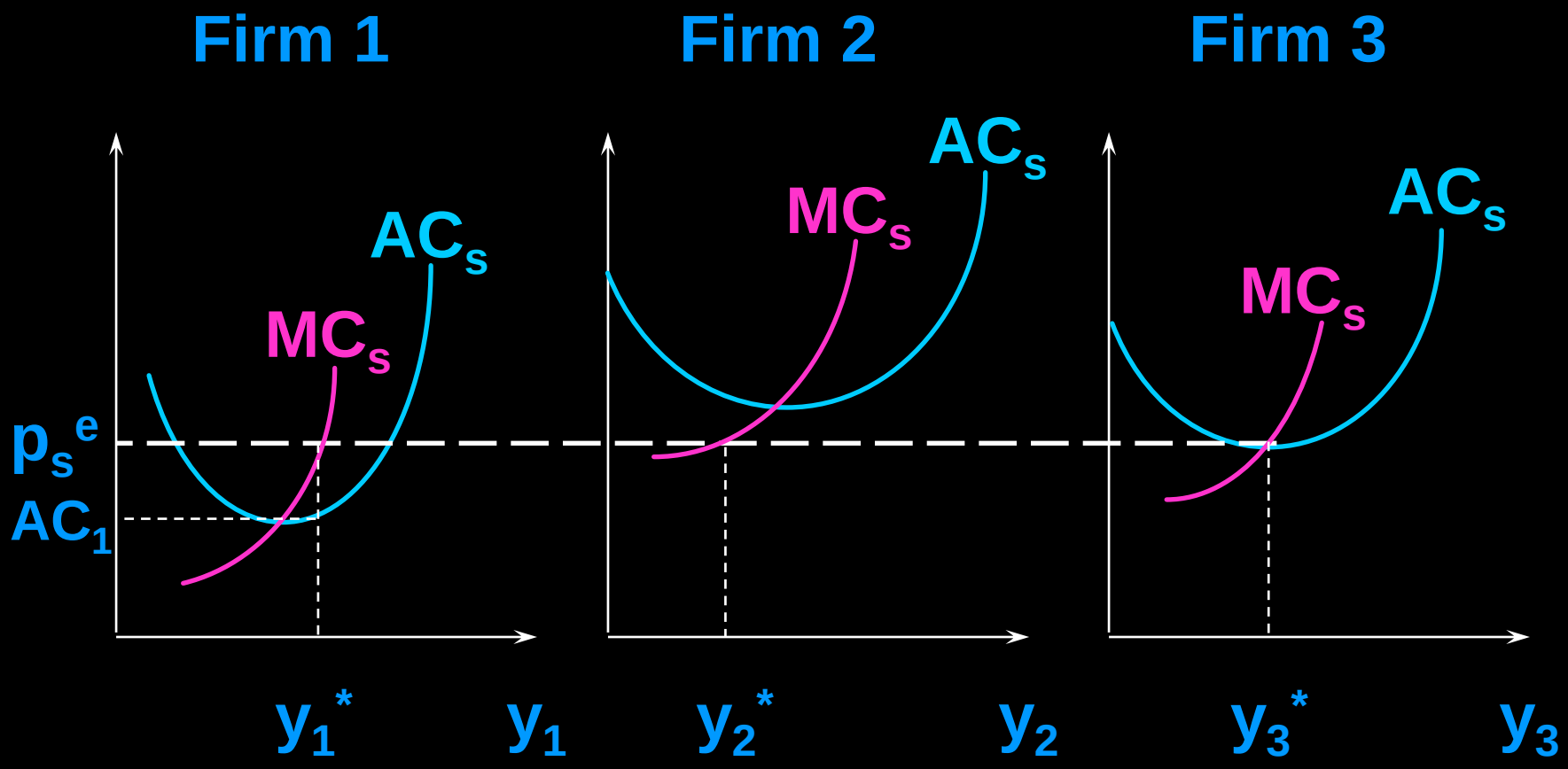
短期不存在企业进入和退出，企业的利润可能为正或为负。

Short-Run Industry Equilibrium

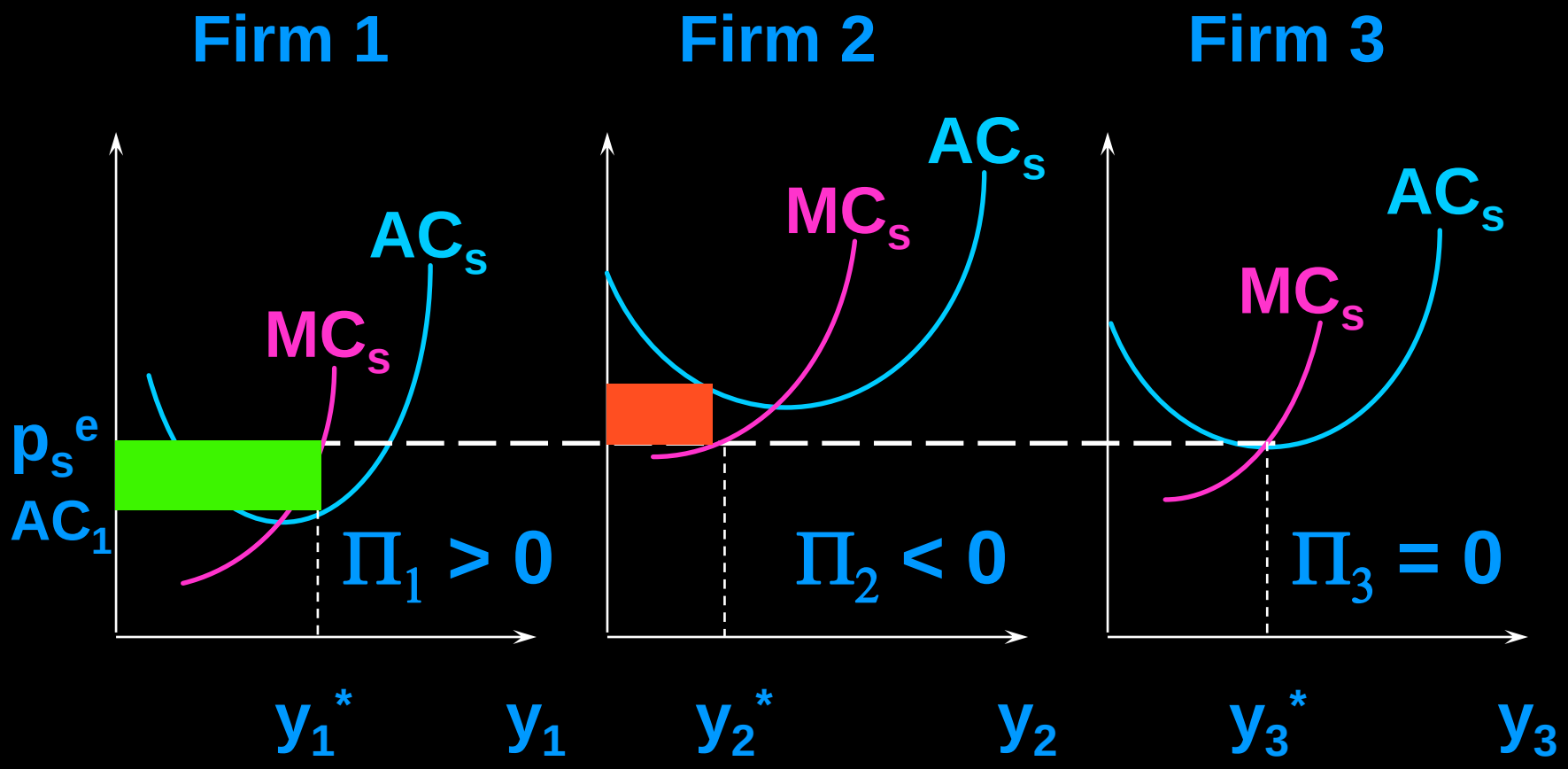


Short-run equilibrium price clears the market and is taken as given by each firm.

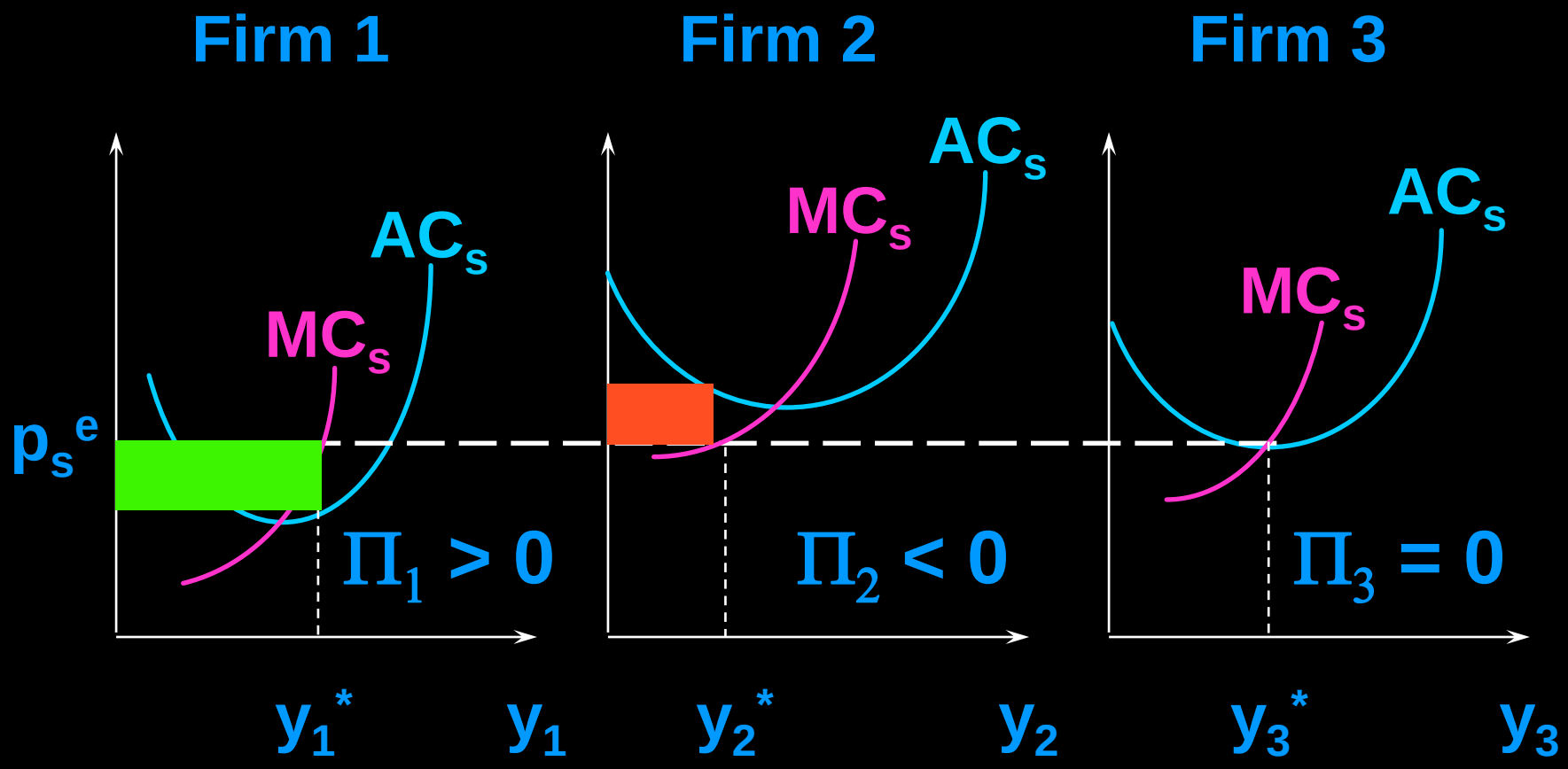
Short-Run Industry Equilibrium



Short-Run Industry Equilibrium



Short-Run Industry Equilibrium



Firm 1 earns a positive profit.

Firm 2 earns a negative profit.

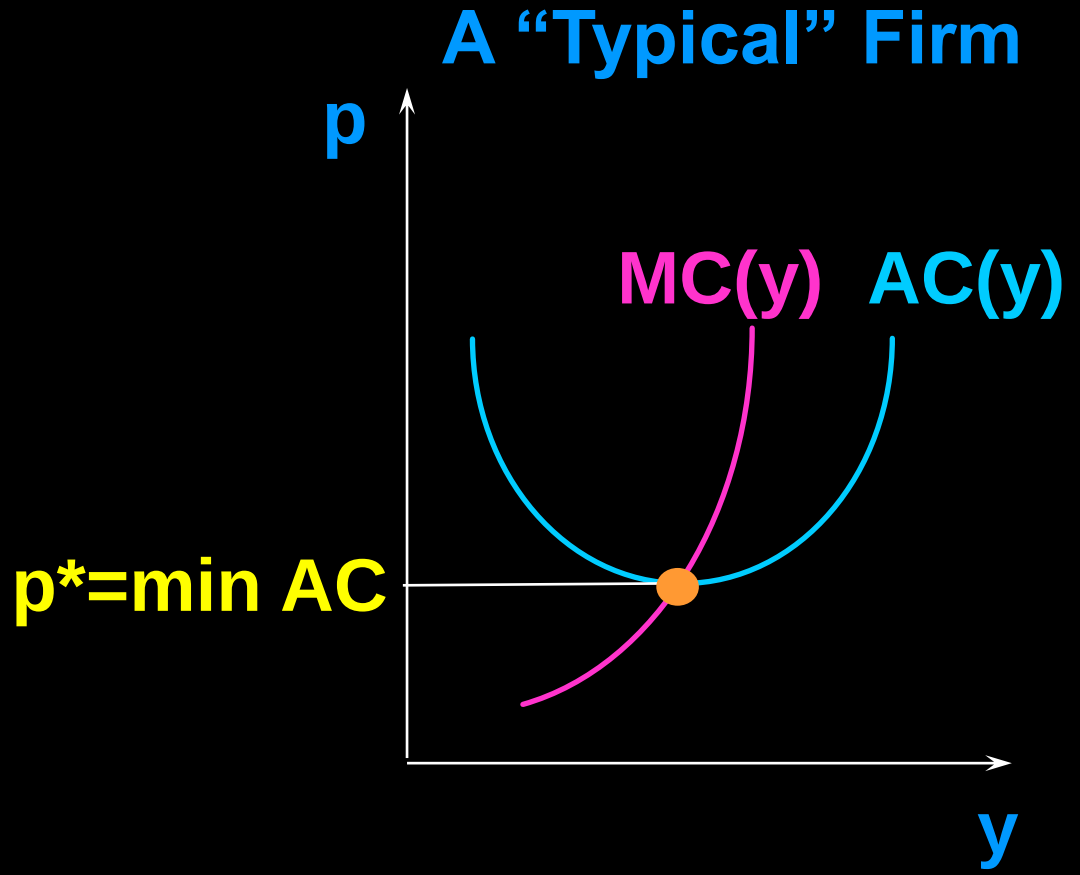
Firm 3 breaks even.

Long-Run Industry Supply

- In the **long-run** every firm now in the industry is **free** to exit and firms now outside the industry are free to enter.
- The industry's long-run supply function must account for entry and exit as well as for the supply choices of firms that choose to be in the industry.

长期行业供给曲线的推导需要考虑企业的进入和退出

Long-Run Industry Supply



企业所能接受的最低市场价格为p* = min AC(y)；当价格低于p*时，企业退出

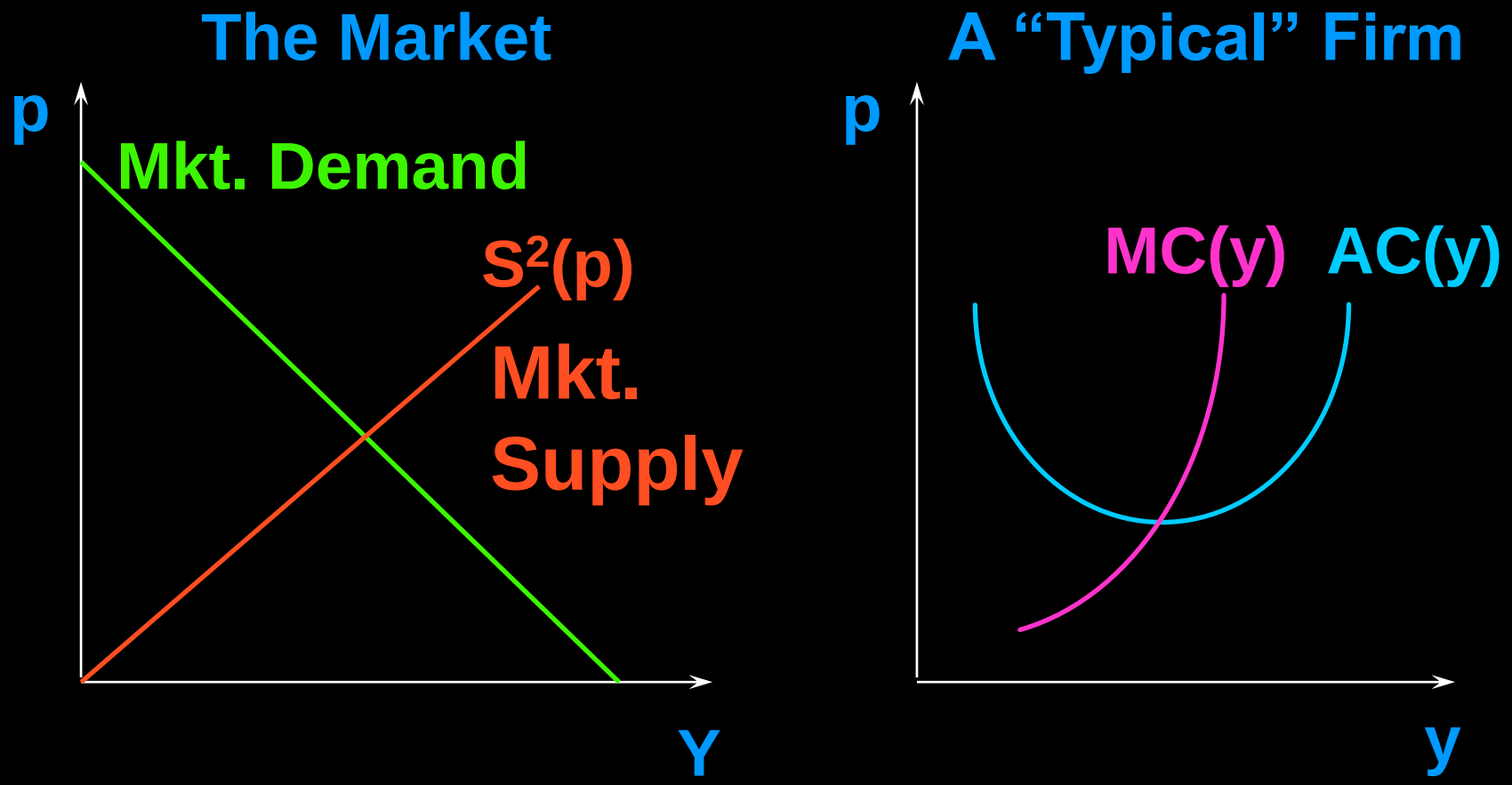
Long-Run Industry Supply

- **Positive economic profit induces entry.**
- **Economic profit is positive when the market price p_s^e is higher than a firm's minimum av. total cost;**

  $p_s^e > \min AC(y)$.

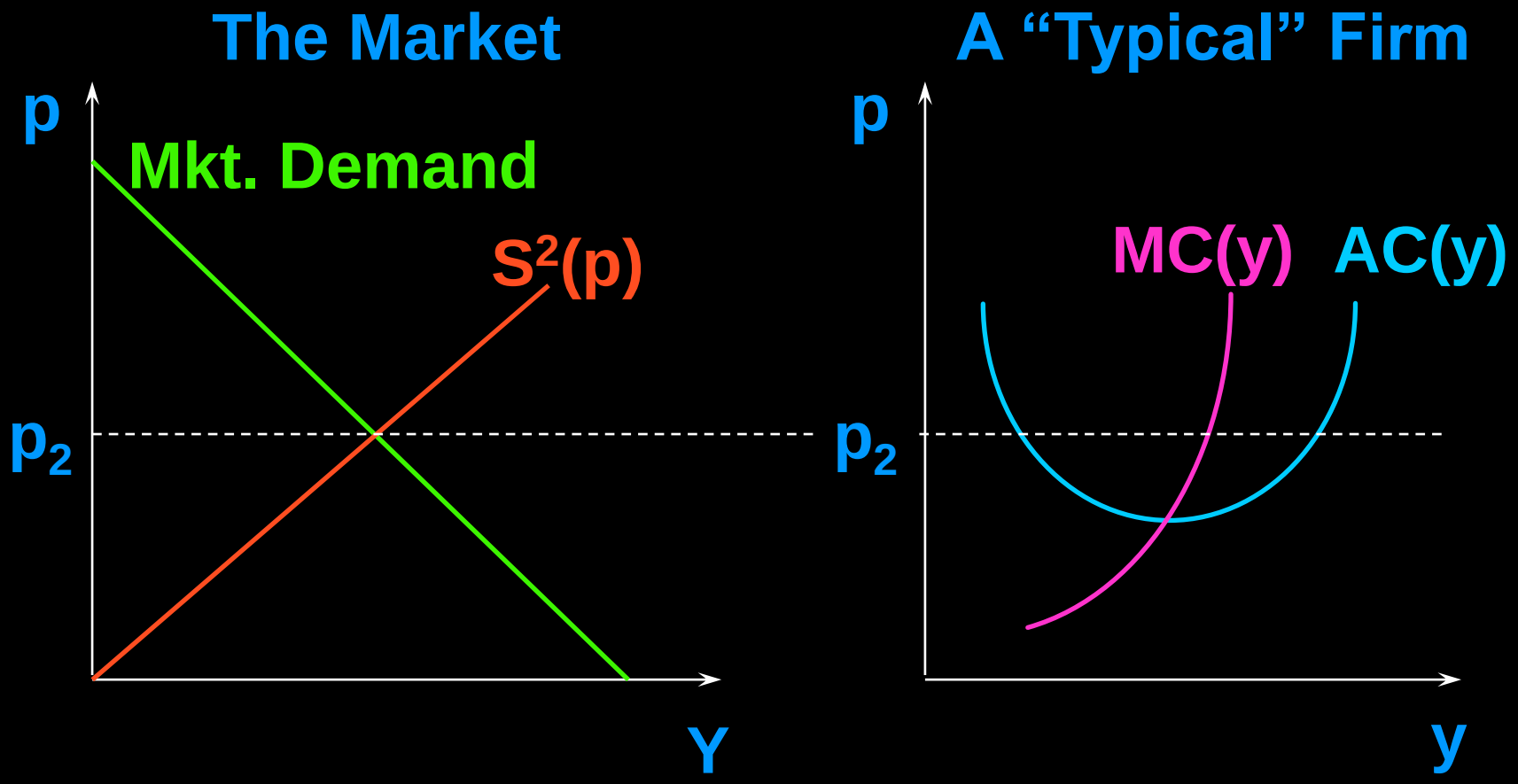
  经济利润为正时，更多的企业进入市场，导致供给增加、市场价格下降
- **Entry increases industry supply, causing p_s^e to fall.**

Long-Run Industry Supply



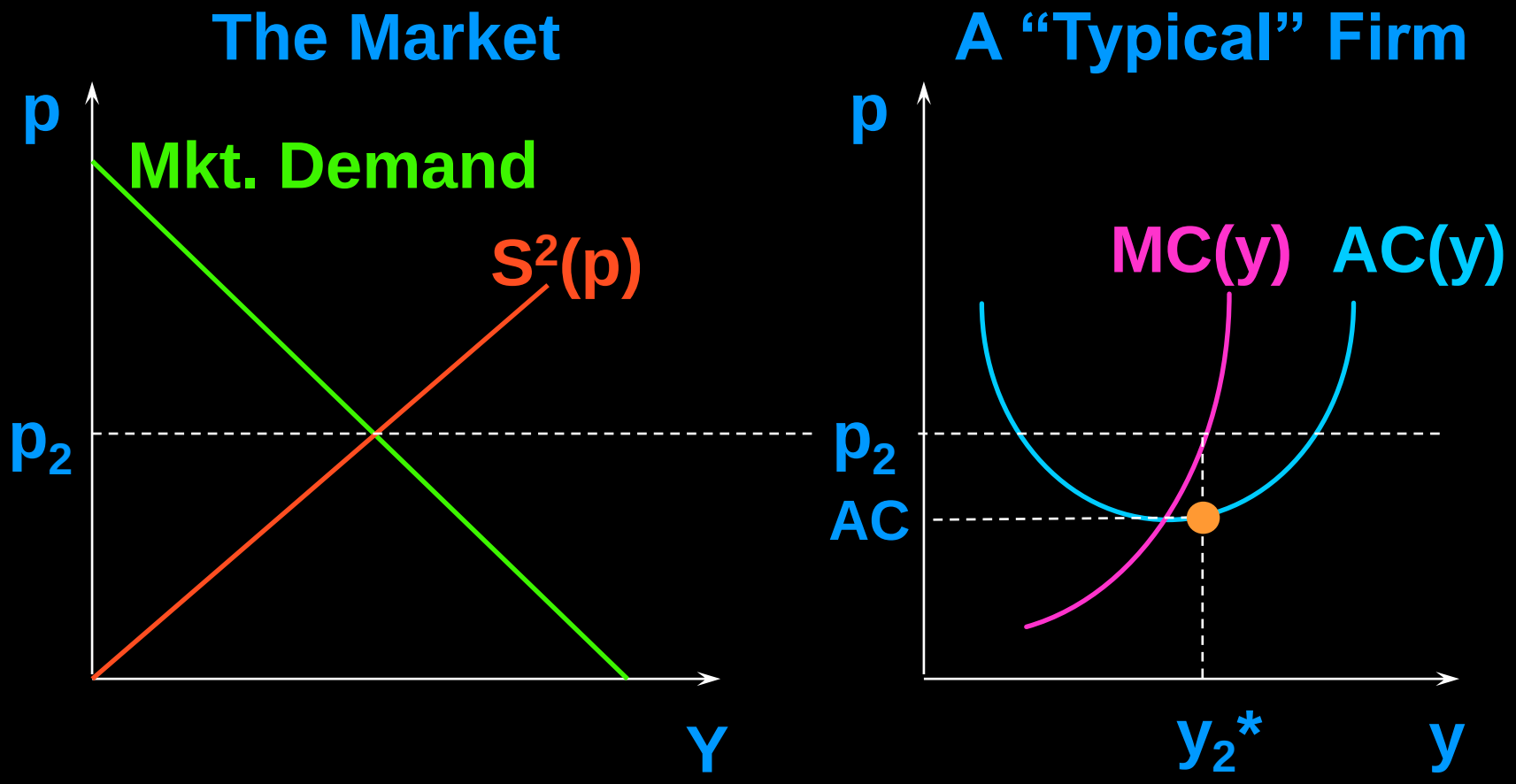
Suppose the industry initially contains only two firms.

Long-Run Industry Supply



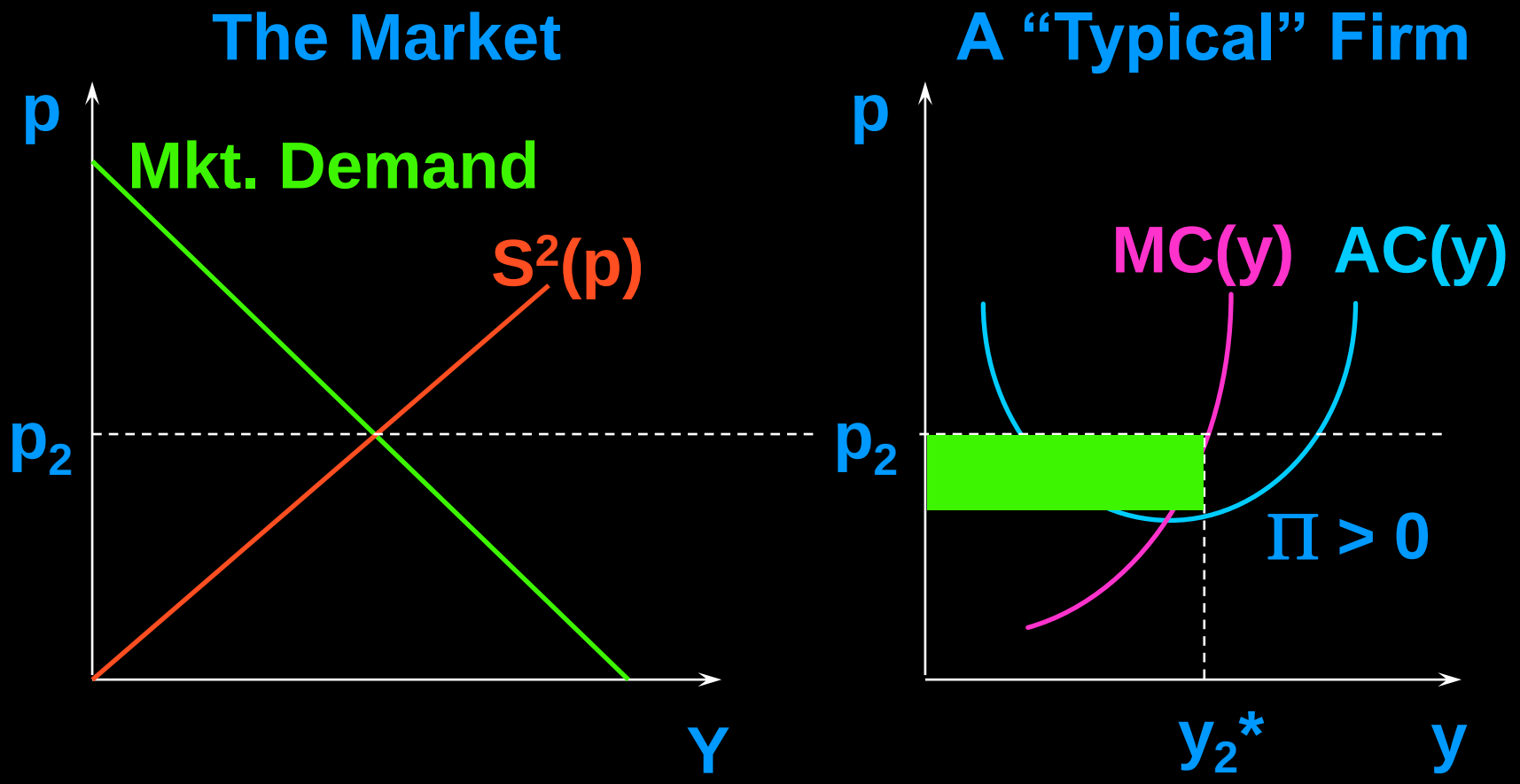
Then the market-clearing price is p_2.

Long-Run Industry Supply



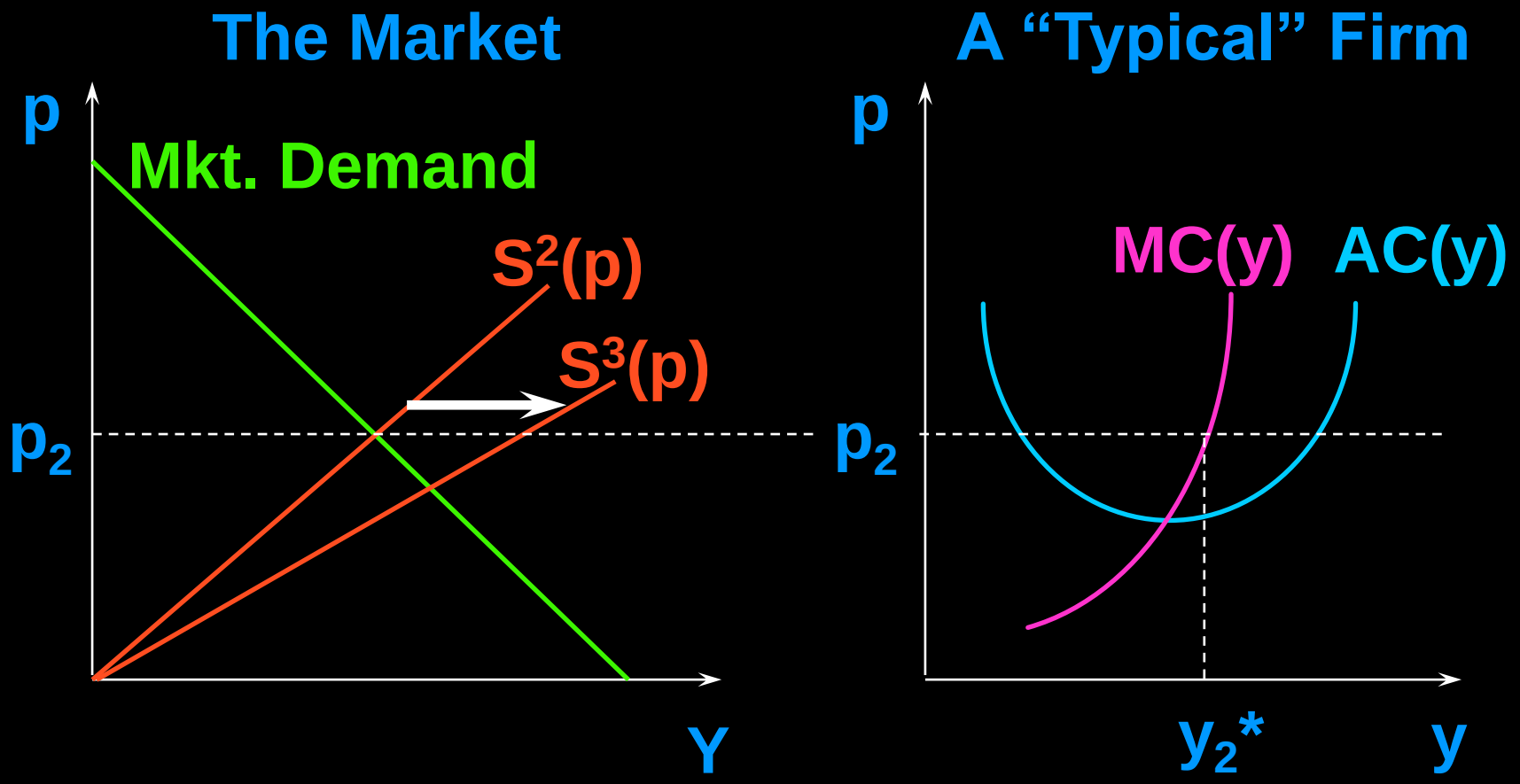
Then the market-clearing price is p_2.
Each firm produces y_2^* units of output.

Long-Run Industry Supply



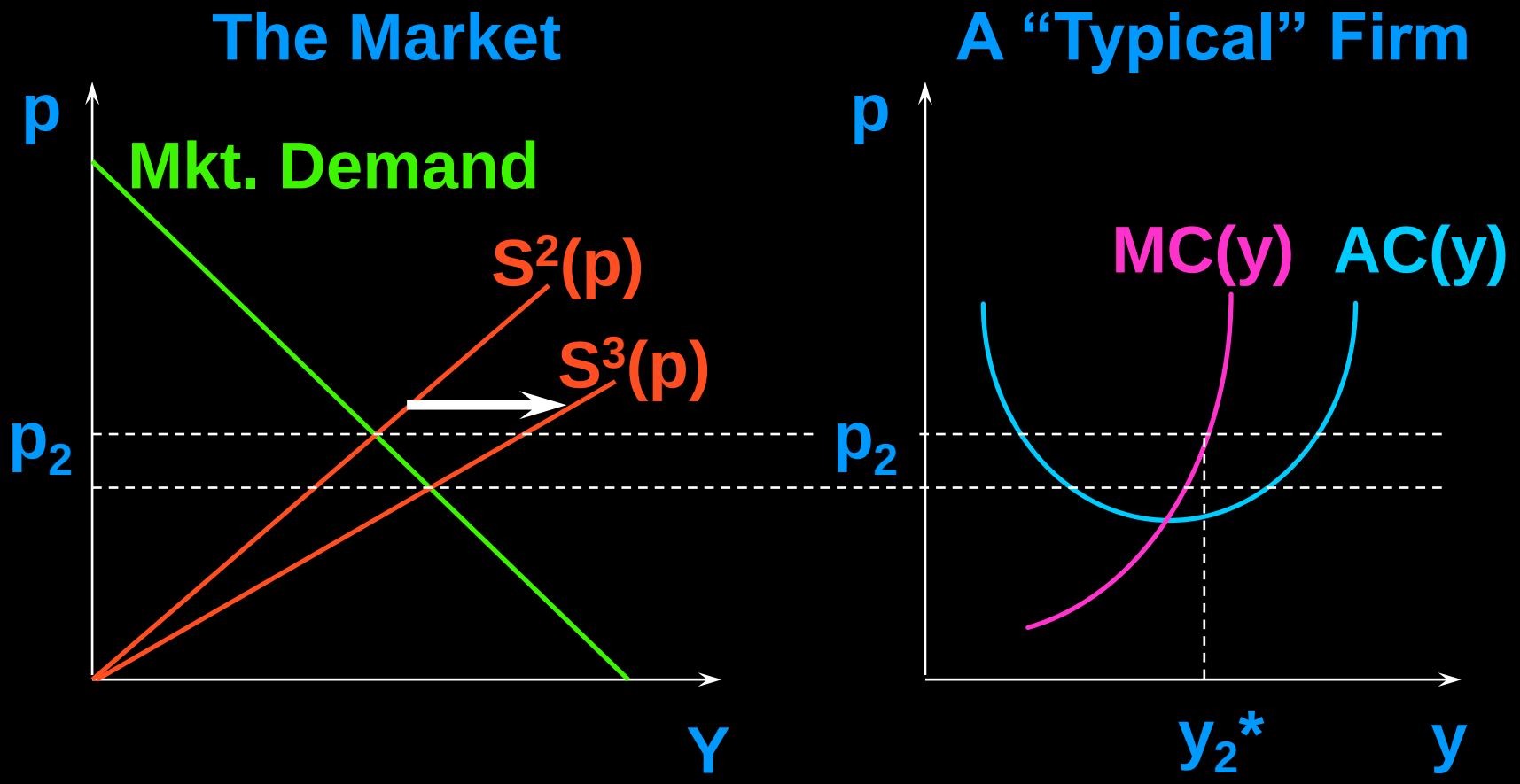
Each firm makes a positive economic profit, inducing entry by another firm.

Long-Run Industry Supply



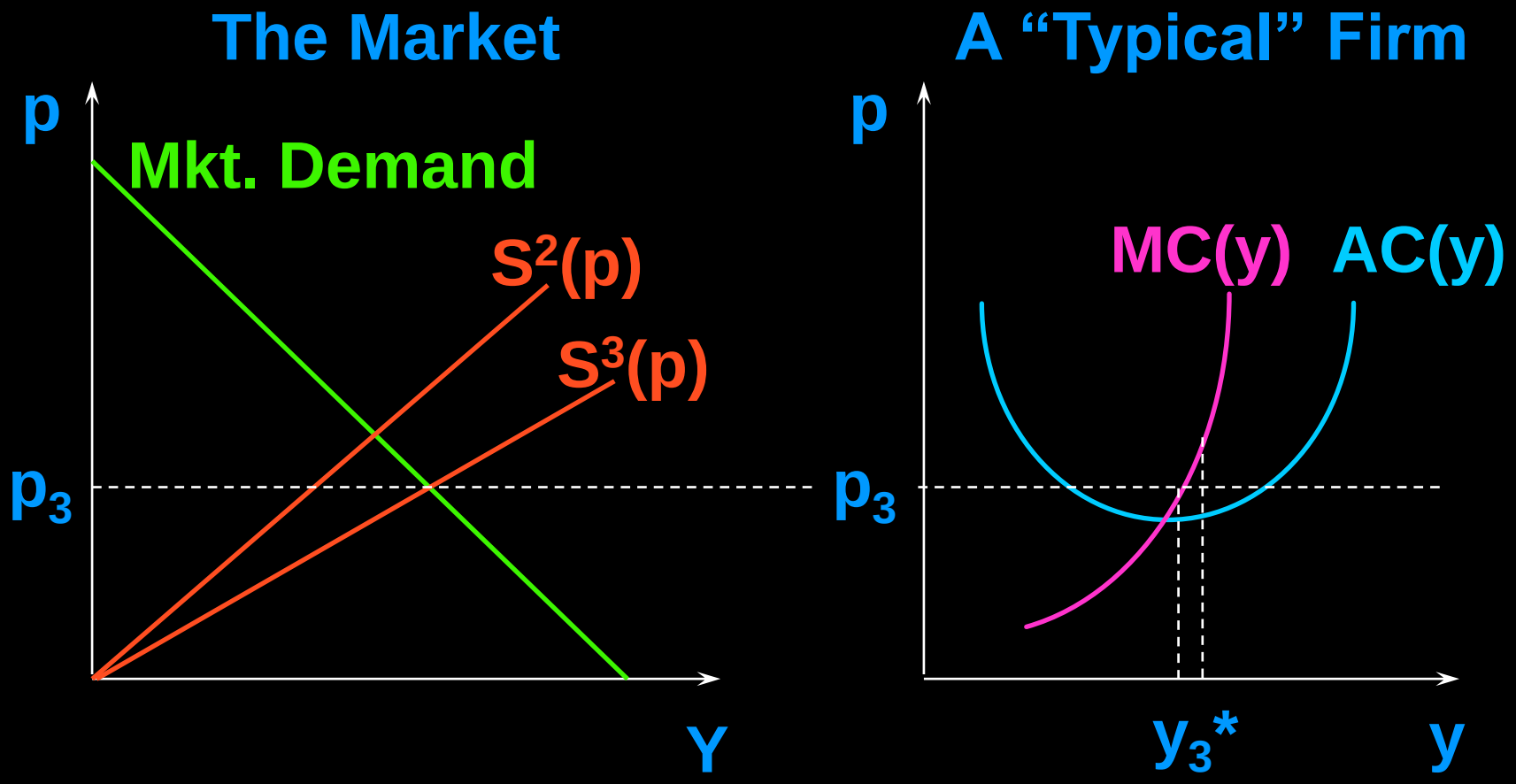
Market supply shifts outwards.

Long-Run Industry Supply



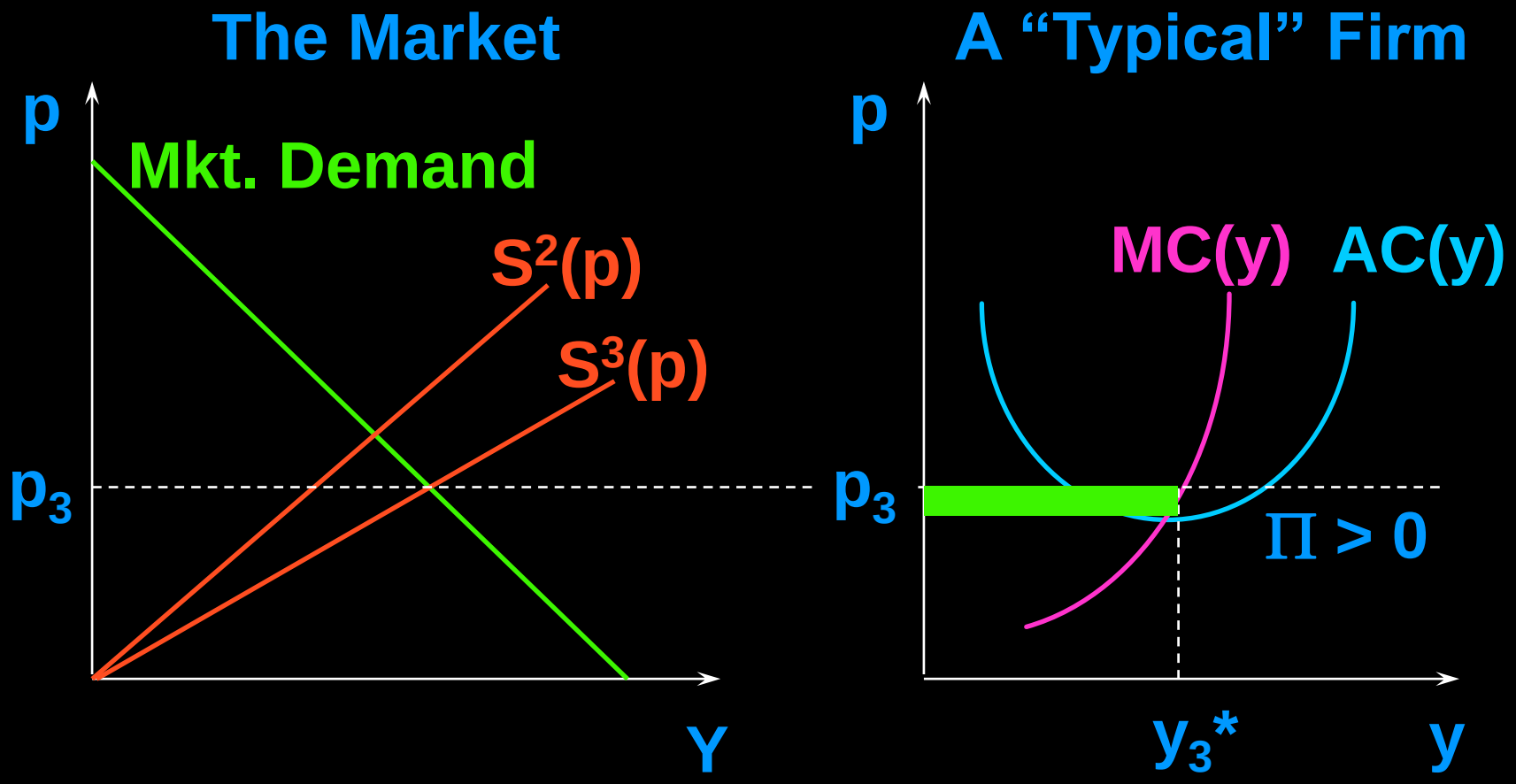
Market supply shifts outwards.
Market price falls.

Long-Run Industry Supply



Each firm produces less.

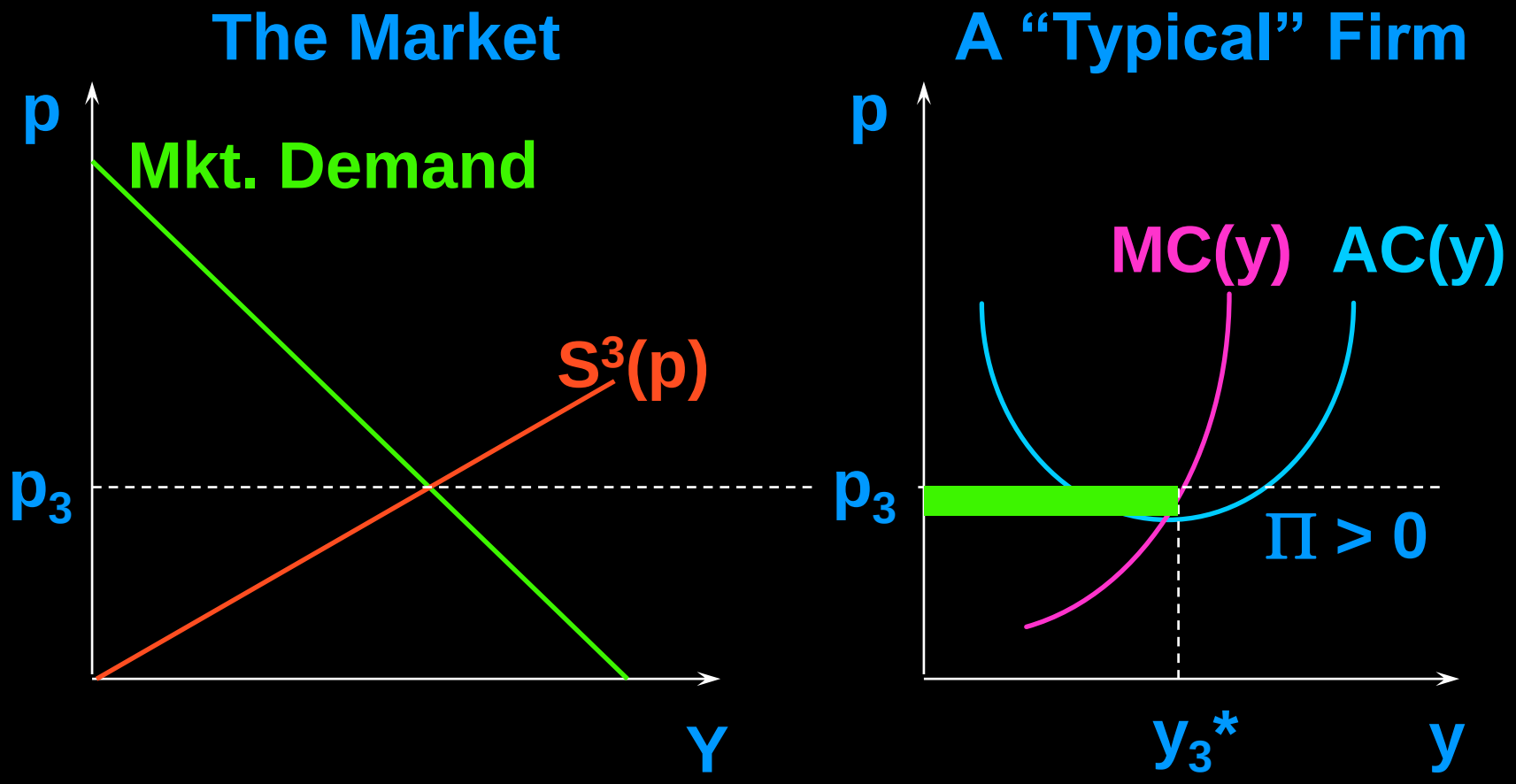
Long-Run Industry Supply



Each firm produces less.

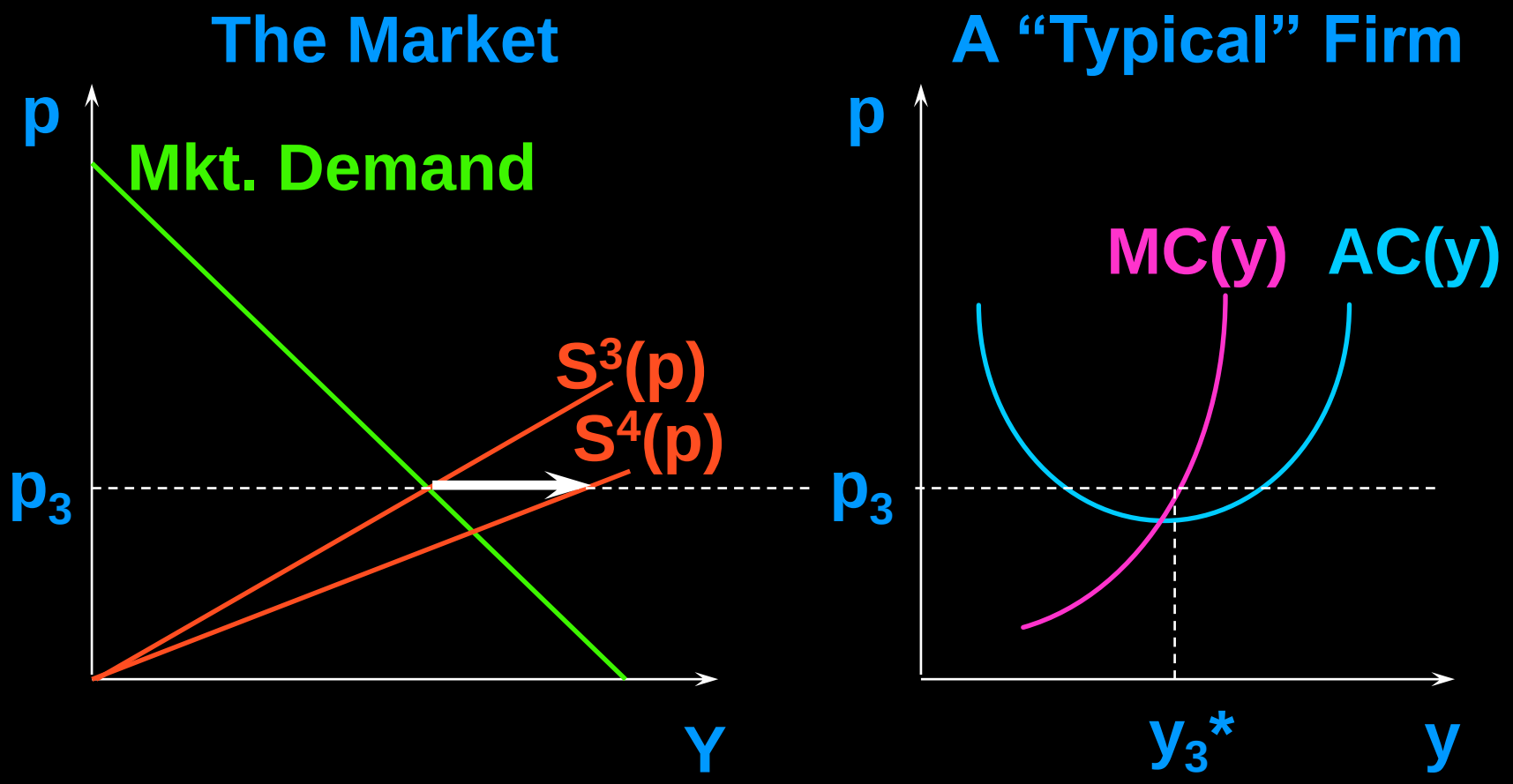
Each firm's economic profit is reduced.

Long-Run Industry Supply



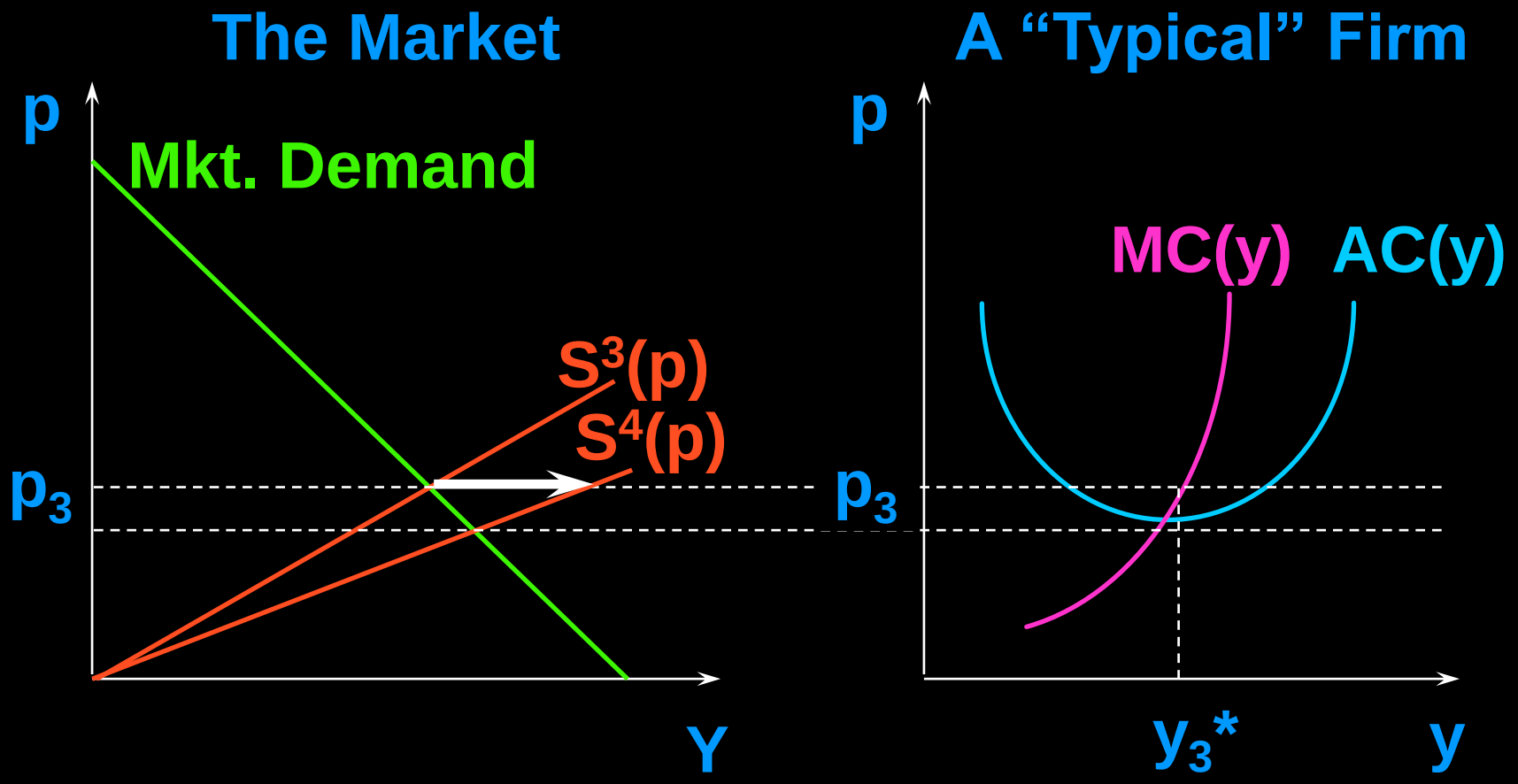
Each firm's economic profit is positive. Will another firm enter?

Long-Run Industry Supply



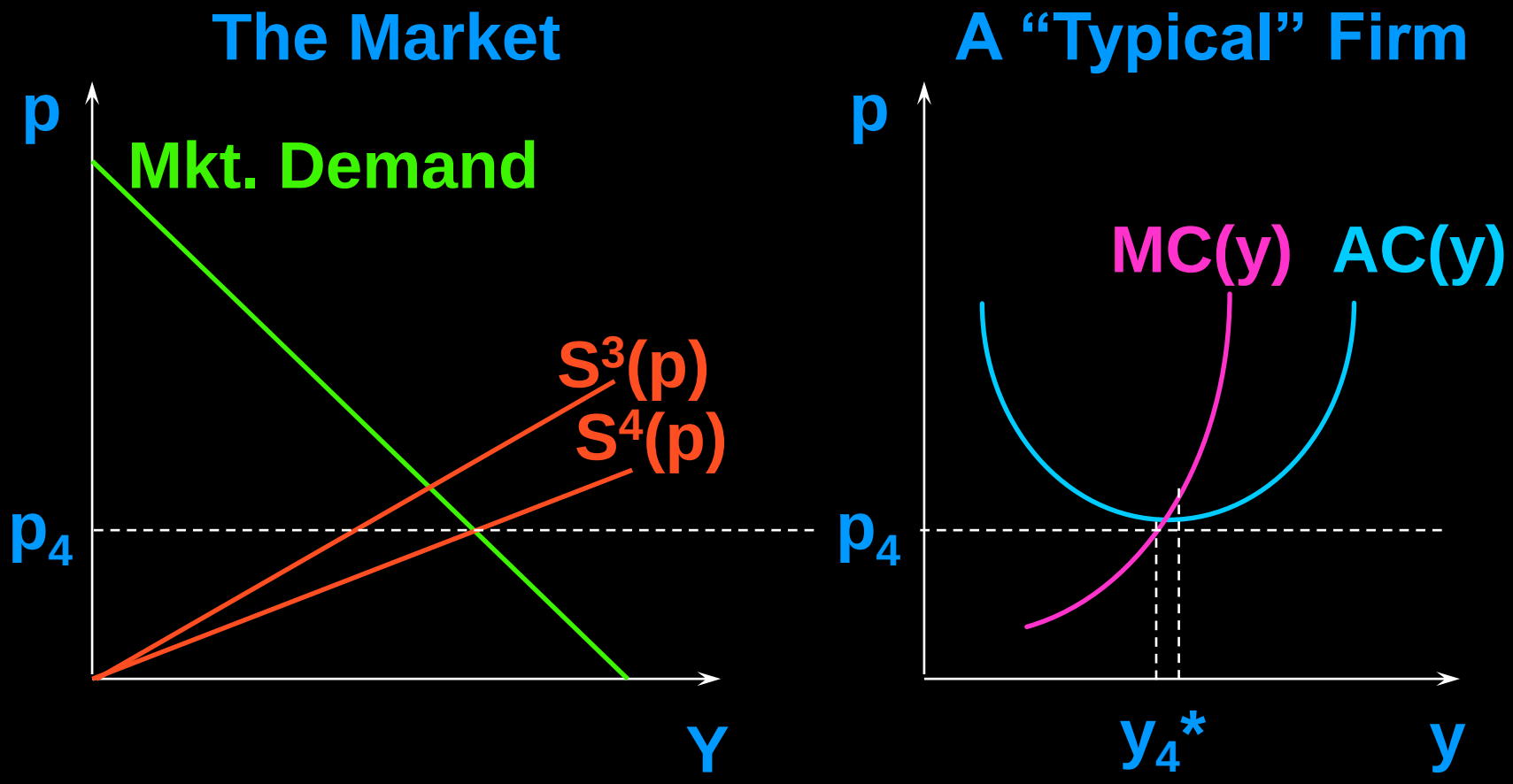
Market supply would shift outwards again.

Long-Run Industry Supply



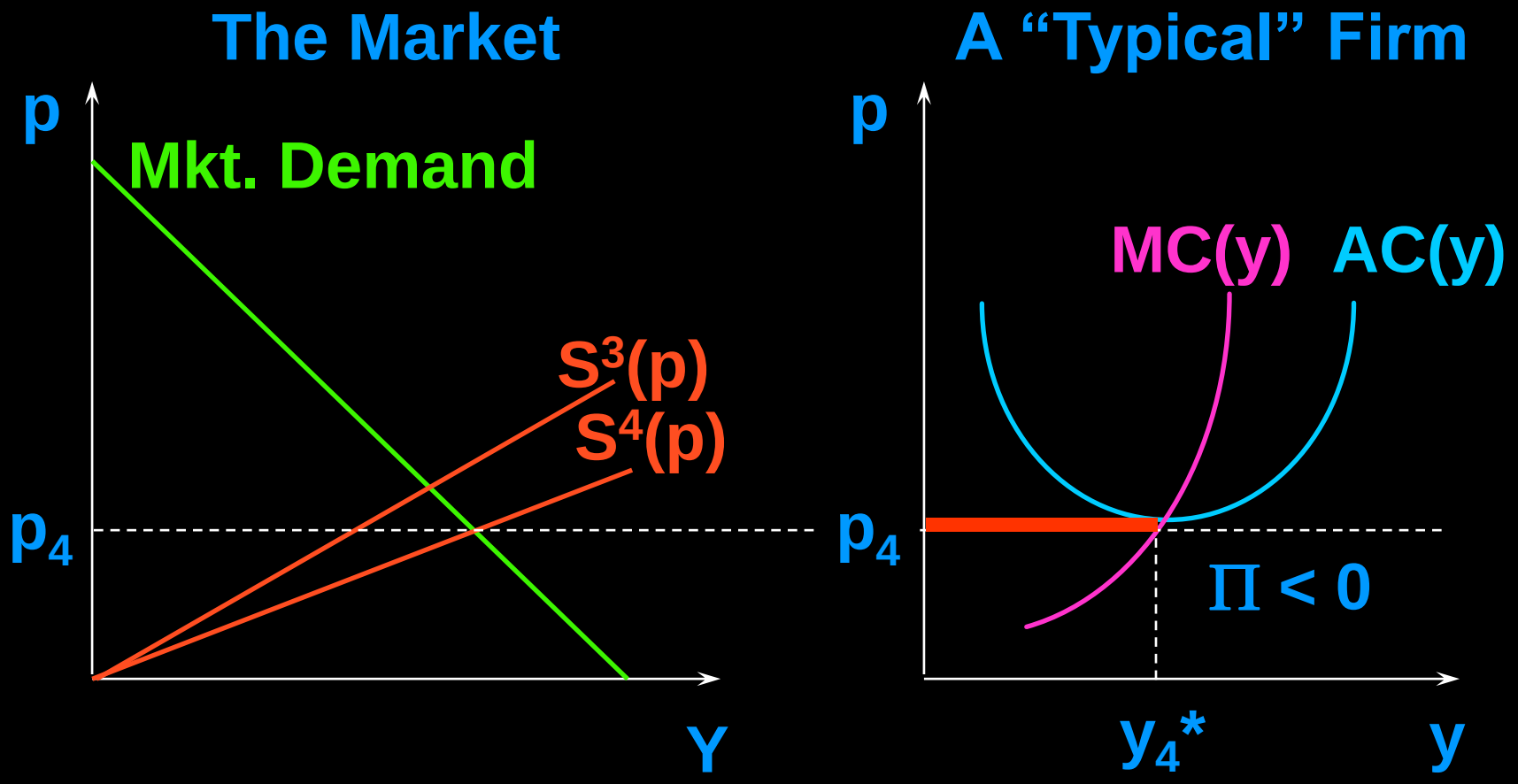
Market supply would shift outwards again.
Market price would fall again.

Long-Run Industry Supply



Each firm would produce less again.

Long-Run Industry Supply

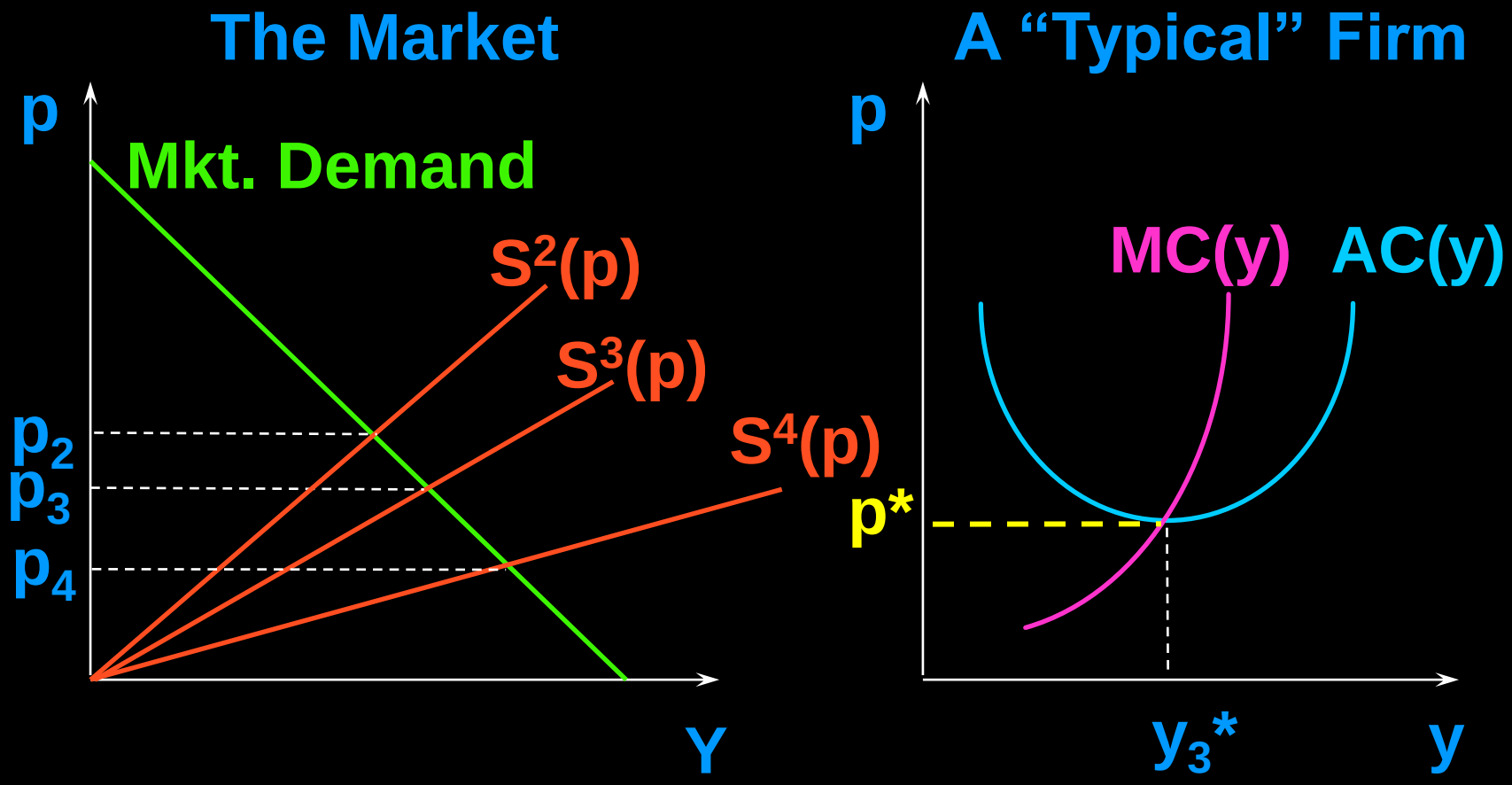


Each firm would produce less again. Each firm's economic profit would be negative. So the fourth firm would not enter.

Long-Run Industry Supply

- **The long-run number of firms in the industry is the largest number for which the market price is at least as large as min AC(y).**
  - 厂商所能接受的最低价格等于平均成本的最小值，记为 **p* = min AC(y)**; 当价格低于平均成本最小值时，企业利润为负
  - 均衡时的企业数量是保证价格恰好不低于平均成本最小值（非负利润）时市场所能容纳的最大企业数量

Long-Run Industry Supply



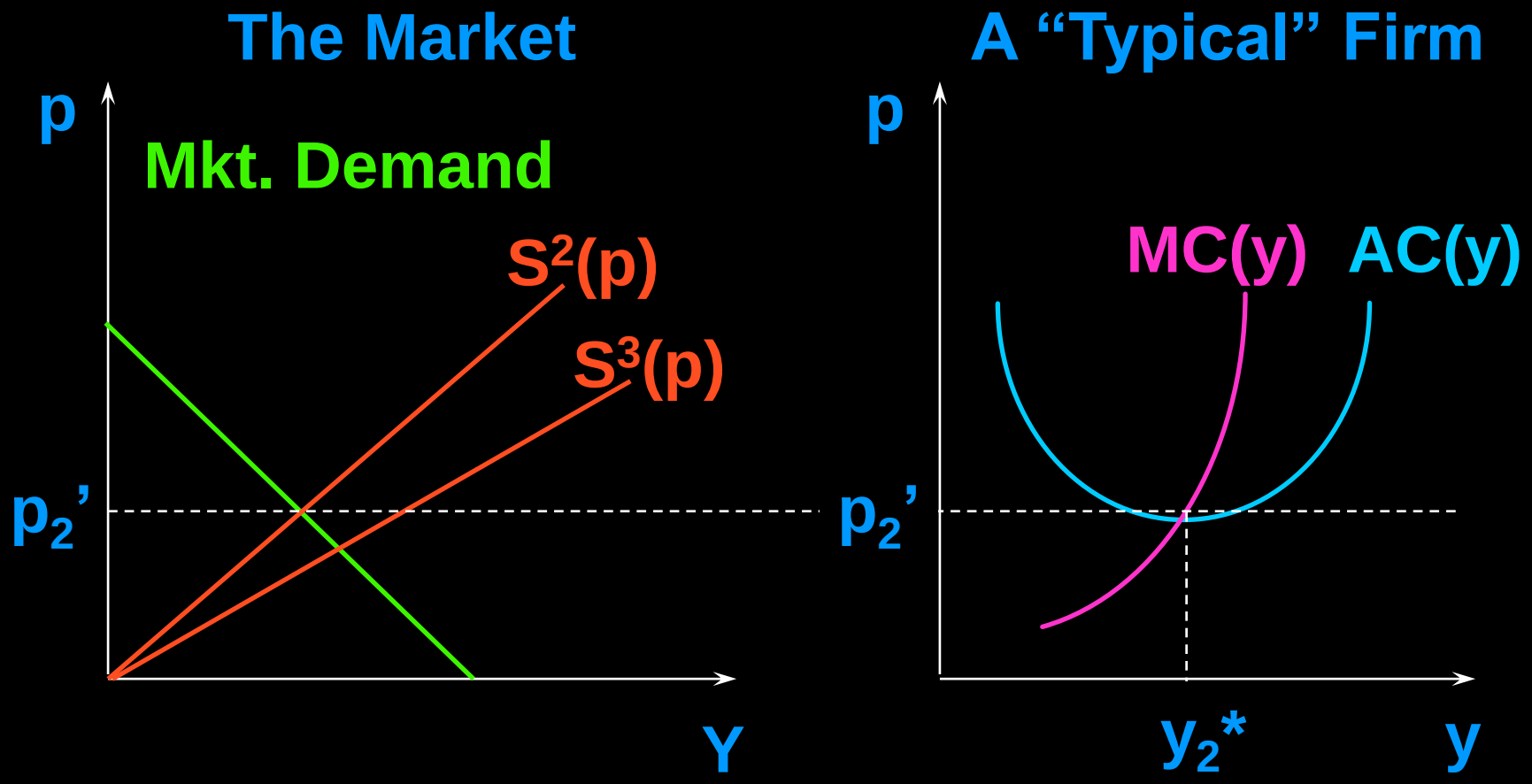
当有3家企业时，市场价格恰好不低于p*=min AC(y)，因此均衡企业数量为3

p* = min AC(y)是厂商所能接受的最低市场价格

Long-Run Industry Supply

- **Now we can construct the industry's long-run supply curve.**
- **Suppose that market demand is large enough to sustain only two firms in the industry.**

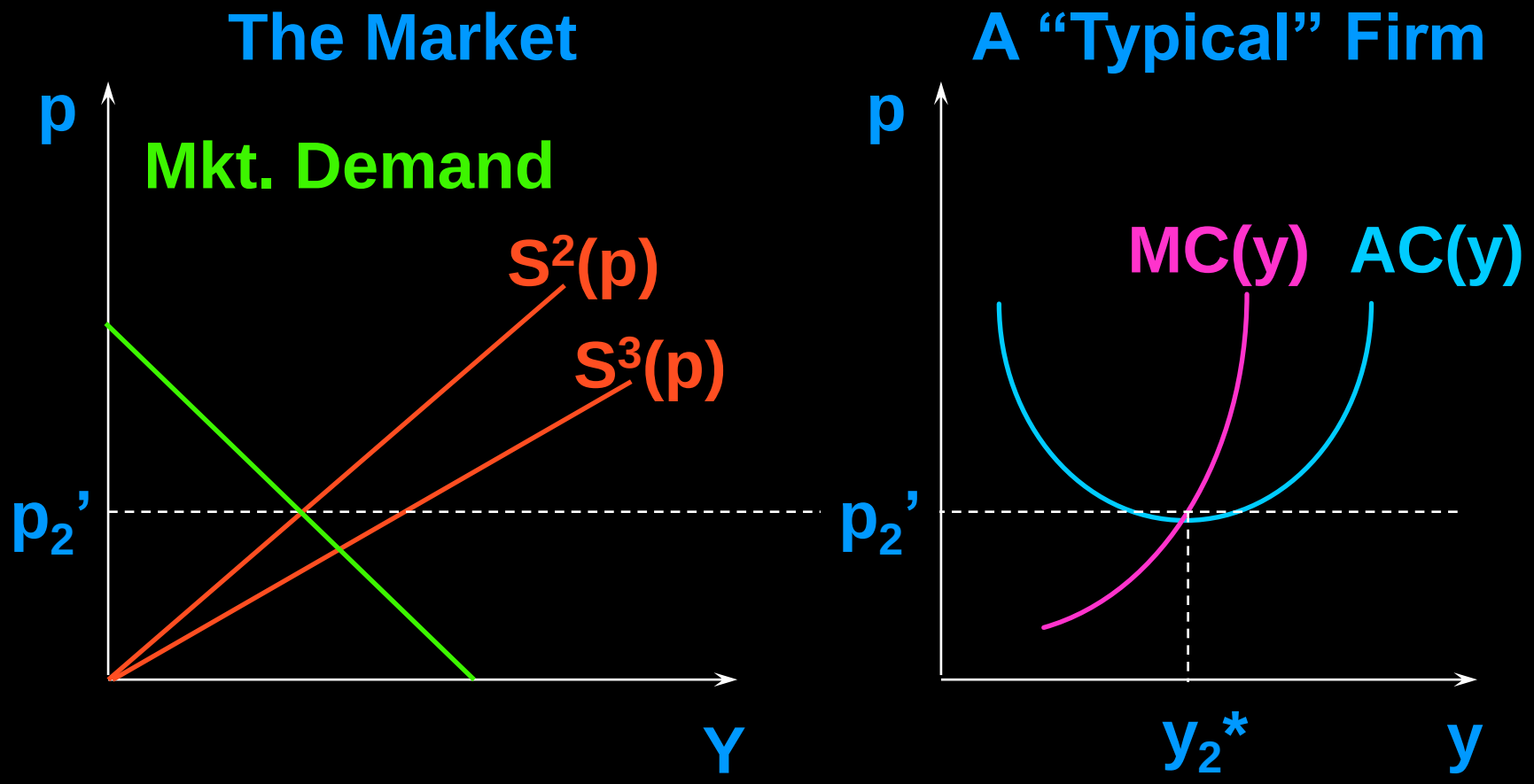
Long-Run Industry Supply



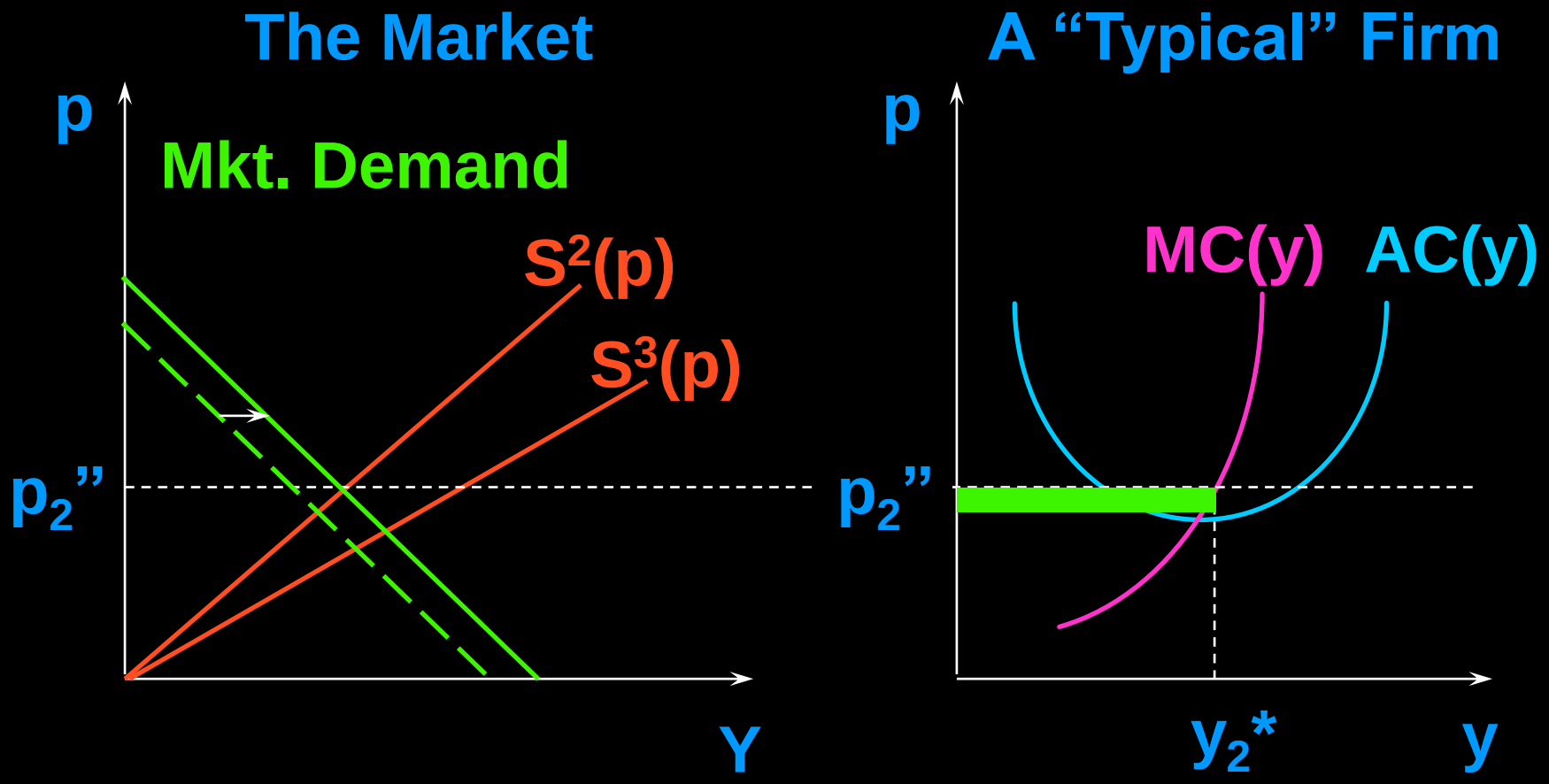
Long-Run Industry Supply

- **Then market demand increases, the market price rises, each firm produces more, and earns a higher economic profit.**

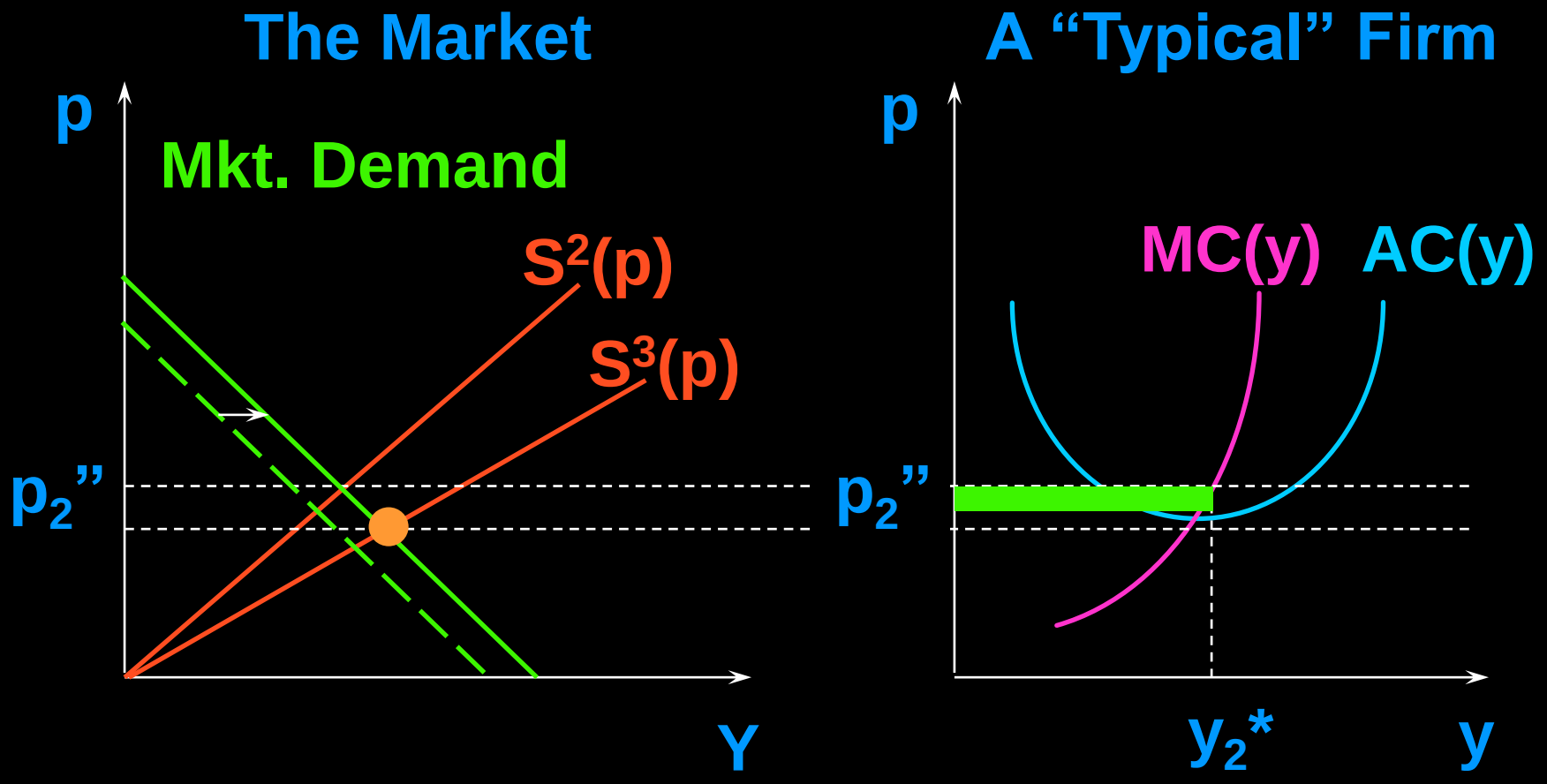
Long-Run Industry Supply



Long-Run Industry Supply



Long-Run Industry Supply

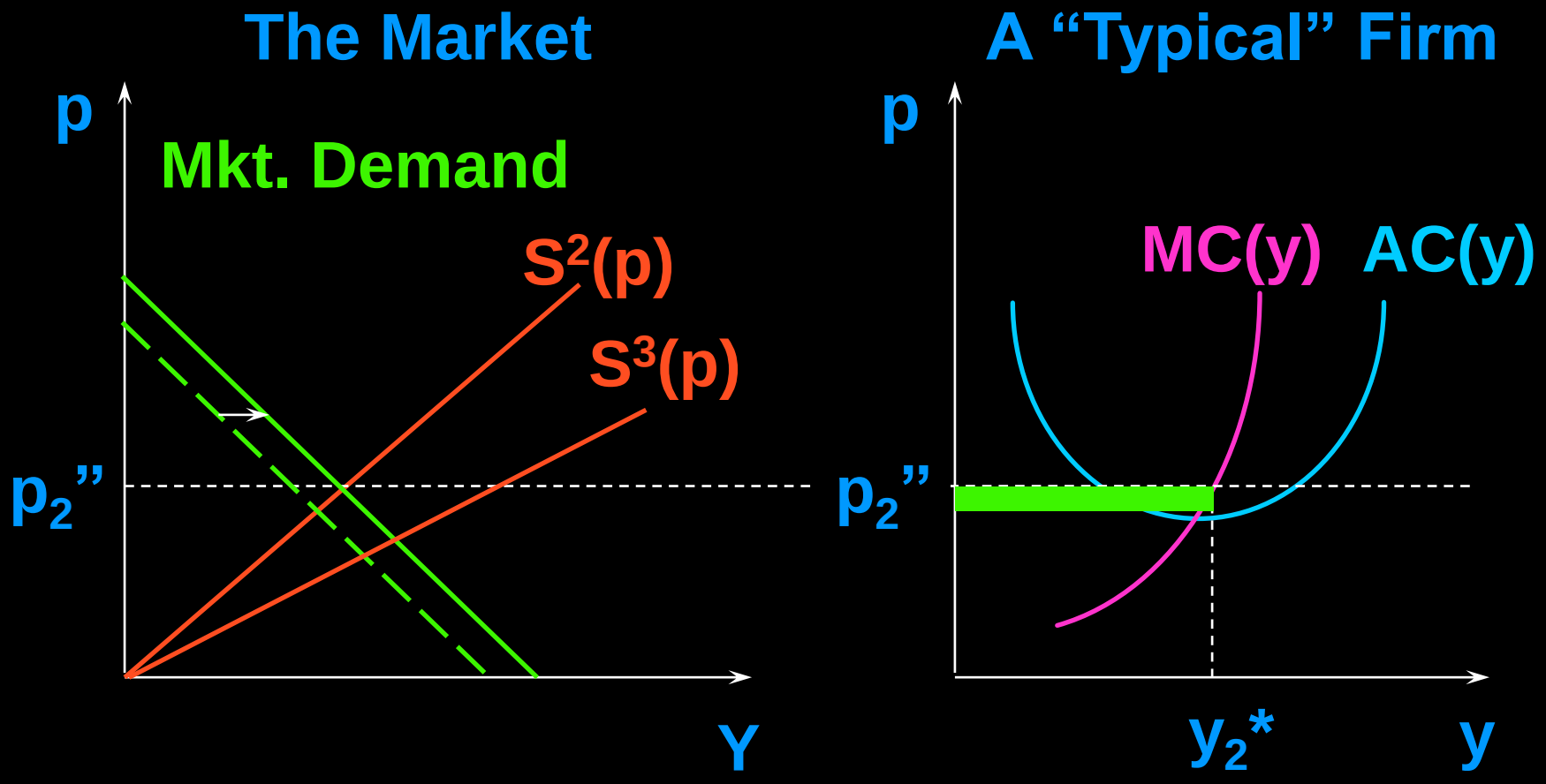


Notice that a 3rd firm will not enter since it would earn negative economic profits.

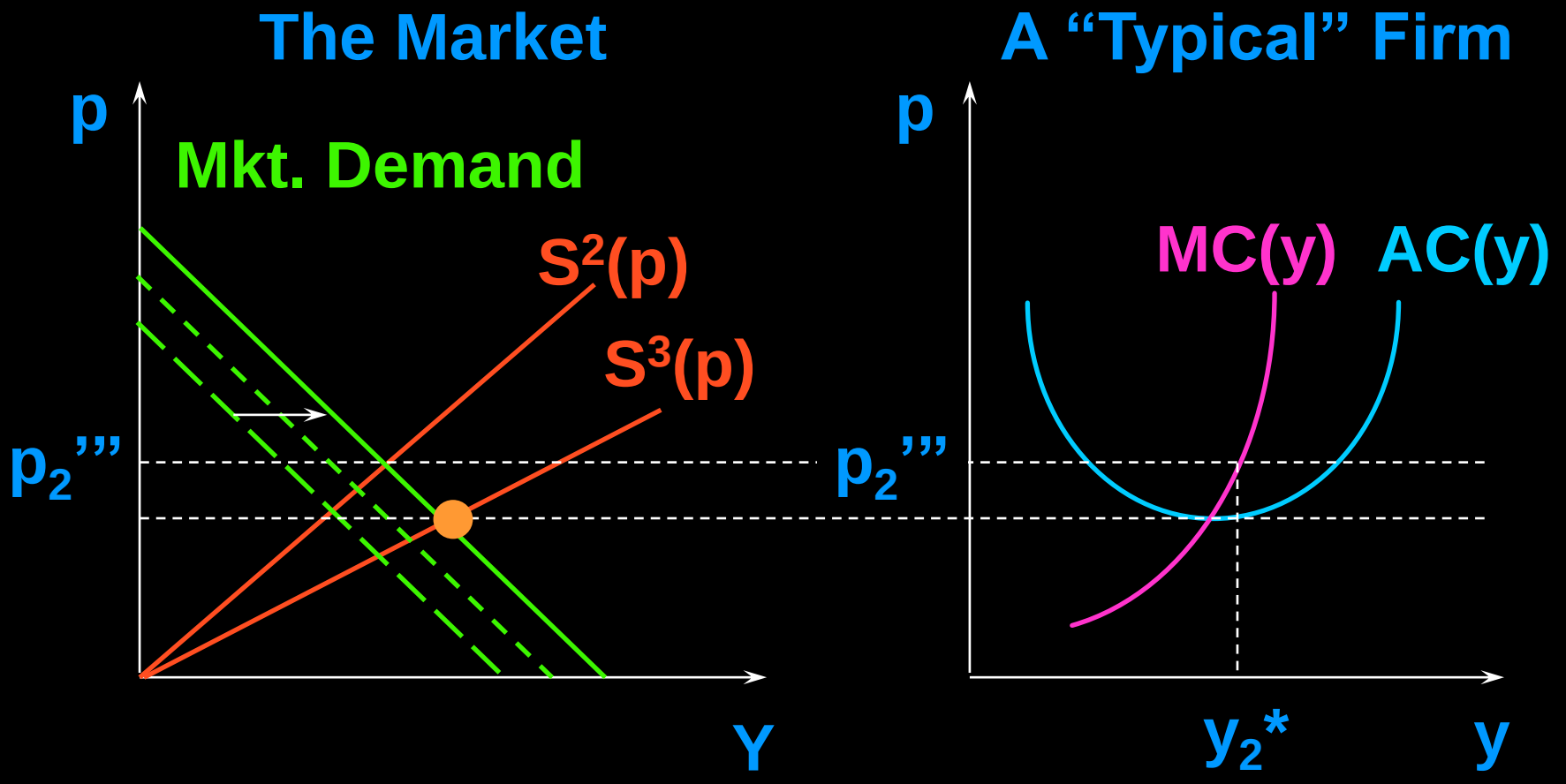
Long-Run Industry Supply

- **As market demand increases further, the market price rises further, the two incumbent firms each produce more and earn still higher economic profits -- until a 3rd firm becomes indifferent between entering and staying out.**

Long-Run Industry Supply



Long-Run Industry Supply



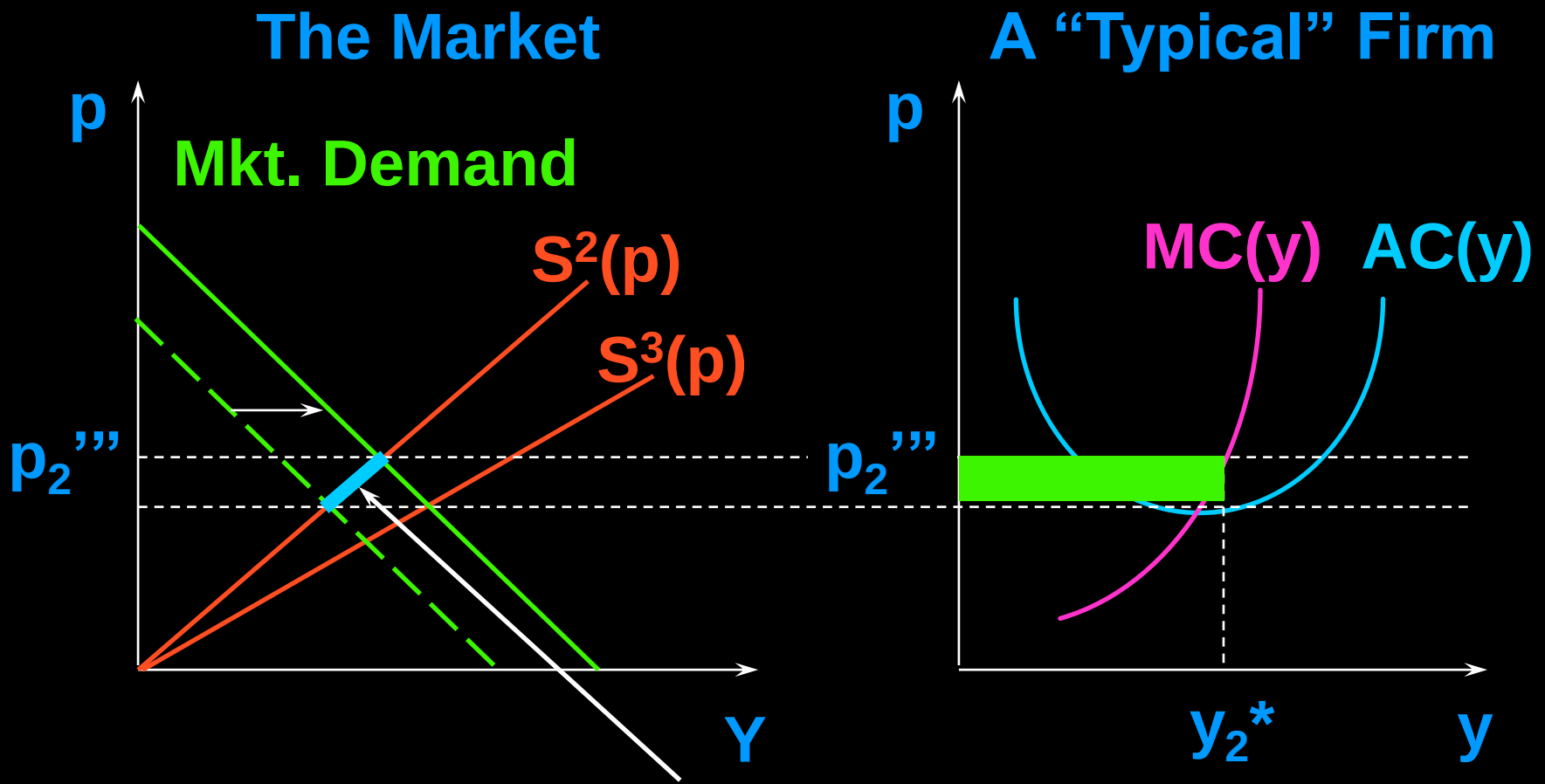
A third firm can now **enter**, causing all firms to earn zero economic profits. (需求外移到实线位置时，若第三家企业进入则利润为0)

Long-Run Industry Supply

- **So any further increase in market demand will cause the number of firms in the industry to rise to three.**

  市场需求的增加(外移)会增加均衡时的企业数量

Long-Run Industry Supply

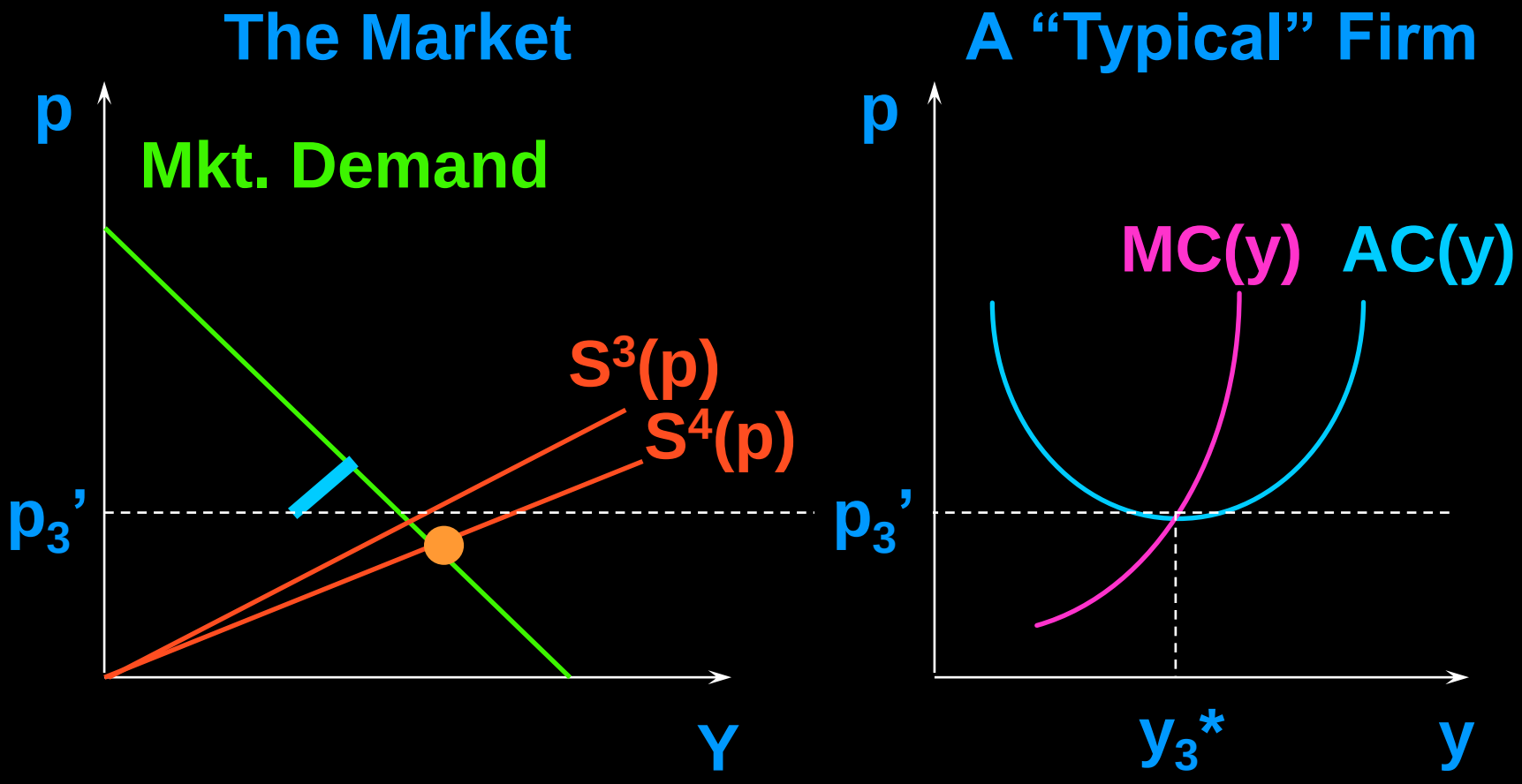


The only relevant part of the short-run supply curve for n = 2 firms in the industry.

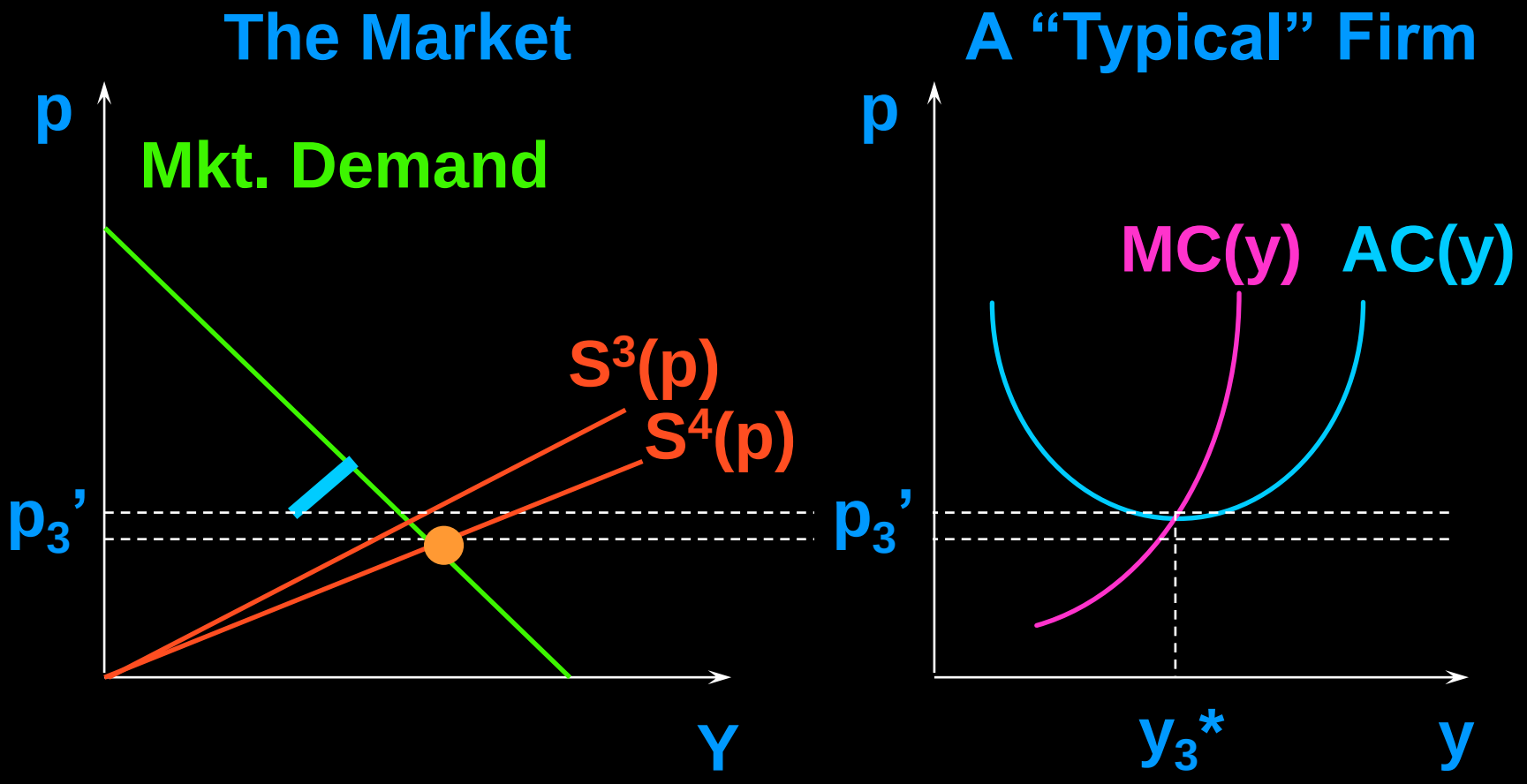
Long-Run Industry Supply

- **How much further can market demand increase before a fourth firm enters the industry?**

Long-Run Industry Supply

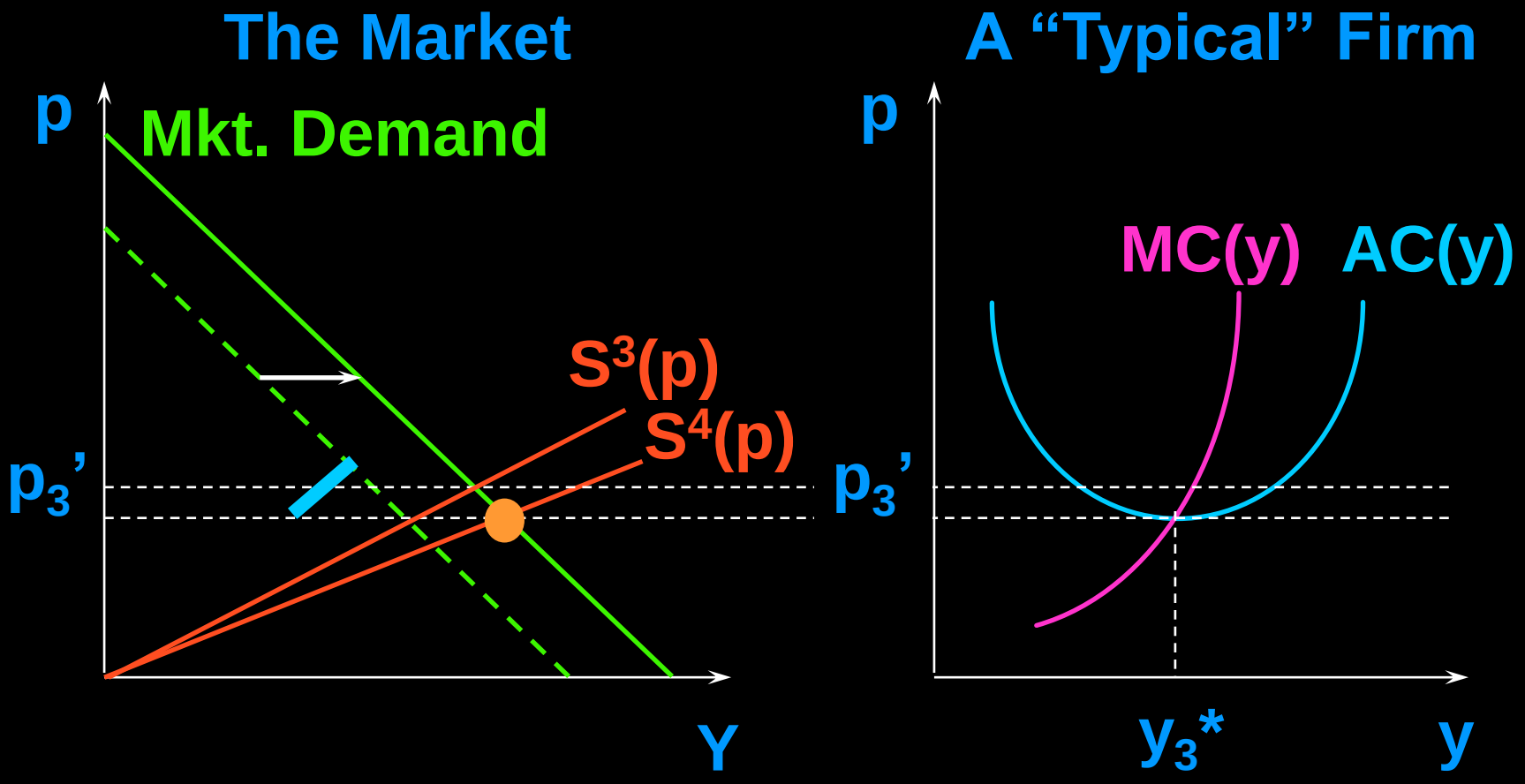


Long-Run Industry Supply



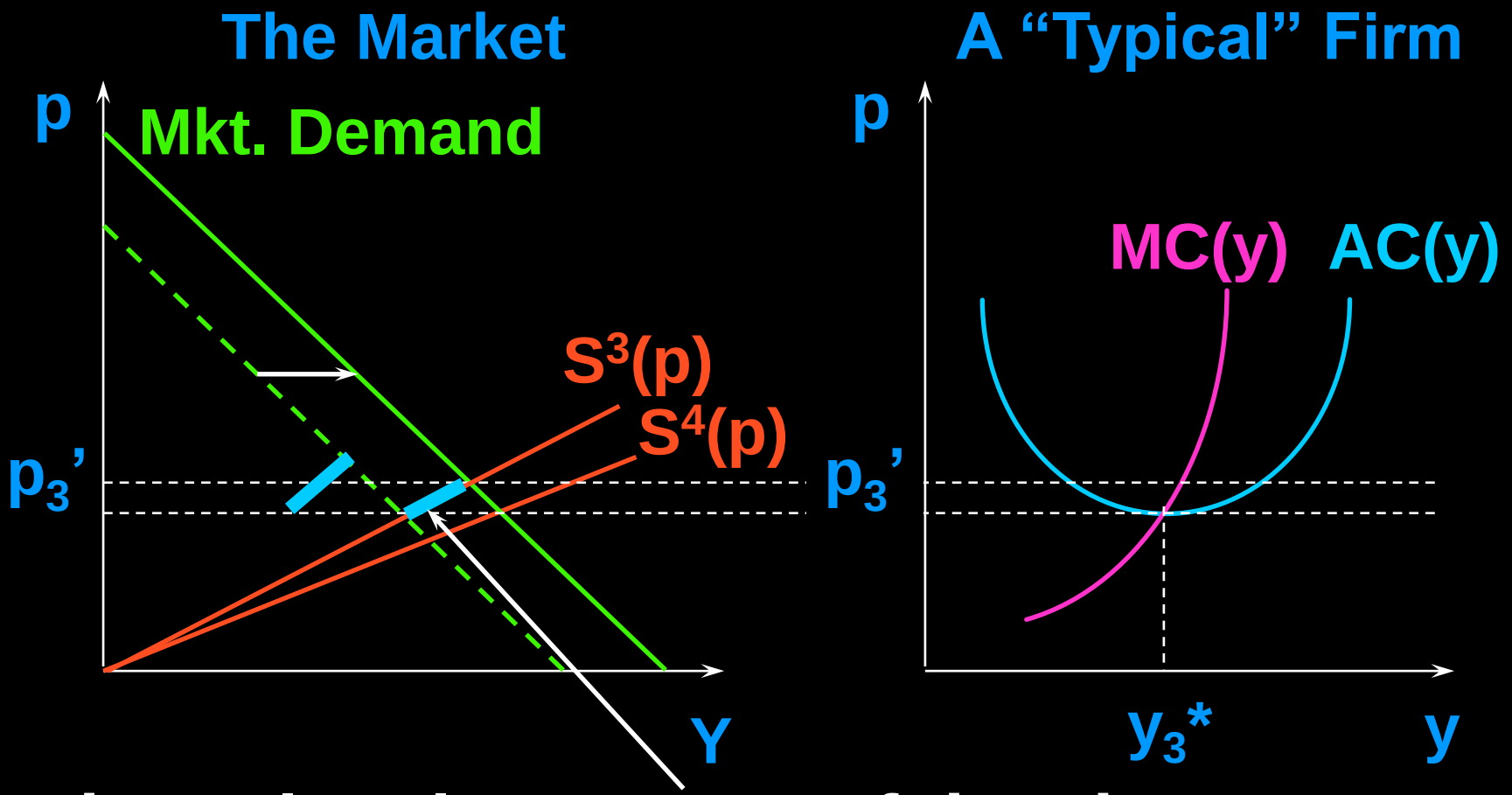
A 4th firm would now earn negative economic profits if it entered the industry.

Long-Run Industry Supply



But now a 4th firm would earn zero economic profit if it entered the industry.

Long-Run Industry Supply

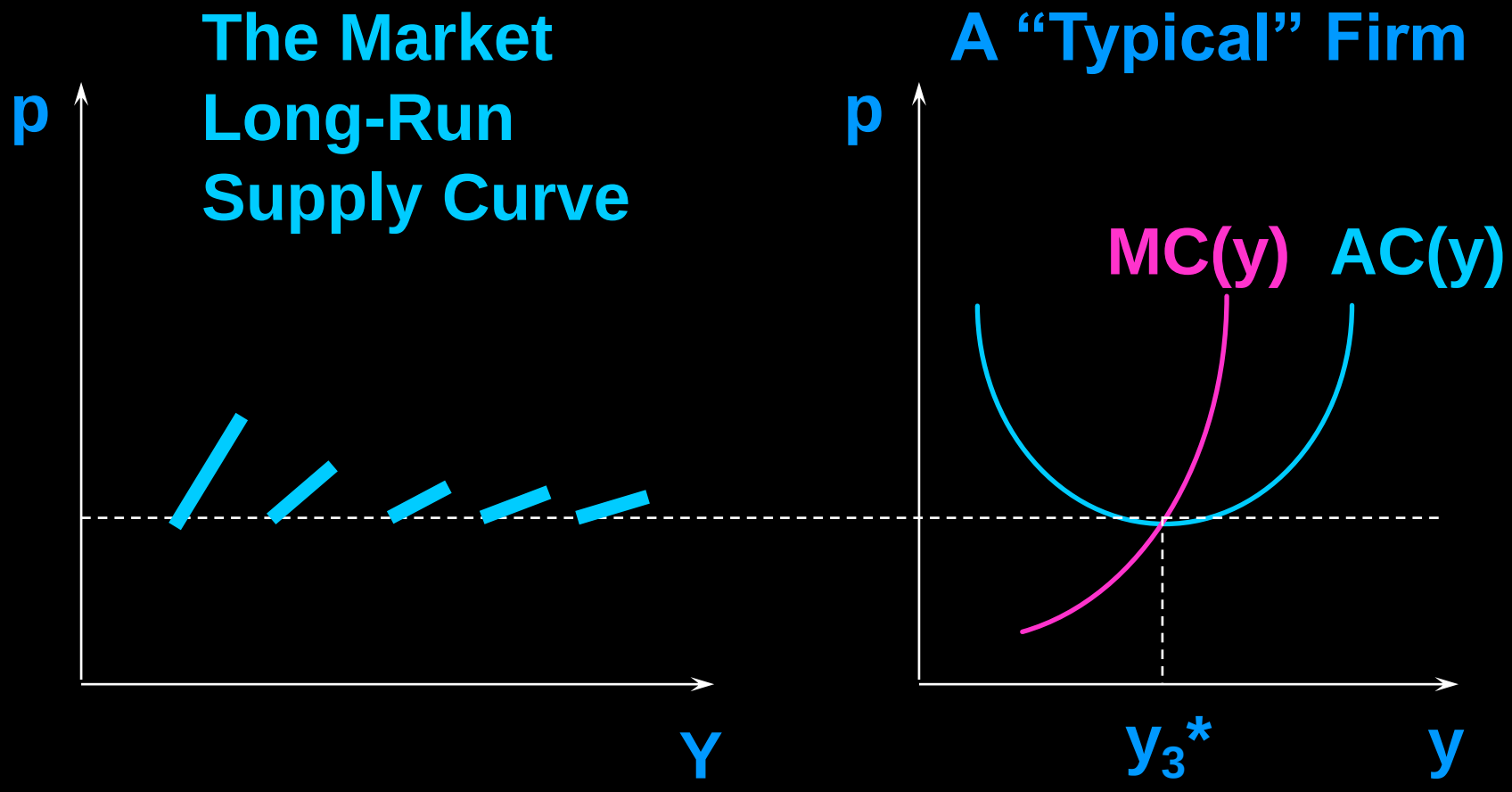


The only relevant part of the short-run supply curve for n = 3 firms in the industry.

Long-Run Industry Supply

- **Continuing in this manner builds the industry's long-run supply curve, one section at-a-time from successive short-run industry supply curves.**

Long-Run Industry Supply

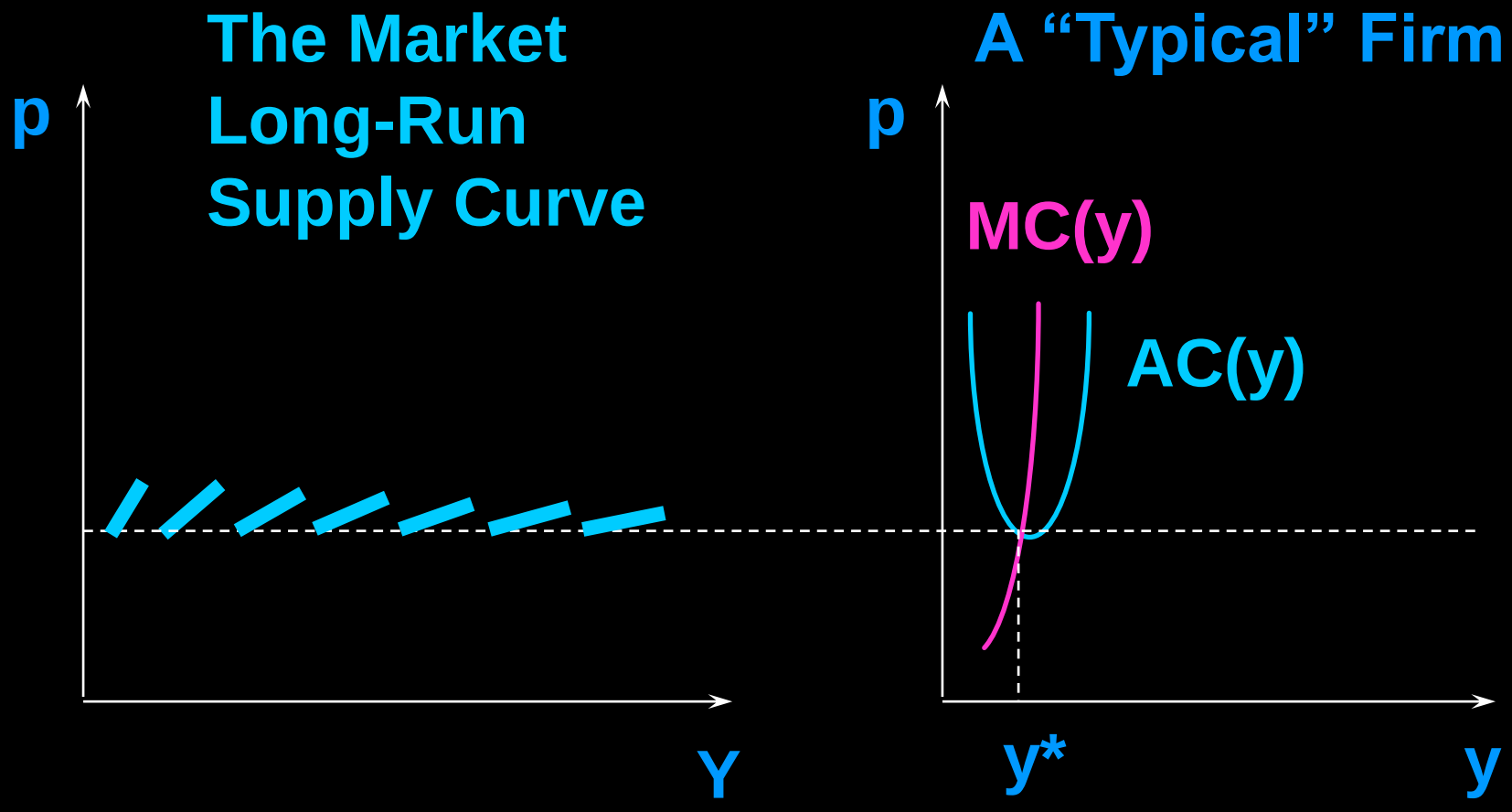


Notice that the bottom of each segment of the supply curve is min AC(y)

Long-Run Industry Supply

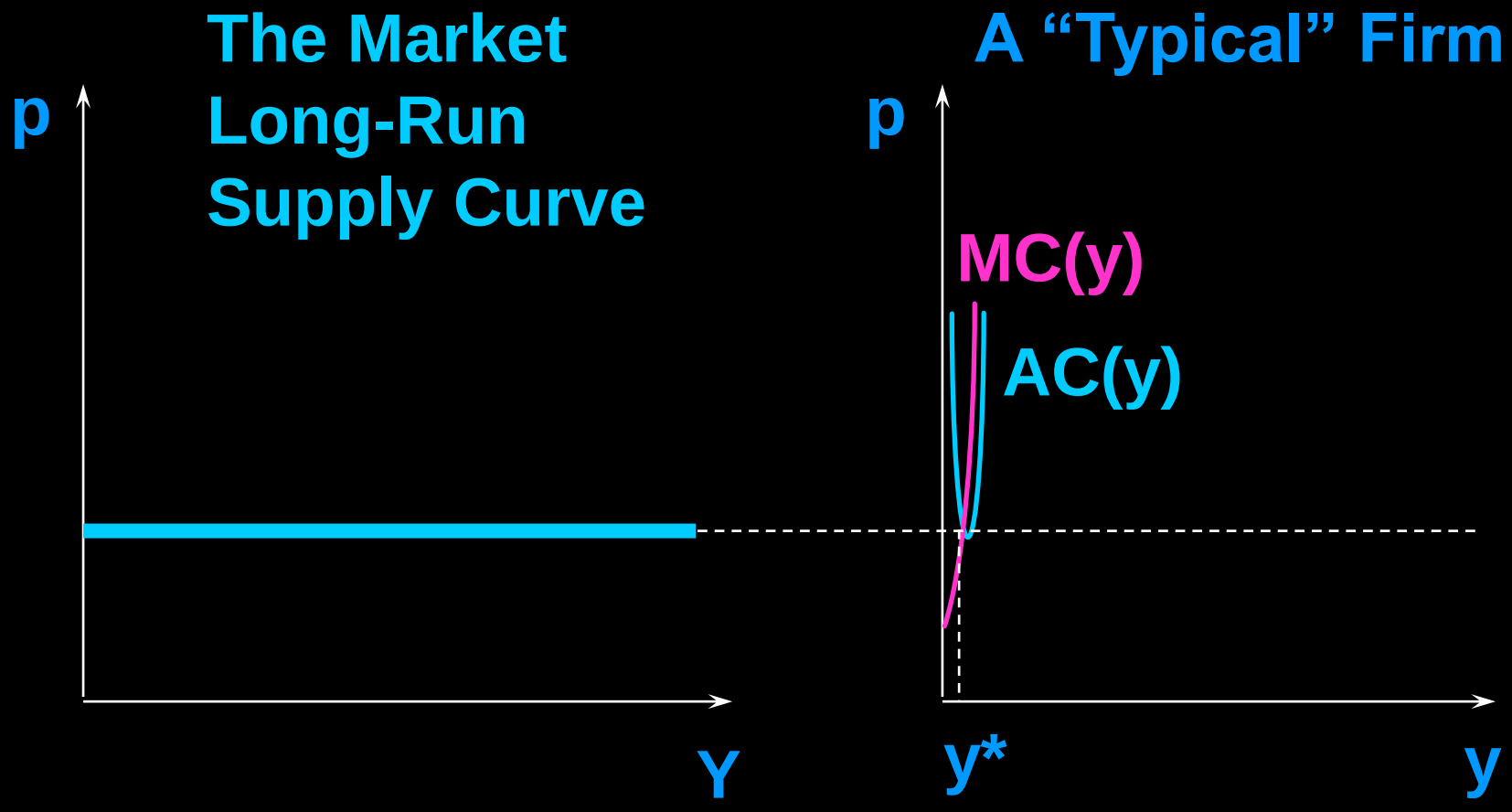
- As each firm gets “smaller” relative to the industry, the long-run industry supply curve approaches a **horizontal line** at the height of min AC(y).

Long-Run Industry Supply



The bottom of each segment of the supply curve is min AC(y). As firms get “smaller” the segments get shorter.

Long-Run Industry Supply



In the limit, as firms become infinitesimally small, the industry’s long-run supply curve is horizontal at min AC(y).

Long-Run Market Equilibrium Price

- **In the long-run market equilibrium, the market price is determined solely by the long-run minimum average production cost.**

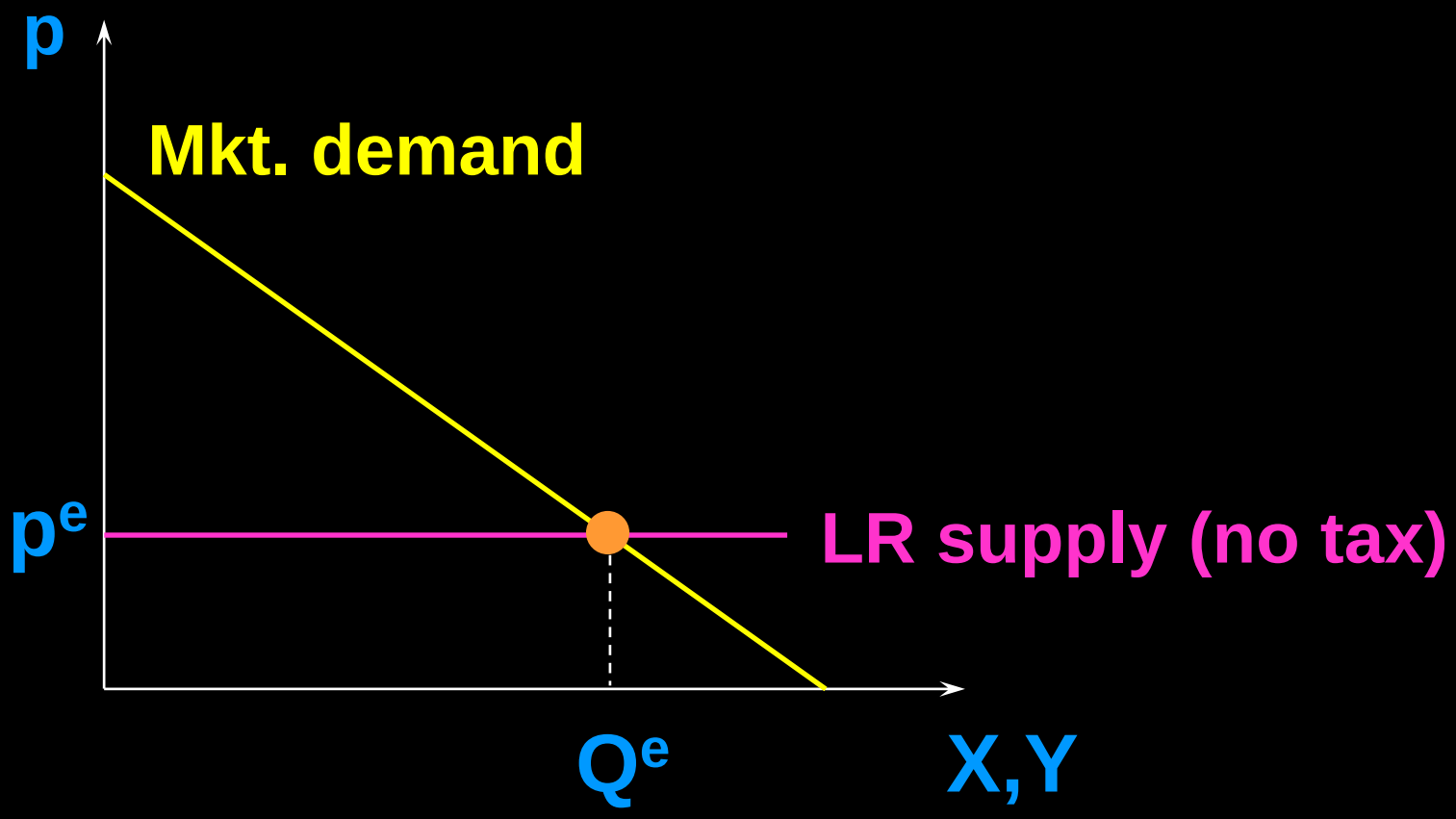
Long-run market price is

$$p^e = \min_{y>0} AC(y).$$

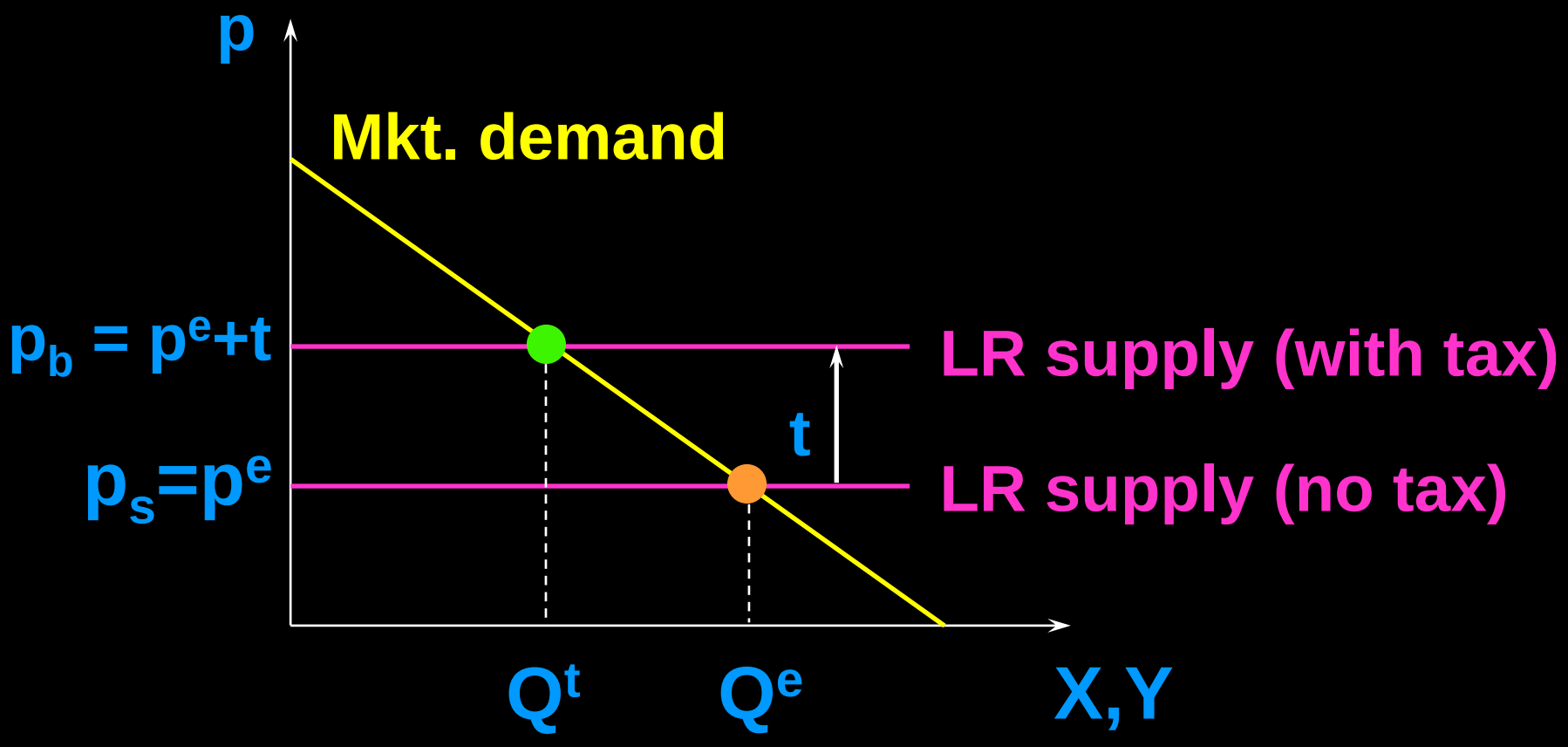
Long-Run Implications for Taxation

- In a **short-run** equilibrium, the burden of a sales or an excise tax is typically shared by both buyers and sellers, **tax incidence** of the tax depending upon the own-price elasticities of demand and supply.
- Q: Is this true in a long-run market equilibrium?

Long-Run Implications for Taxation

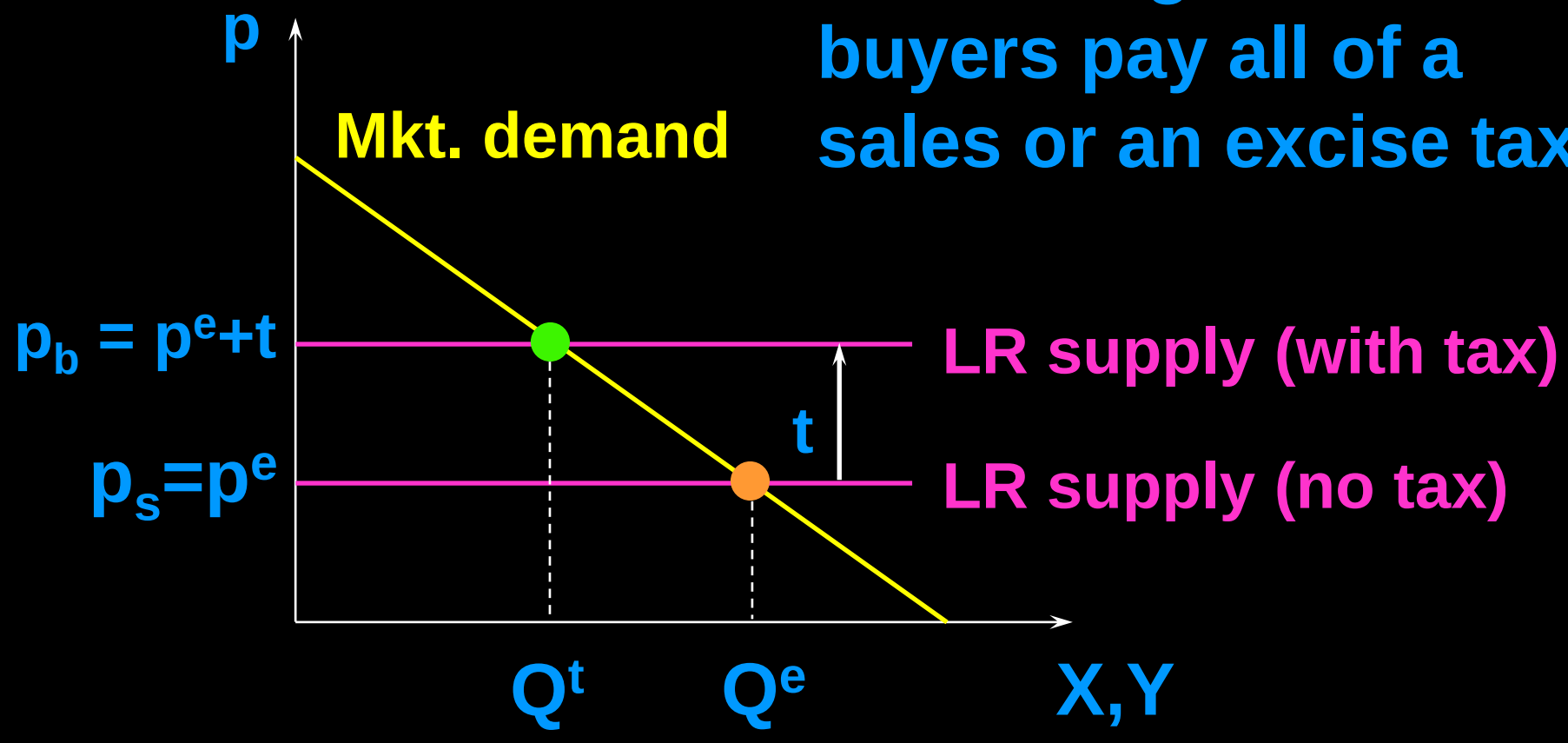


Long-Run Implications for Taxation



Long-Run Implications for Taxation

In the long-run the buyers pay all of a sales or an excise tax.



Fixed Inputs and Economic Rent

- **What if there is a barriers to entry or exit?**
- **E.g., the taxi-cab industry has a barrier to entry even though there are lots of cabs competing with each other.**
- **Liquor licensing is a barrier to entry into a competitive industry.**

Fixed Inputs and Economic Rent

- **Q: When there is a barrier to entry, will not the firms already in the industry make positive economic profits?**

Fixed Inputs and Economic Rent

- **Q: When there is a barrier to entry, will not the firms already in the industry make positive economic profits?**
- **A: No. Each firm in the industry makes a zero economic profit. Why?**

Fixed Inputs and Economic Rent

- An input (e.g. an operating license) that is fixed in the long-run causes a long-run fixed cost, F.
- Long-run total cost, $c(y) = F + c_v(y)$.
- And long-run average total cost,
  $$AC(y) = AFC(y) + AVC(y).$$
- In the long-run equilibrium, what will be the value of F?

Fixed Inputs and Economic Rent

- **Think of a firm that needs an operating license -- the license is a fixed input that is rented but not owned by the firm.**
- **If the firm makes a positive economic profit then another firm can offer the license owner a higher price for it. In this way, all firms' economic profits are competed away, to zero.**

Fixed Inputs and Economic Rent

- **So in the long-run equilibrium, each firm makes a zero economic profit and each firm's fixed cost is its payment for its operating license.**

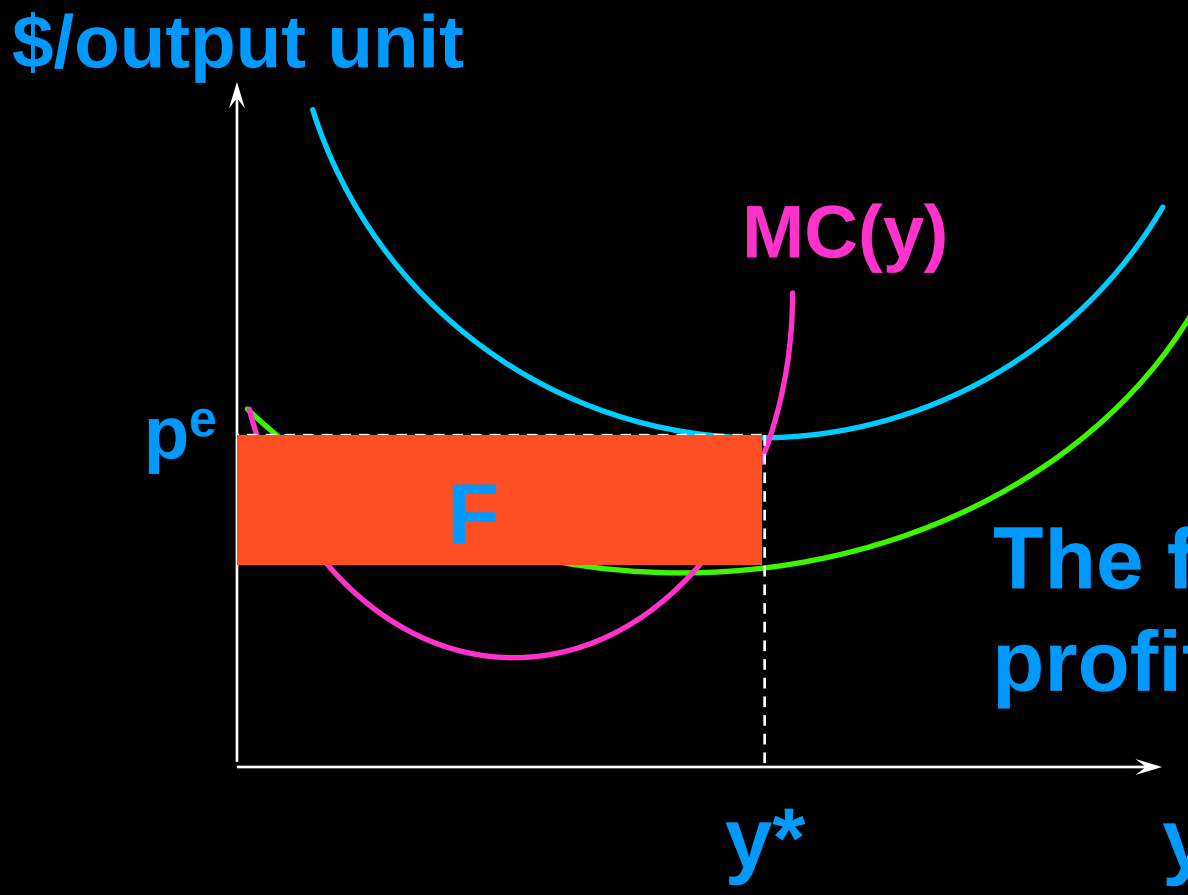
Fixed Inputs and Economic Rent

- **Economic rent** is the payment for an input that is in excess of the minimum payment required to have that input supplied.

  经济租金是支付给要素的报酬超出该要素生产成本的部分，或者说是该要素所能带来的超额收益

- Each license essentially costs zero to supply, so the long-run economic rent paid to the license owner is the firm's long-run fixed cost.

Fixed Inputs and Economic Rent



The firm's economic profit is zero.

F is the payment to the owner of the fixed input (the license); F = economic rent.