# LECTURE 7: COSTS OF PRODUCTION

## Today's Topics — includes Monopolies

1. **What Are Costs?** Total Revenue (*TR*), Total Cost (*TC*), Profit ($\pi$); the Cost of Capital; Economic v. Accounting Profits.
2. **Production and Costs:** the Production Function, the Total Cost Curve, Fixed and Variable Costs, Average and Marginal Costs, Cost Curves.
3. **Costs in the Short Run and the Long Run:** Average Costs, Economies of Scale.
4. **Sunk Costs.**

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**The firm's costs are key to its production and pricing decisions.**

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***Profit ($\pi$)* = $TR - TC$**

**In general, $TR$ and $TC$ (and so profit $\pi$) will vary with the level of output $y$/period.**

**For a price-taking firm, $TR = P \bullet y$.**

**Just how $TC$ varies we now explore.**

# CAPITAL COSTS AS OPPORTUNITY COST

**Total Costs *TC* include all *opportunity costs* = explicit costs + implicit costs.**

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**The opportunity cost of capital is the value forgone: the best alternative return from that capital, whether it's yours, your family's, or borrowed.**

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**A positive economic profit: above-normal return to capital.**

**Example: *Economic Value Added* = operating (accounting) profit − cost of capital × capital**

# THE PRODUCTION FUNCTION

**How are the firm's Total Costs related to its purchasing decisions, as it buys inputs to transform into output?**

| Number of Workers | Output $y$/hour | Marginal Product of Labour | (4) Cost of Factory | (5) Cost of Workers | Total Cost of Inputs (=(4)+(5)) |
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| | | 50 | | | |
| 1 | 50 | | 30 | 10 | 40 |
| | | 40 | | | |
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| 1 | 50 | | 30 | 10 | 40 |
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***Production function*: the relationship between quantity of inputs used to make a good or service and the quantity of output of that good or service.**

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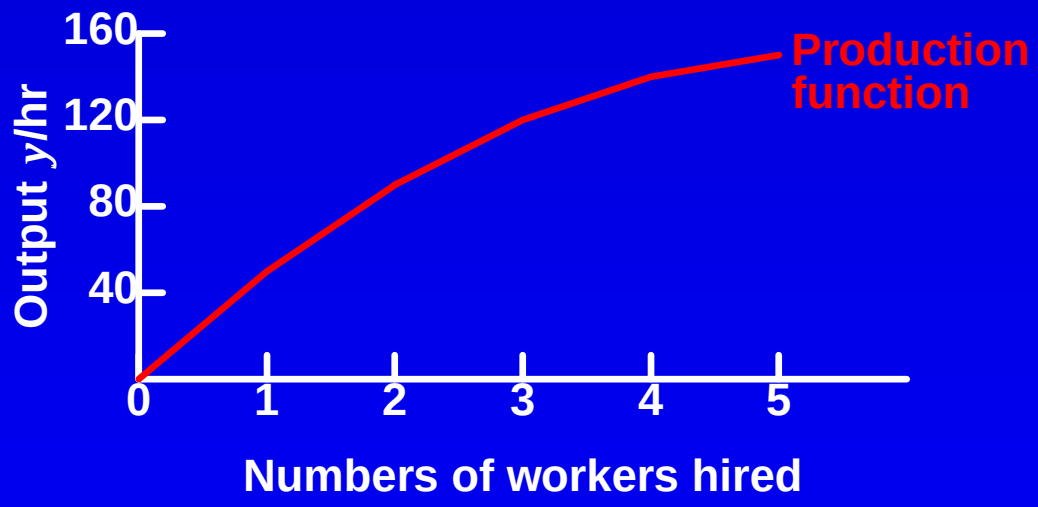

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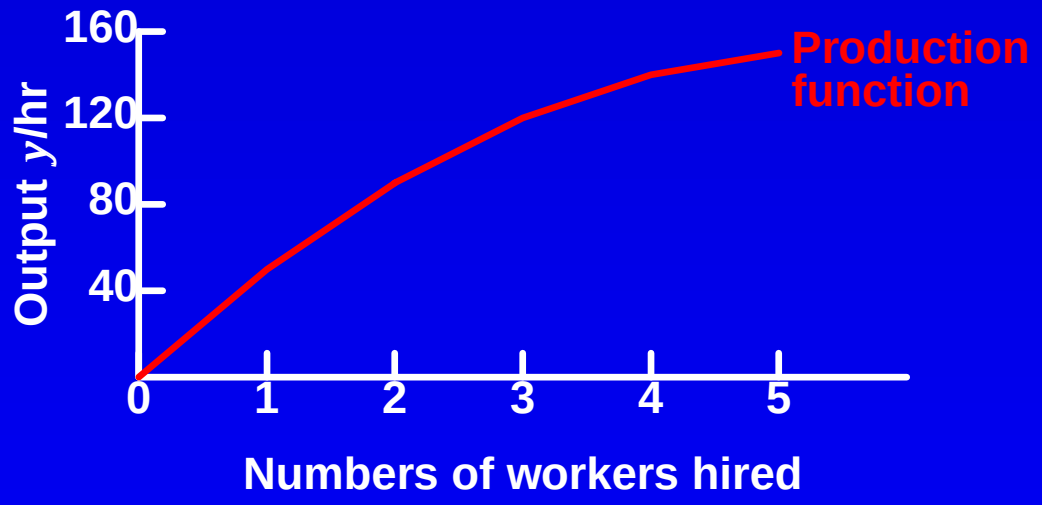


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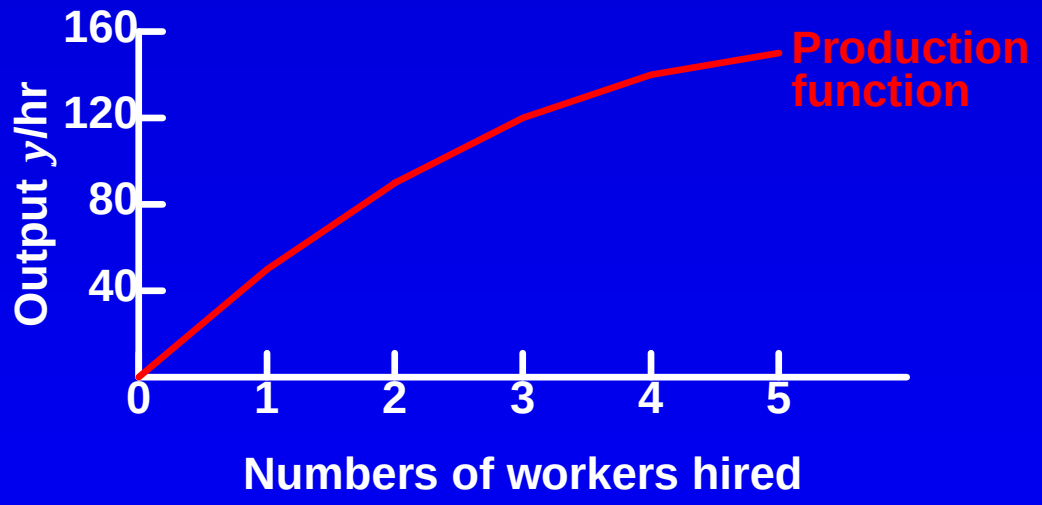


***Marginal Product (MP)*: the increase in output arising from an additional unit of one input.**

***Diminishing MP*: the *MP* of a particular input declines as the quantity of input increases. (Too many cooks spoil the broth?) See the graph.**

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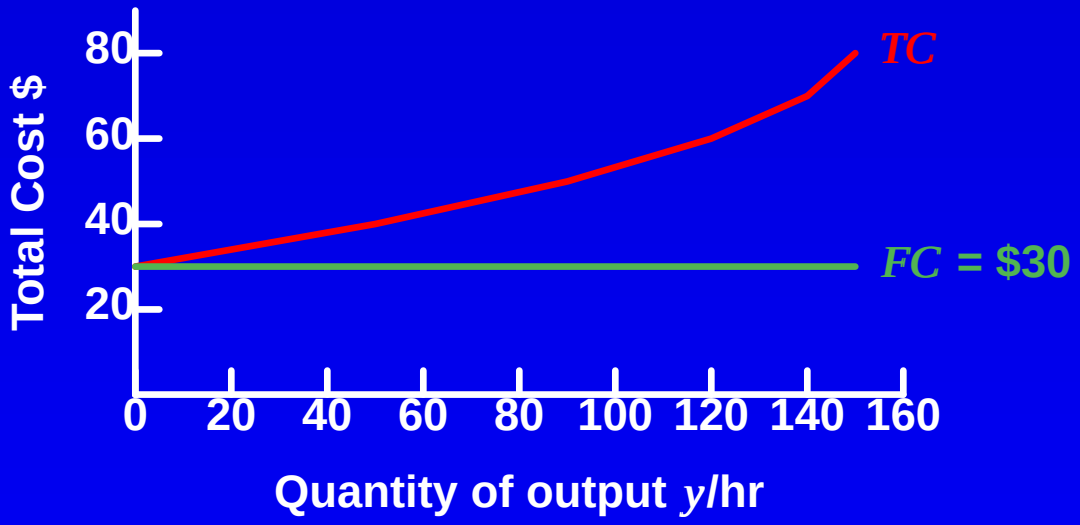

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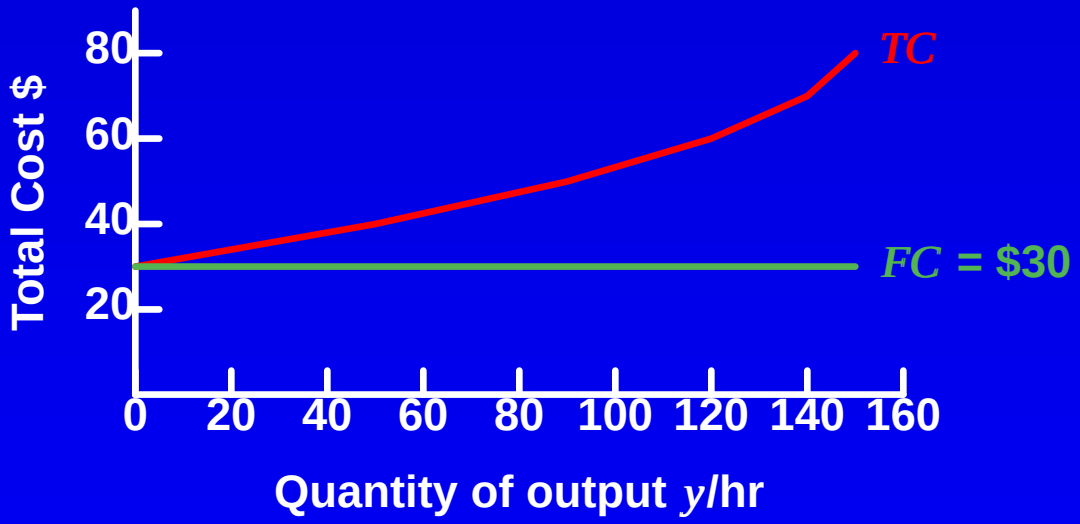


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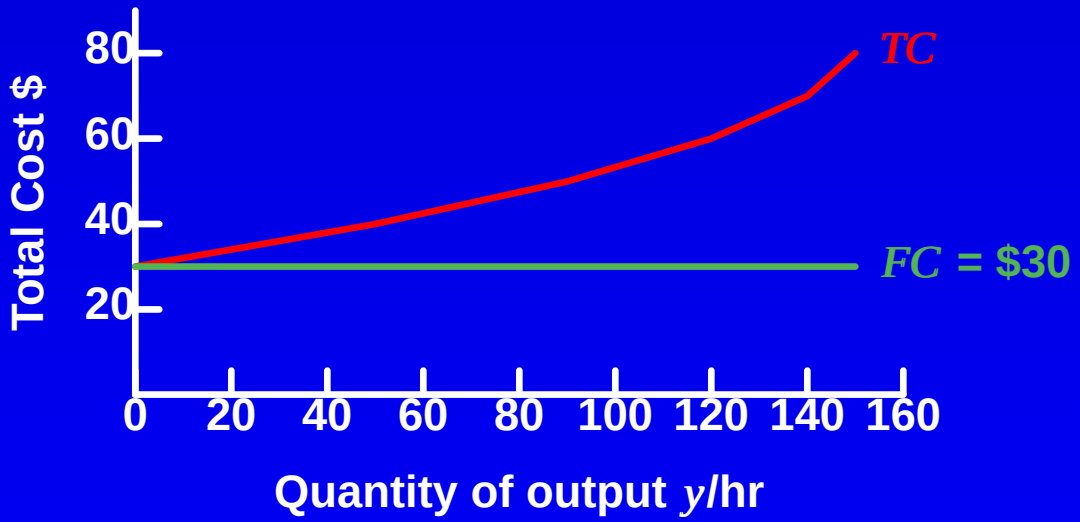


**The Cost of Factory does not change with the level of output; it is *Fixed*.**

**The Cost of Workers rises with the level of output; it is *Variable*.**

# FIXED AND VARIABLE COSTS

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**Examples?**

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**The *Average Fixed Cost (AFC)* =** $\frac{FC}{y}$

**The *Average Variable Cost (AVC)* =** $\frac{VC}{y}$

**(See Lecture 8 for their uses: shut-down decisions.)**

# VARIOUS COST MEASURES: THELMA

| Quantity ($y$/hr) | Total Cost $TC$ $ | Fixed Cost $FC$ $ | Variable Cost $VC$ $ | Average Fixed Cost $AFC = FC/y$ | Average Variable Cost $AVC = VC/y$ | Average Total Cost $ATC = TC/y$ | Marginal Cost $MC = \frac{\Delta TC}{\Delta y}$ |
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| | | | | | | | 0.30 |
| 1 | 3.30 | 3.00 | 0.30 | 3.00 | 0.30 | 3.30 | |
| | | | | | | | 0.50 |
| 2 | 3.80 | 3.00 | 0.80 | 1.50 | 0.40 | 1.90 | |

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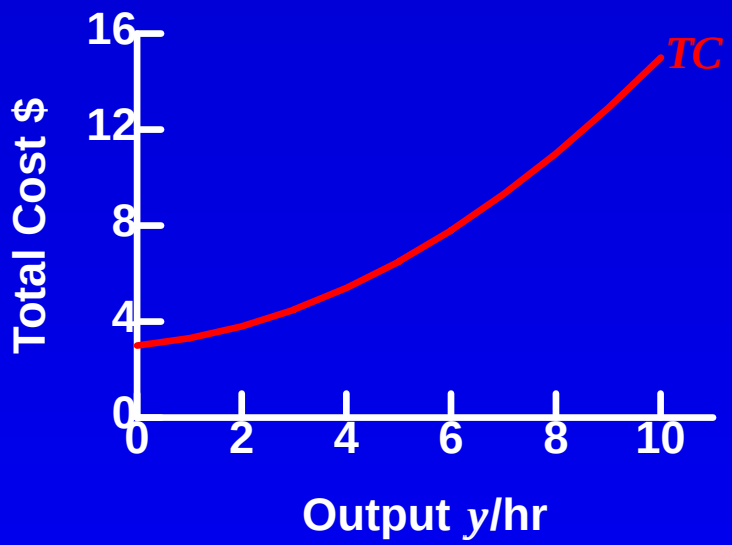
| 2 | 3.80 | 3.00 | 0.80 | 1.50 | 0.40 | 1.90 | 0.70 |
| 3 | 4.50 | 3.00 | 1.50 | 1.00 | 0.50 | 1.50 | 0.90 |
| 4 | 5.40 | 3.00 | 2.40 | 0.75 | 0.60 | 1.35 | 1.10 |
| 5 | 6.50 | 3.00 | 3.50 | 0.60 | 0.70 | 1.30 | 1.30 |
| 6 | 7.80 | 3.00 | 4.80 | 0.50 | 0.80 | 1.30 | 1.50 |
| 7 | 9.30 | 3.00 | 6.30 | 0.43 | 0.90 | 1.33 | 1.70 |
| 8 | 11.00 | 3.00 | 8.00 | 0.38 | 1.00 | 1.38 | 1.90 |
| 9 | 12.90 | 3.00 | 9.90 | 0.33 | 1.10 | 1.43 | 2.10 |
| 10 | 15.00 | 3.00 | 12.00 | 0.30 | 1.20 | 1.50 | |

(Thelma's Lemonade Shop, GKSM Table 13.2.)

# THELMA'S TOTAL-COST CURVE



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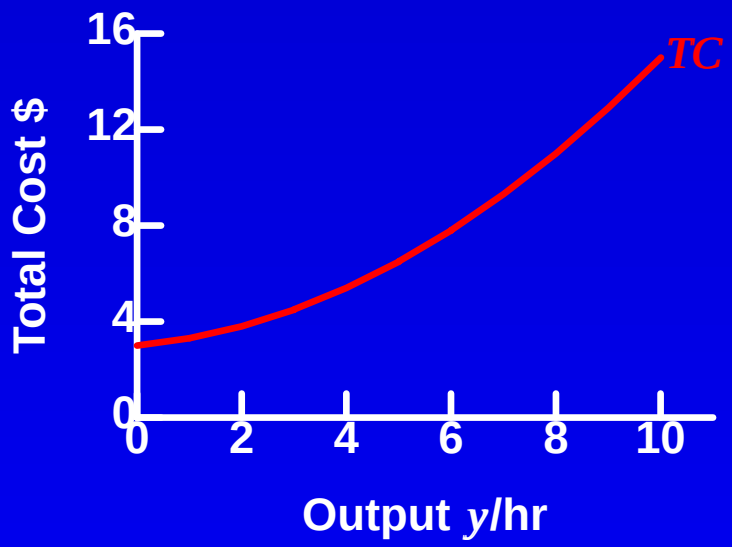
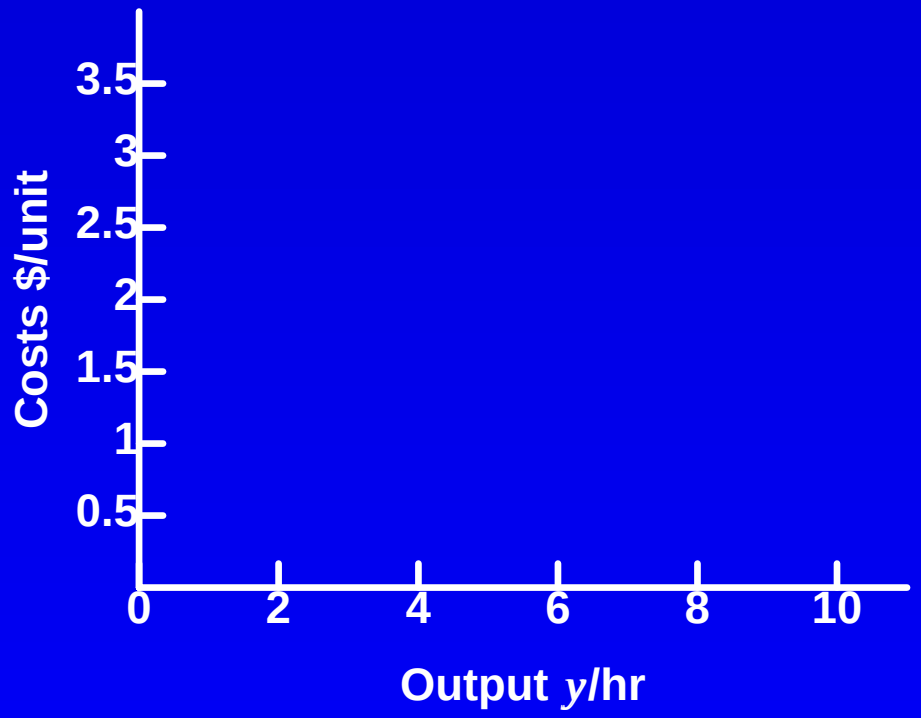



**The *TC* curve gets steeper as the quantity of output/hr increases because of *diminishing Marginal Product.* (Thelma needs to hire disproportionately more workers.)**

# PLOTTING THELMA'S COST CURVES



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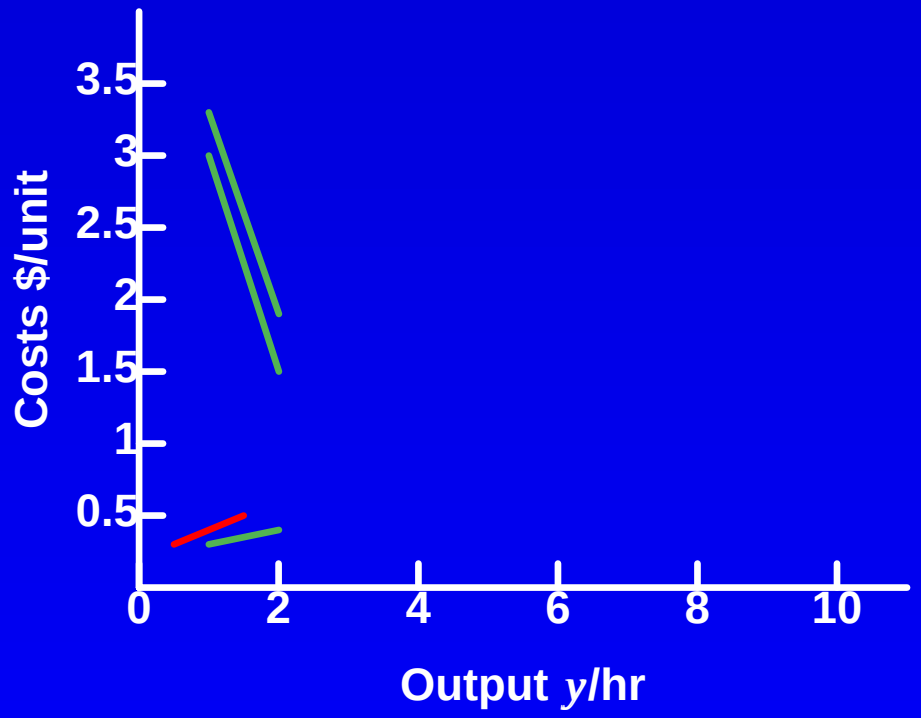

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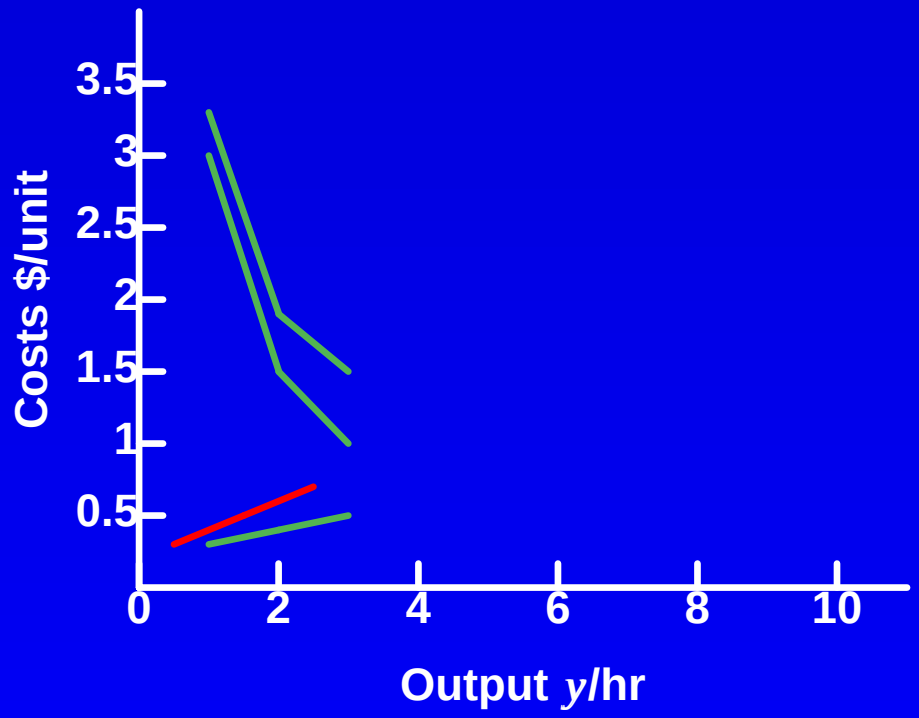

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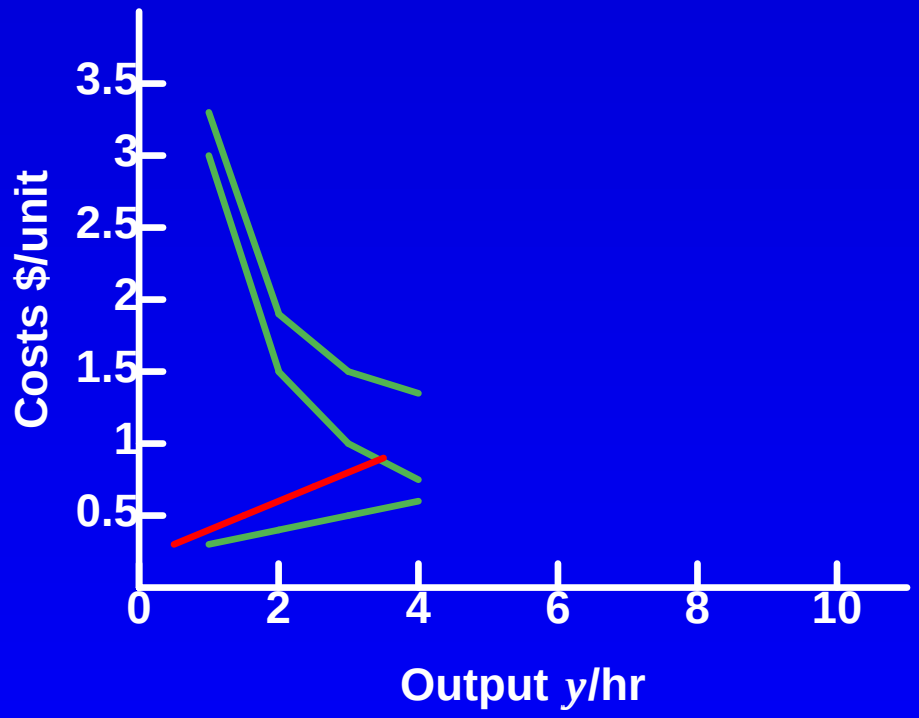

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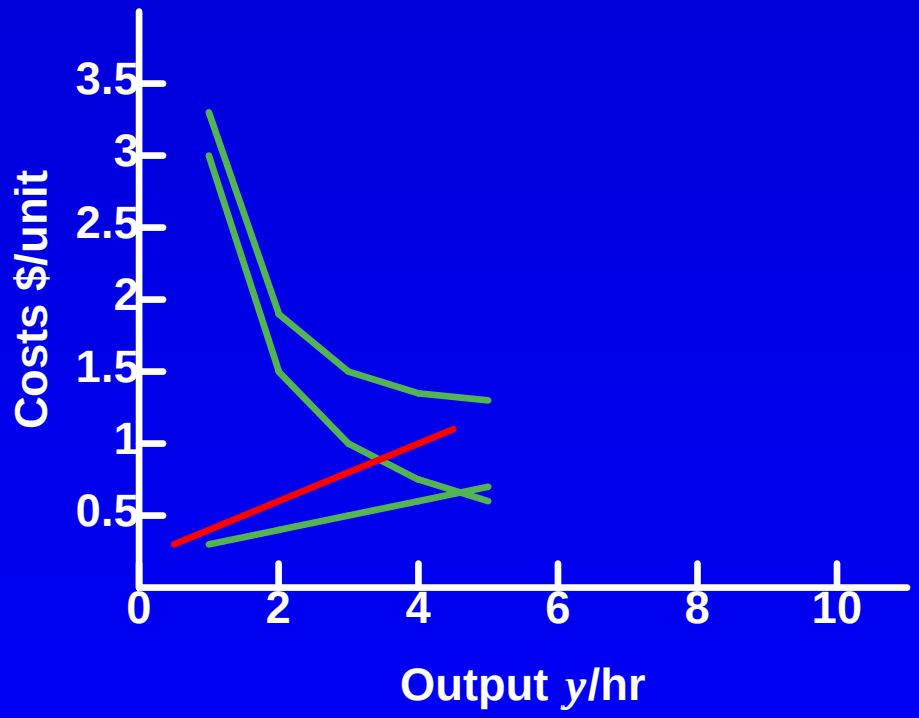

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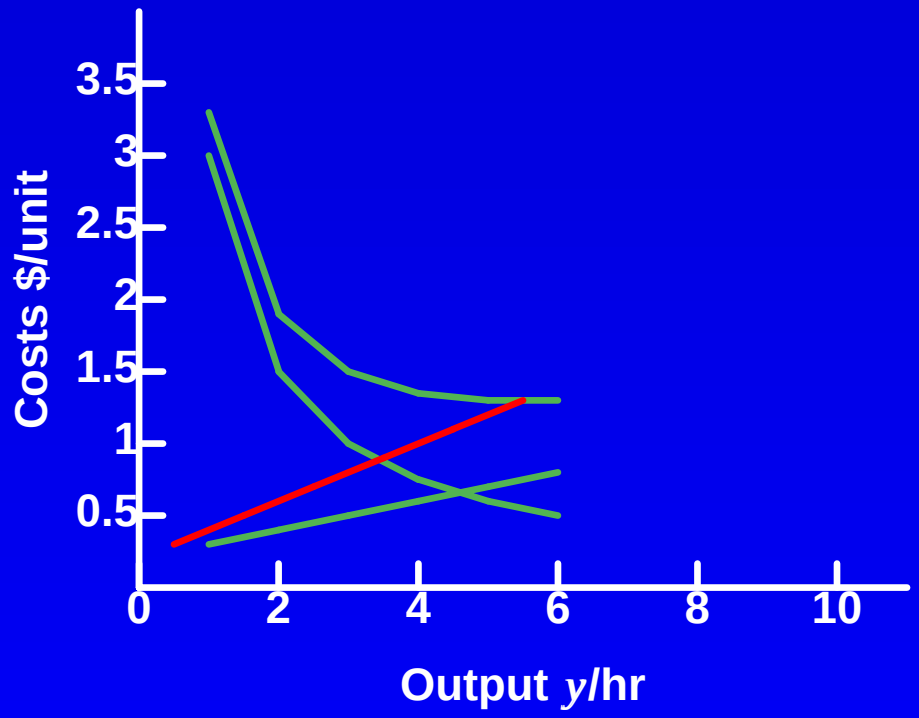

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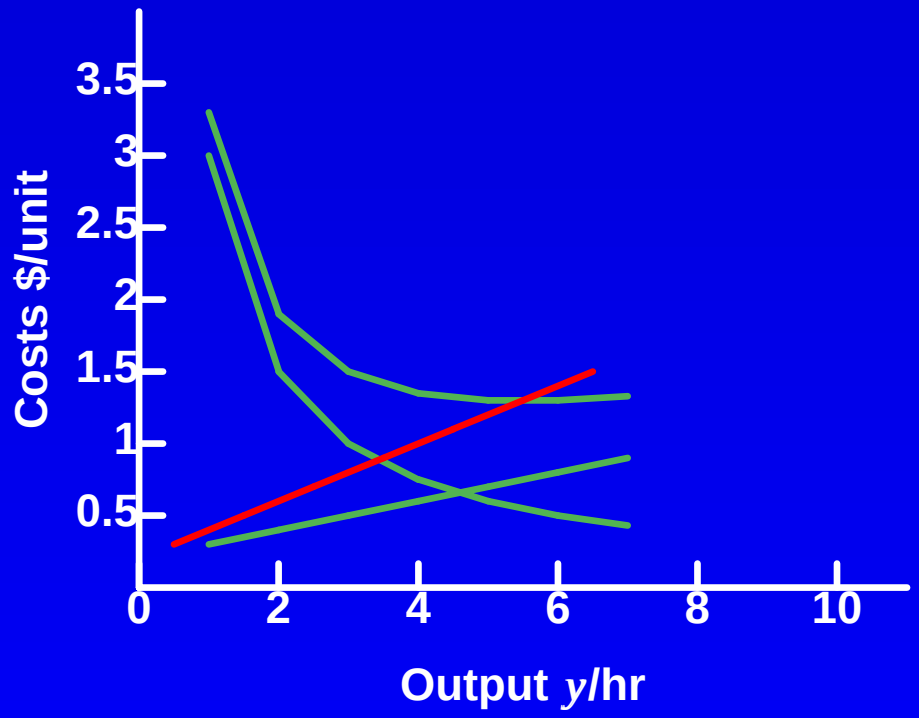

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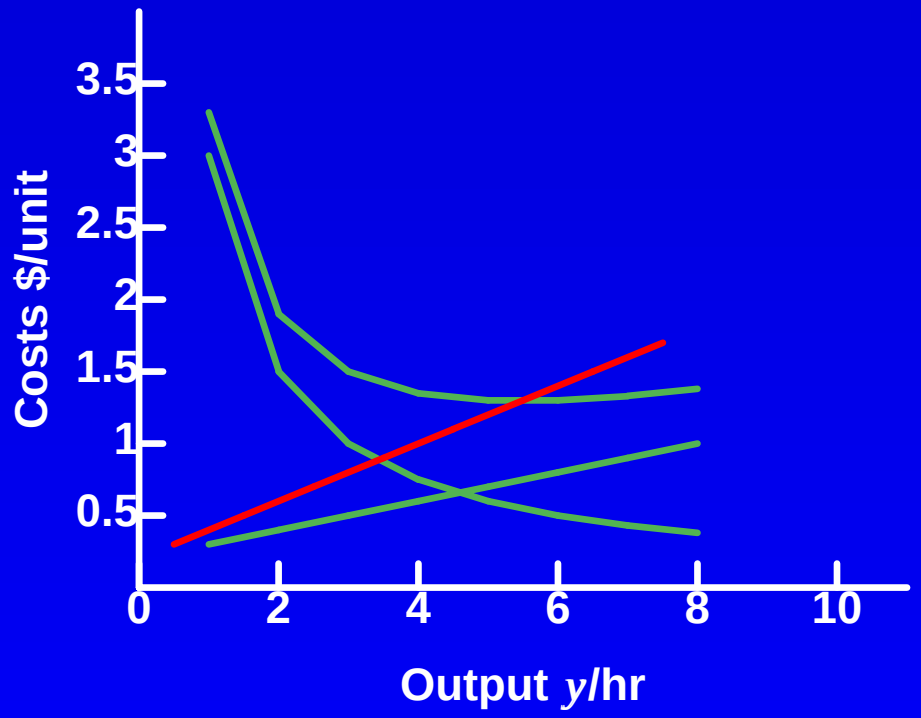

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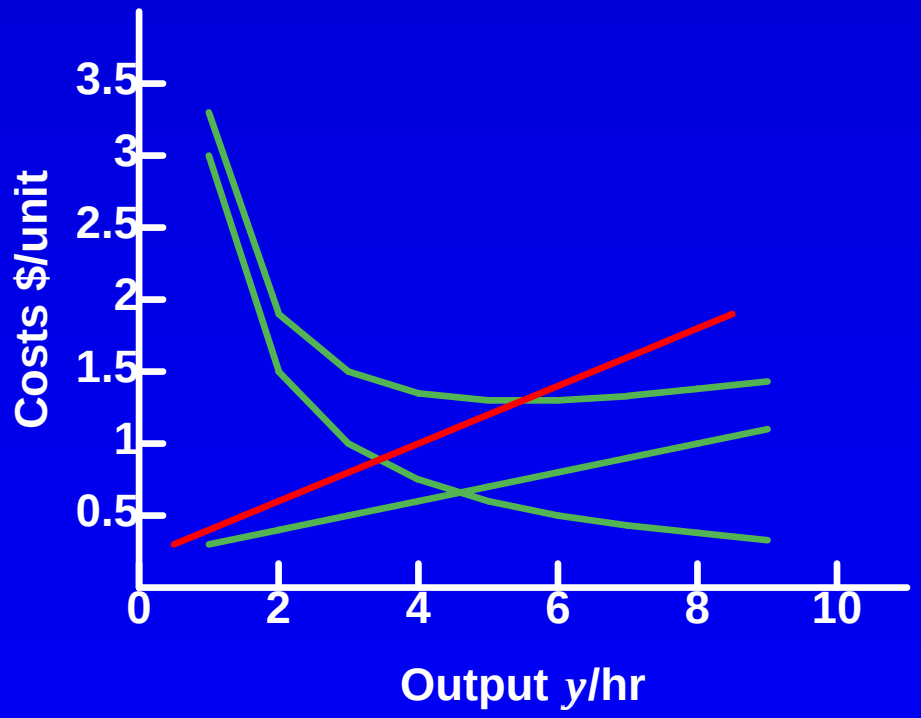

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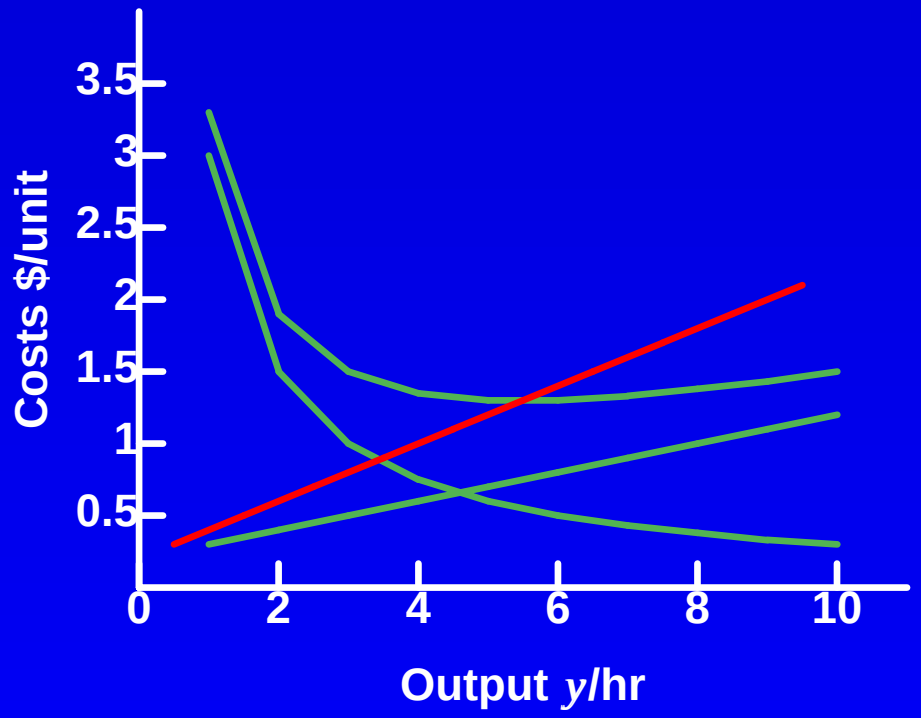

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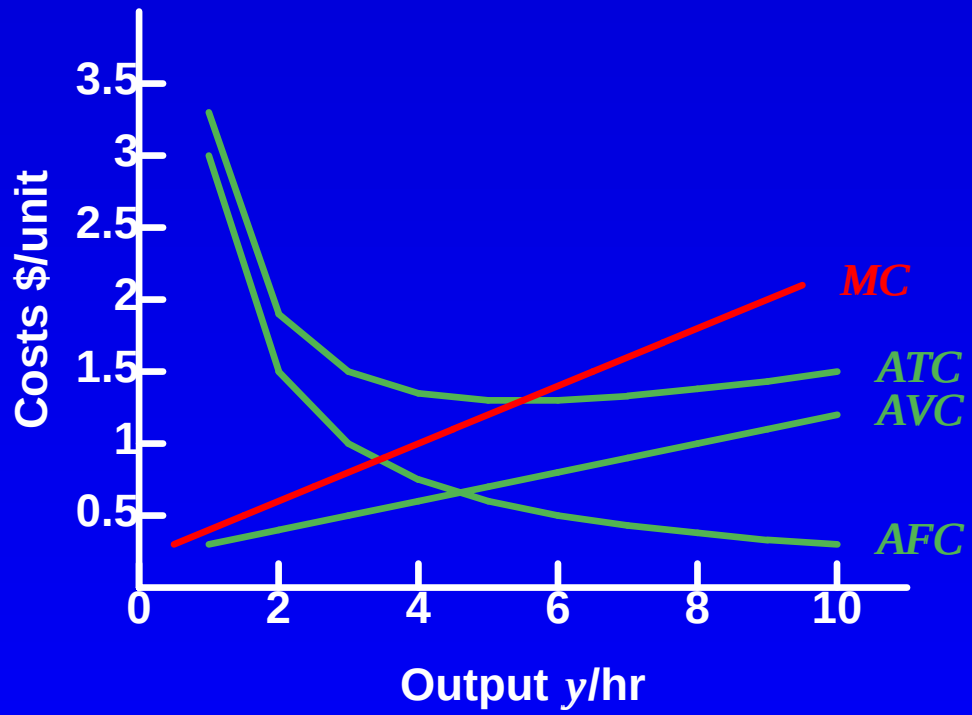


**Very useful when deciding how much to produce to maximise profit (see next two Lectures).**

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**3. *MC* and *AC*: when *MC* < *AC* $\rightarrow$ *AC* falling;**
**when *MC* > *AC* $\rightarrow$ *AC* rising.**

**(Think of *MC* as the speedo's instant speed measure, and *AC* as the distance/time since the trip began.)**

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**(Think of *MC* as the speedo's instant speed measure, and *AC* as the distance/time since the trip began.)**

**At the output level *y* where *MC* = *AC*, *AC* is a minimum: the *Efficient Scale of production.***

# VARIOUS MEASURES OF BOB'S COSTS

| $y$/hr | $TC$ $ | $FC$ $ | $VC$ $ | $AFC = FC/y$ | $AVC = VC/y$ | $ATC = TC/y$ | $MC = \frac{\Delta TC}{\Delta y}$ |
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|---|---|---|---|---|---|---|---|
| 0 | 2.00 | 2.00 | 0.00 | – | – | – | 1.00 |
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|---|---|---|---|---|---|---|---|
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| | | | | | | | 1.00 |
| 1 | 3.00 | 2.00 | 1.00 | 2.00 | 1.00 | 3.00 | |
| | | | | | | | 0.80 |
| 2 | 3.80 | 2.00 | 1.80 | 1.00 | 0.90 | 1.90 | |

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| | | | | | | | 1.00 |
| 1 | 3.00 | 2.00 | 1.00 | 2.00 | 1.00 | 3.00 | |
| | | | | | | | 0.80 |
| 2 | 3.80 | 2.00 | 1.80 | 1.00 | 0.90 | 1.90 | |
| | | | | | | | 0.60 |
| 3 | 4.40 | 2.00 | 2.40 | 0.67 | 0.80 | 1.47 | |

# VARIOUS MEASURES OF BOB'S COSTS

| $y$/hr | $TC$ $ | $FC$ $ | $VC$ $ | $AFC = FC/y$ | $AVC = VC/y$ | $ATC = TC/y$ | $MC = \frac{\Delta TC}{\Delta y}$ |
|---|---|---|---|---|---|---|---|
| 0 | 2.00 | 2.00 | 0.00 | – | – | – | |
| | | | | | | | 1.00 |
| 1 | 3.00 | 2.00 | 1.00 | 2.00 | 1.00 | 3.00 | |
| | | | | | | | 0.80 |
| 2 | 3.80 | 2.00 | 1.80 | 1.00 | 0.90 | 1.90 | |
| | | | | | | | 0.60 |
| 3 | 4.40 | 2.00 | 2.40 | 0.67 | 0.80 | 1.47 | |
| | | | | | | | 0.40 |
| 4 | 4.80 | 2.00 | 2.80 | 0.50 | 0.70 | 1.20 | |

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| 1 | 3.00 | 2.00 | 1.00 | 2.00 | 1.00 | 3.00 | |
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| 2 | 3.80 | 2.00 | 1.80 | 1.00 | 0.90 | 1.90 | |
| | | | | | | | 0.60 |
| 3 | 4.40 | 2.00 | 2.40 | 0.67 | 0.80 | 1.47 | |
| | | | | | | | 0.40 |
| 4 | 4.80 | 2.00 | 2.80 | 0.50 | 0.70 | 1.20 | |
| | | | | | | | 0.40 |
| 5 | 5.20 | 2.00 | 3.20 | 0.40 | 0.64 | 1.04 | |

# VARIOUS MEASURES OF BOB'S COSTS

| $y$/hr | $TC$ $ | $FC$ $ | $VC$ $ | $AFC = FC/y$ | $AVC = VC/y$ | $ATC = TC/y$ | $MC = \frac{\Delta TC}{\Delta y}$ |
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| 0 | 2.00 | 2.00 | 0.00 | – | – | – | |
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| 1 | 3.00 | 2.00 | 1.00 | 2.00 | 1.00 | 3.00 | |
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| | | | | | | | 0.60 |
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| | | | | | | | 0.40 |
| 4 | 4.80 | 2.00 | 2.80 | 0.50 | 0.70 | 1.20 | |
| | | | | | | | 0.40 |
| 5 | 5.20 | 2.00 | 3.20 | 0.40 | 0.64 | 1.04 | |
| | | | | | | | 0.60 |
| 6 | 5.80 | 2.00 | 3.80 | 0.33 | 0.63 | 0.96 | |

# VARIOUS MEASURES OF BOB'S COSTS

| $y$/hr | $TC$ $ | $FC$ $ | $VC$ $ | $AFC = FC/y$ | $AVC = VC/y$ | $ATC = TC/y$ | $MC = \frac{\Delta TC}{\Delta y}$ |
|---|---|---|---|---|---|---|---|
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| | | | | | | | 0.80 |
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| | | | | | | | 0.60 |
| 6 | 5.80 | 2.00 | 3.80 | 0.33 | 0.63 | 0.96 | |
| | | | | | | | 0.80 |
| 7 | 6.60 | 2.00 | 4.60 | 0.29 | 0.66 | 0.95 | |
| | | | | | | | 1.00 |
| 8 | 7.60 | 2.00 | 5.60 | 0.25 | 0.70 | 0.95 | |
| | | | | | | | 1.20 |
| 9 | 8.80 | 2.00 | 6.80 | 0.22 | 0.76 | 0.98 | |
| | | | | | | | 1.40 |
| 10 | 10.20 | 2.00 | 8.20 | 0.20 | 0.82 | 1.02 | |
| | | | | | | | 1.60 |
| 11 | 11.80 | 2.00 | 9.80 | 0.18 | 0.89 | 1.07 | |
| | | | | | | | 1.80 |
| 12 | 13.60 | 2.00 | 11.60 | 0.17 | 0.97 | 1.14 | |
| | | | | | | | 2.00 |
| 13 | 15.60 | 2.00 | 13.60 | 0.15 | 1.05 | 1.20 | |
| | | | | | | | 2.20 |
| 14 | 17.80 | 2.00 | 15.80 | 0.14 | 1.13 | 1.27 | |

(Bob's Bagel Bin GKSM Table 13.3)

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(Bob's Bagel Bin GKSM Table 13.3)

**"Many hands make light work": $y$ from 0 to 3**

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| $y$/hr | $TC$ $ | $FC$ $ | $VC$ $ | $AFC = FC/y$ | $AVC = VC/y$ | $ATC = TC/y$ | $MC = \frac{\Delta TC}{\Delta y}$ |
|---|---|---|---|---|---|---|---|
| 0 | 2.00 | 2.00 | 0.00 | – | – | – | |
| | | | | | | | 1.00 |
| 1 | 3.00 | 2.00 | 1.00 | 2.00 | 1.00 | 3.00 | |
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| | | | | | | | 0.40 |
| 4 | 4.80 | 2.00 | 2.80 | 0.50 | 0.70 | 1.20 | |
| | | | | | | | 0.40 |
| 5 | 5.20 | 2.00 | 3.20 | 0.40 | 0.64 | 1.04 | |
| | | | | | | | 0.60 |
| 6 | 5.80 | 2.00 | 3.80 | 0.33 | 0.63 | 0.96 | |
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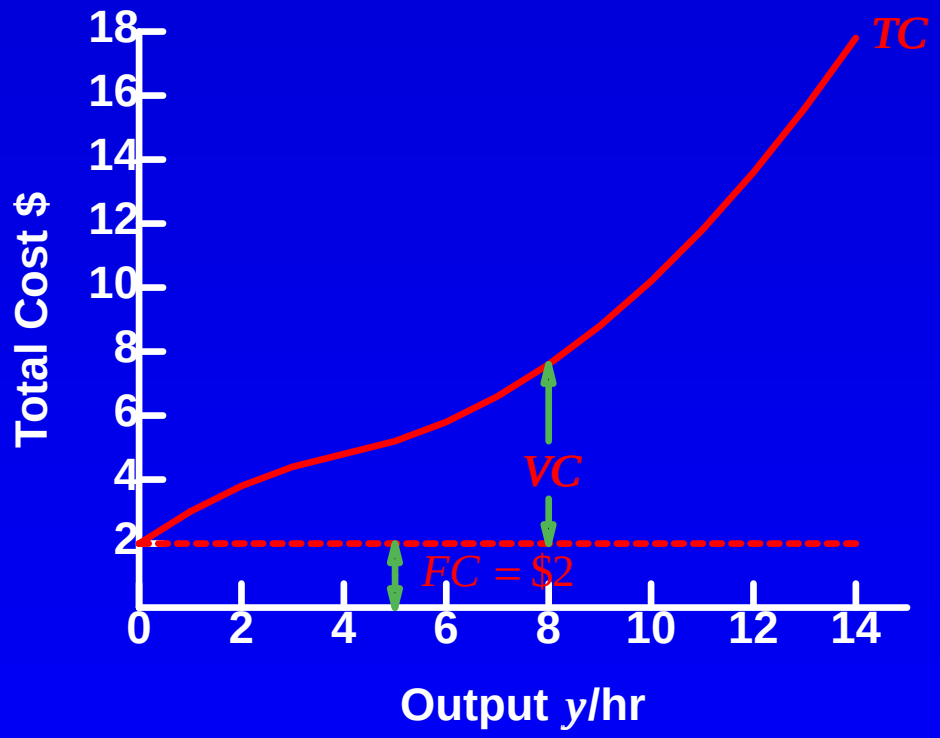
**(Bob's Bagel Bin GKSM Table 13.3)**

**"Many hands make light work": $y$ from 0 to 3**
**"Too many cooks spoil the broth": $y$ greater than 4**

# BOB'S TOTAL-COST CURVE



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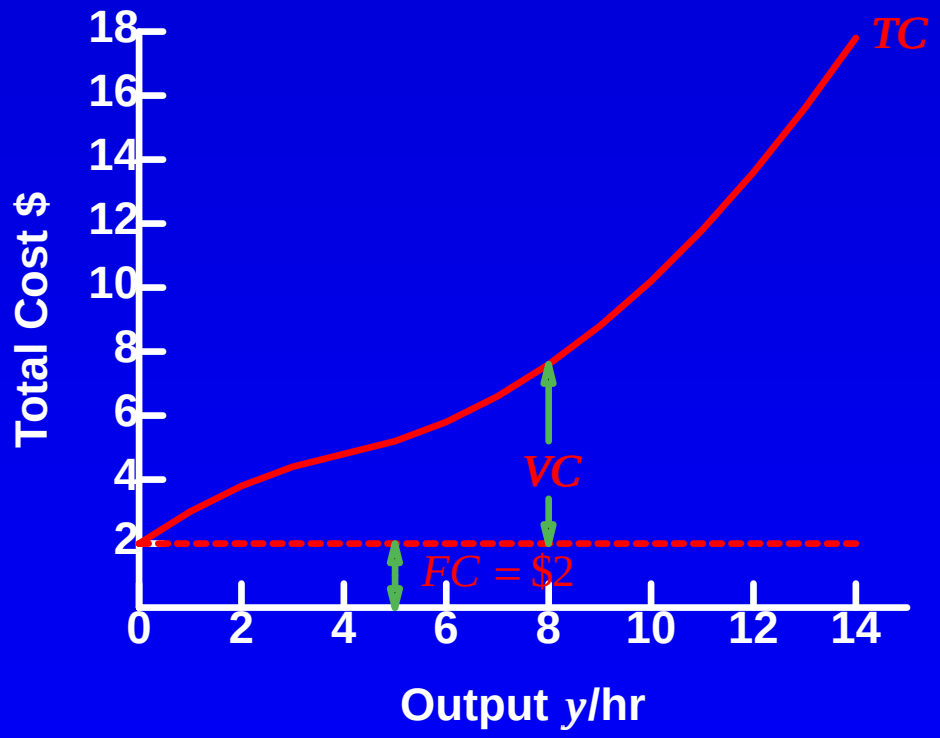
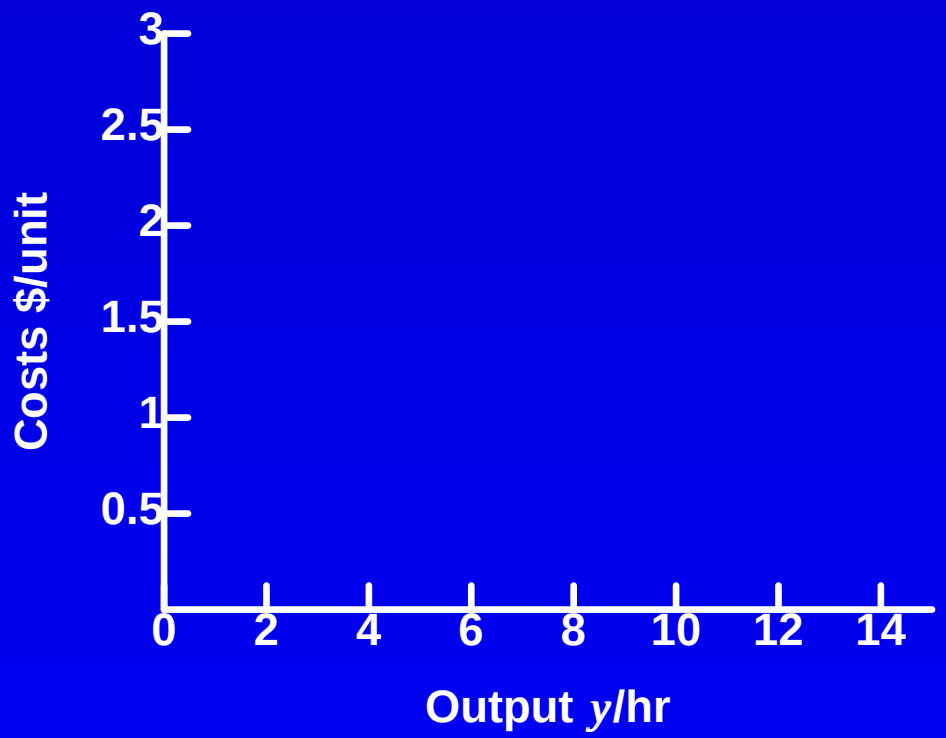



**What is Bob's marginal fixed cost?**

# GRAPHICALLY



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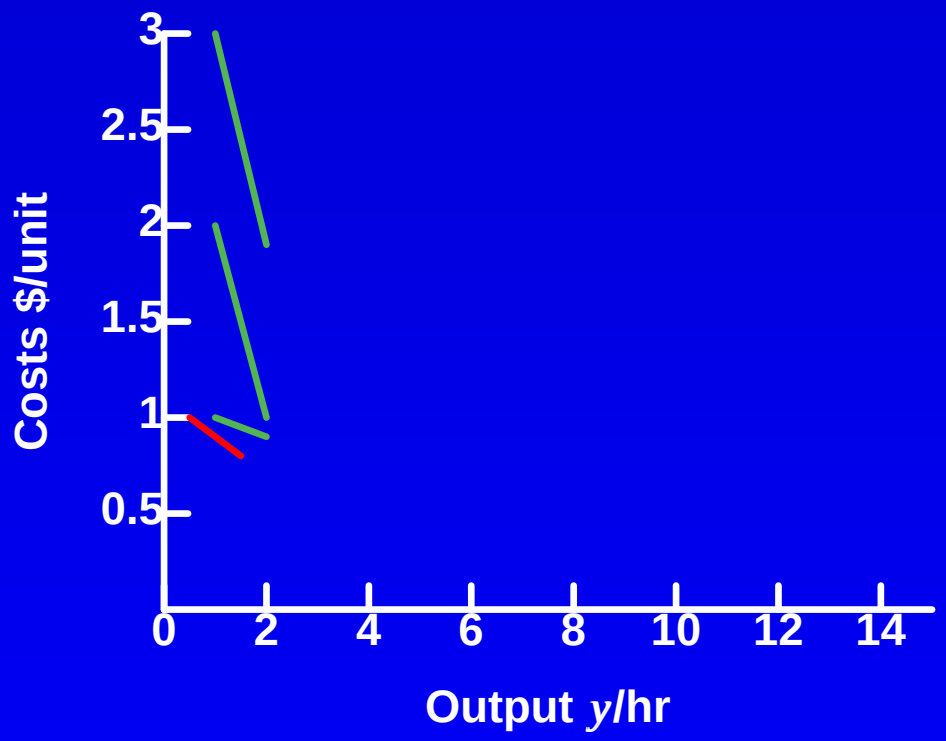

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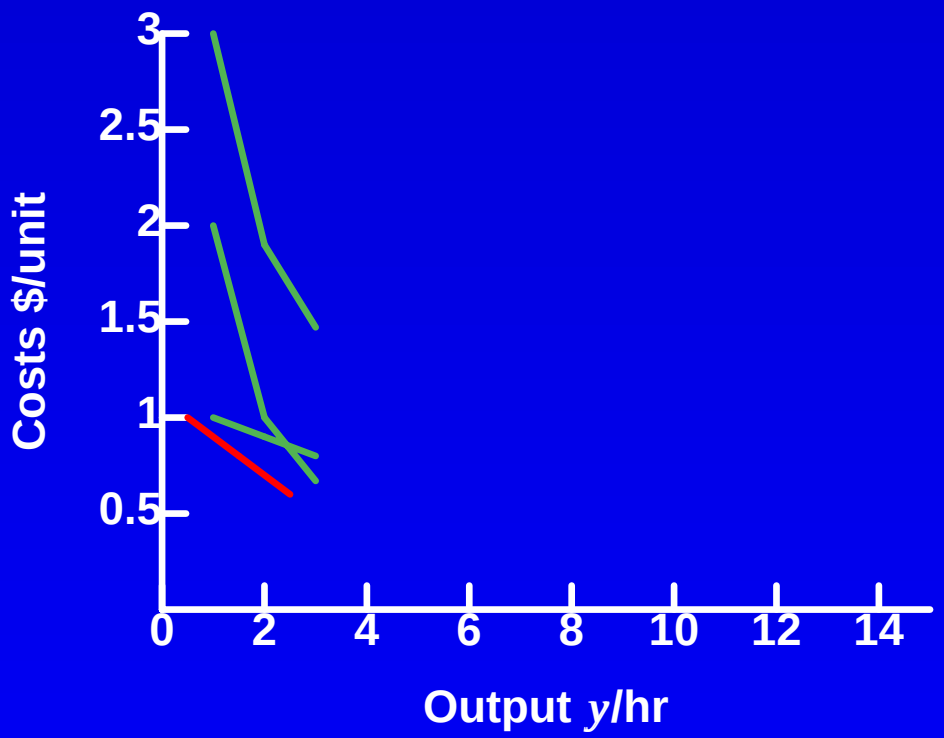

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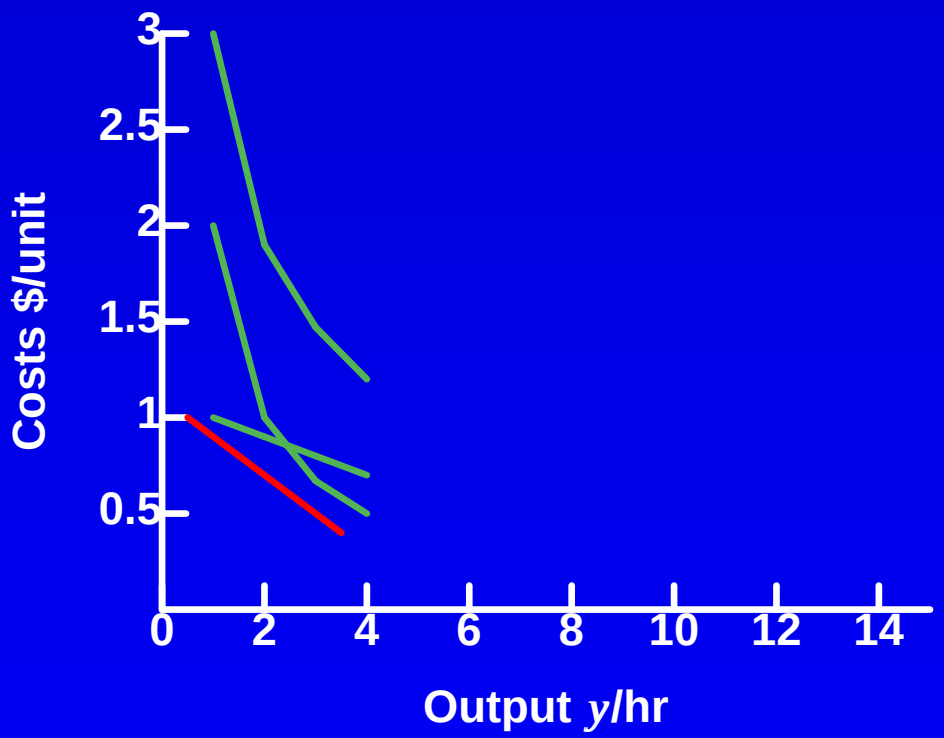

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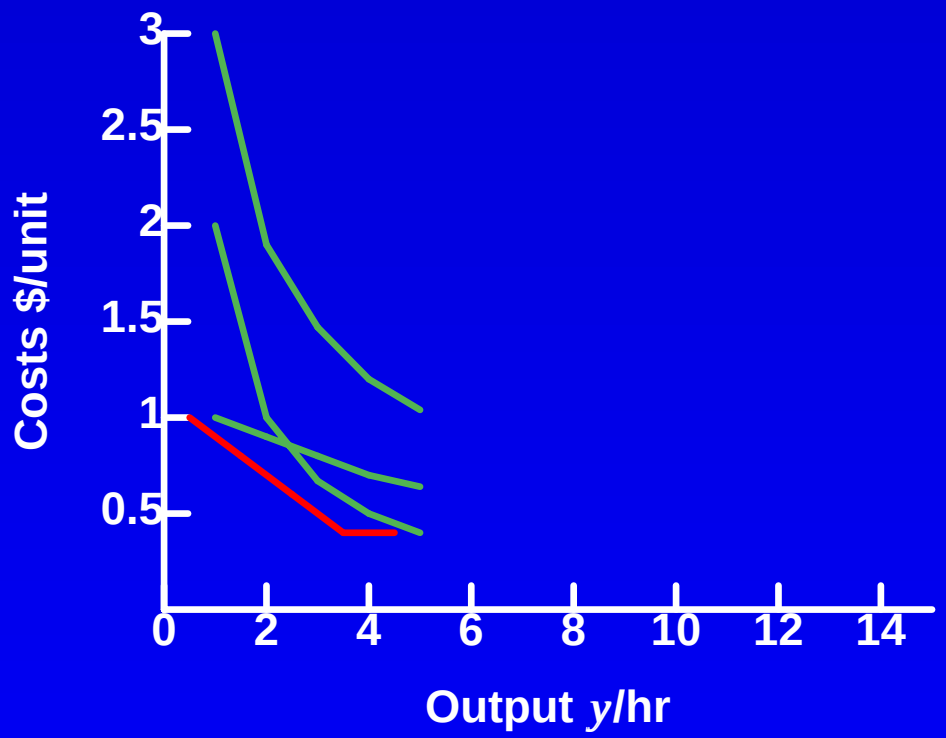

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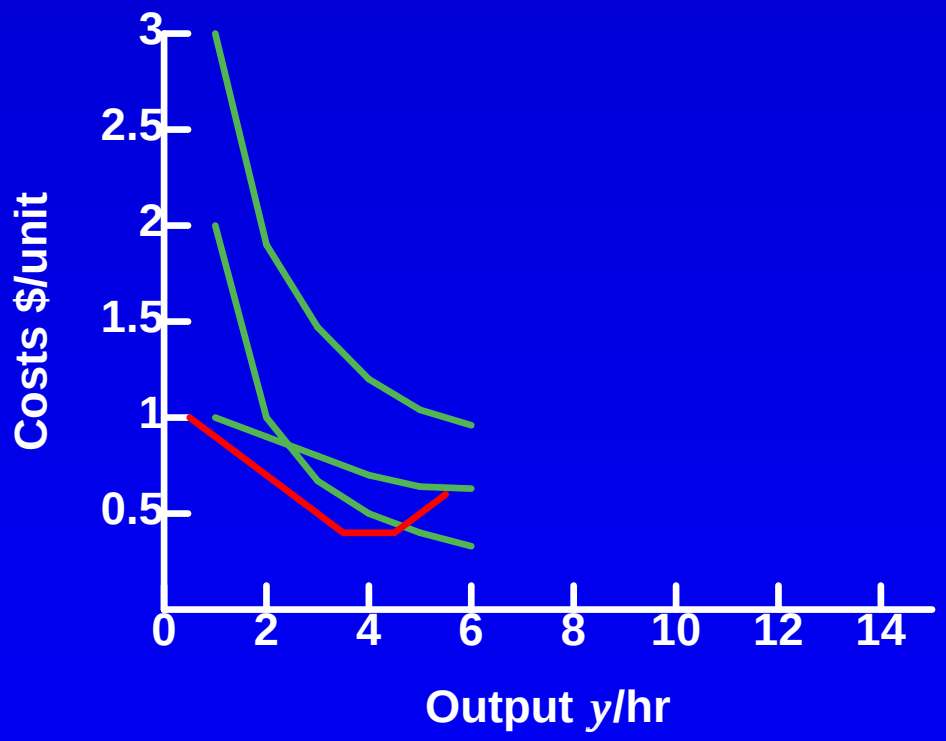

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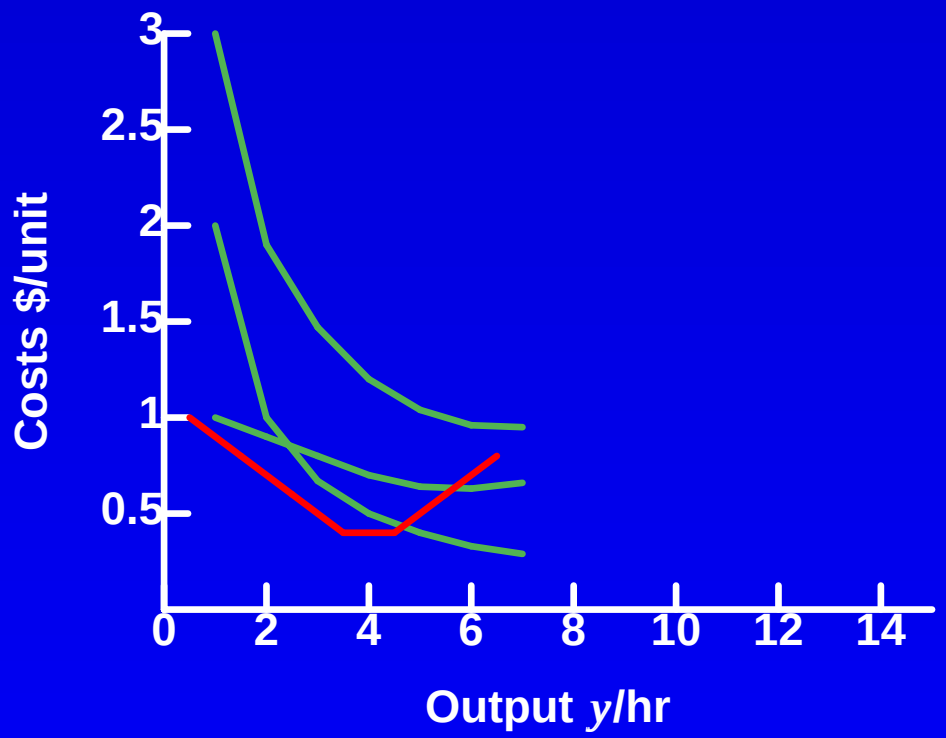

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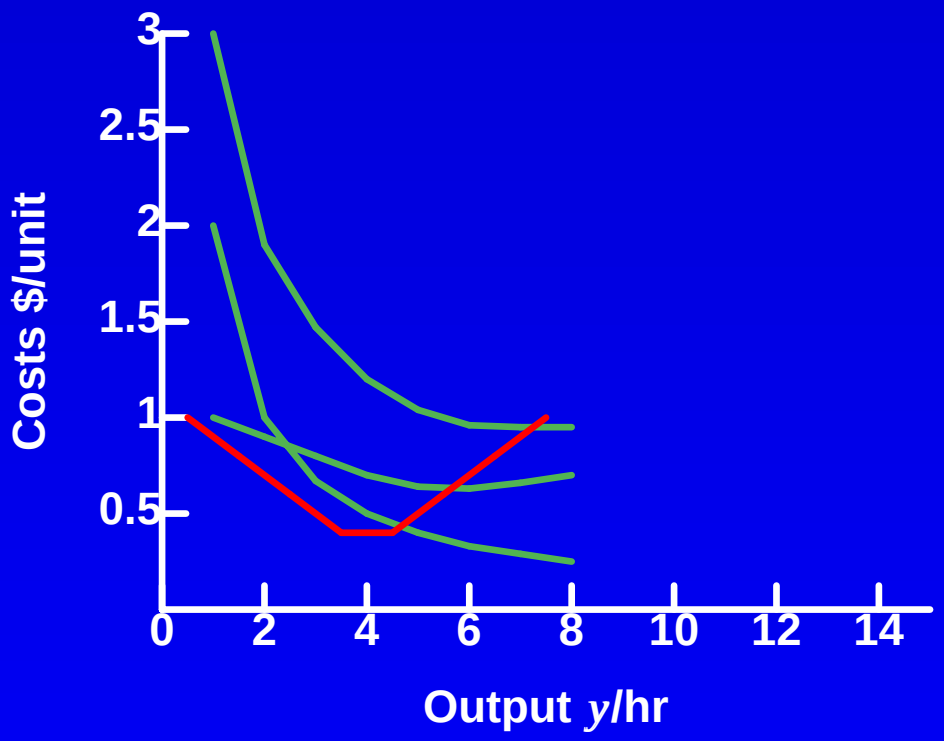

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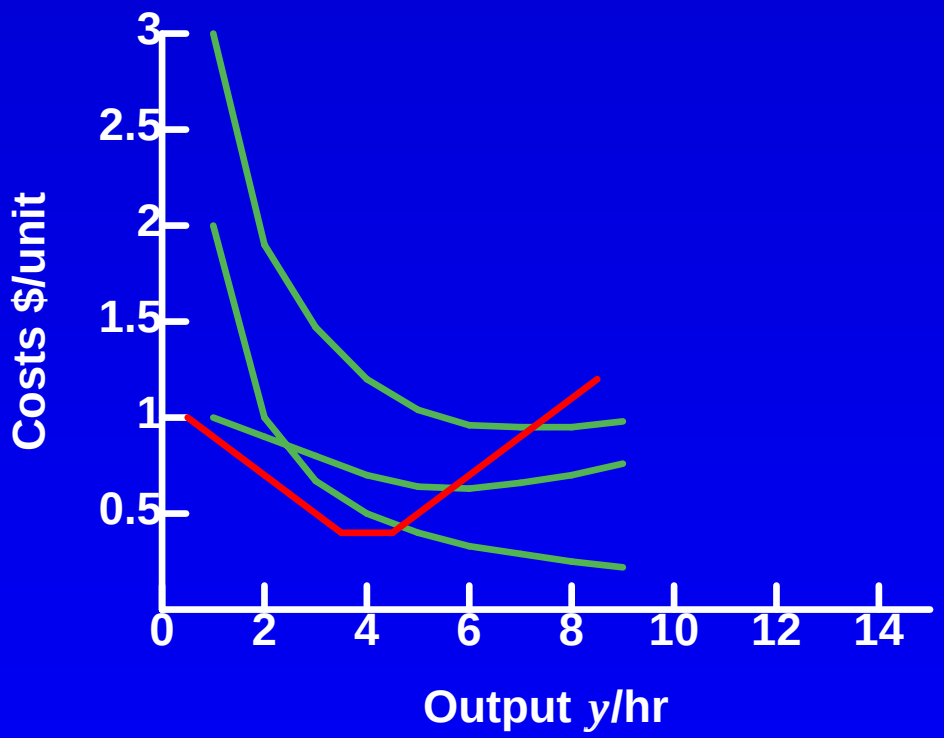

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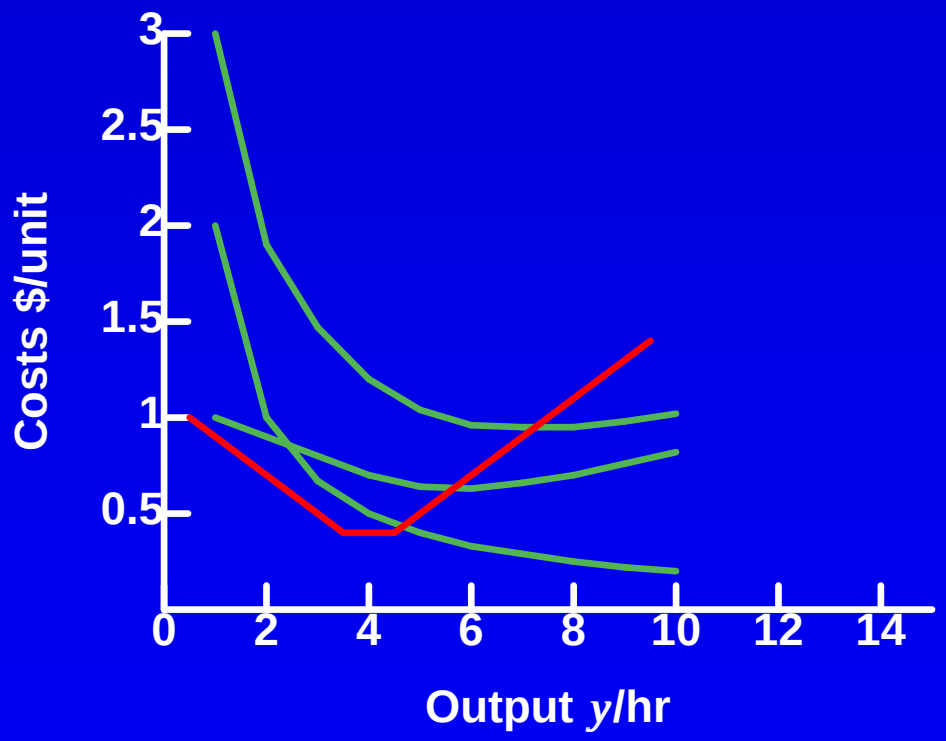

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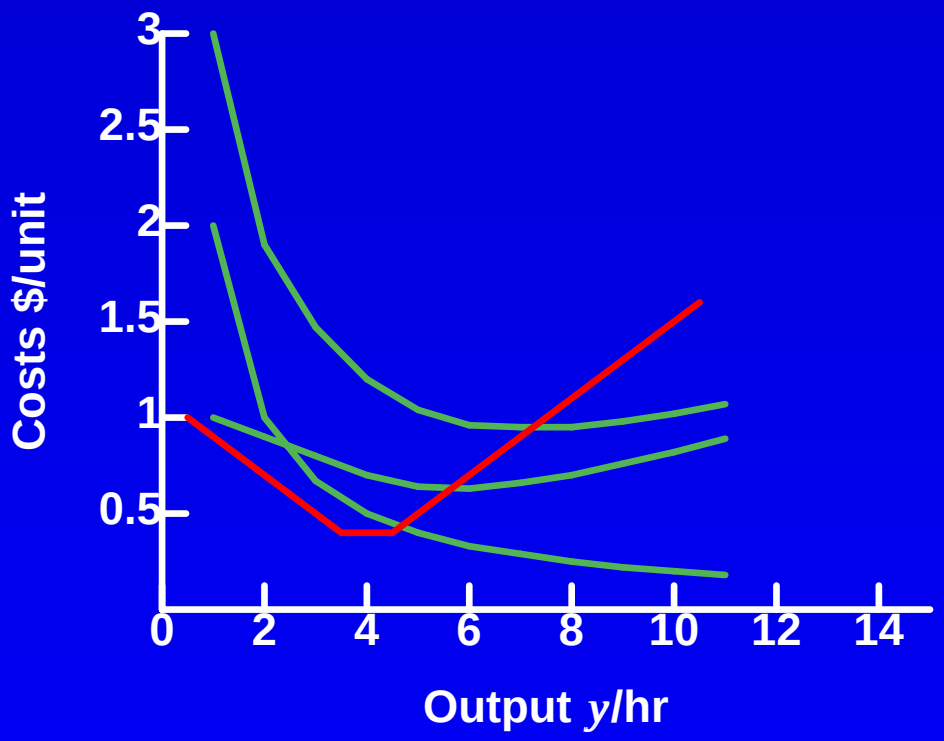

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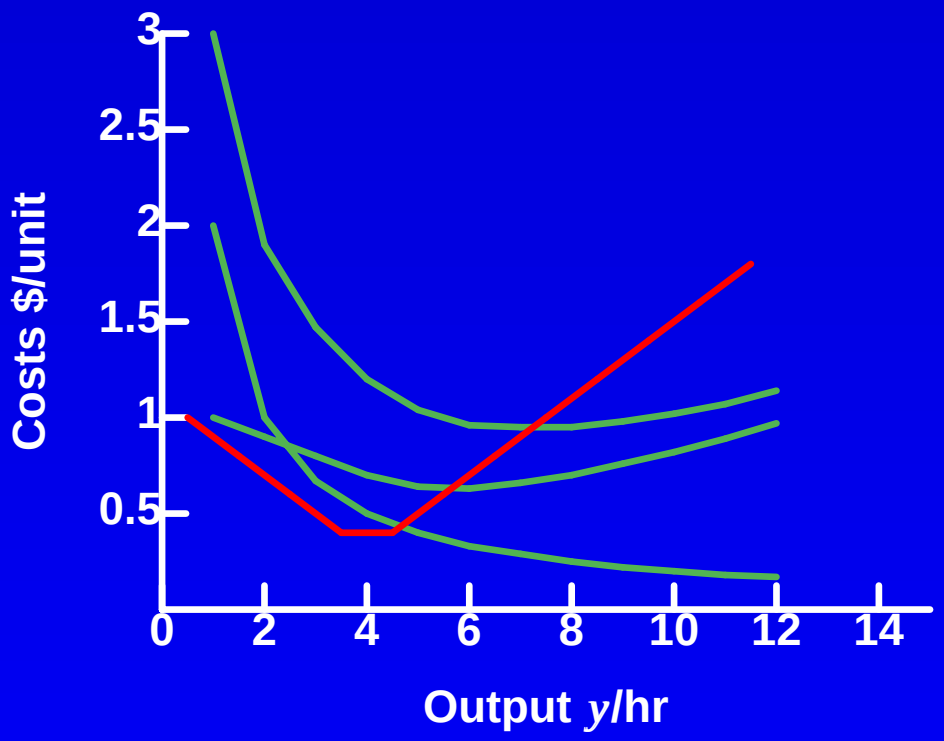

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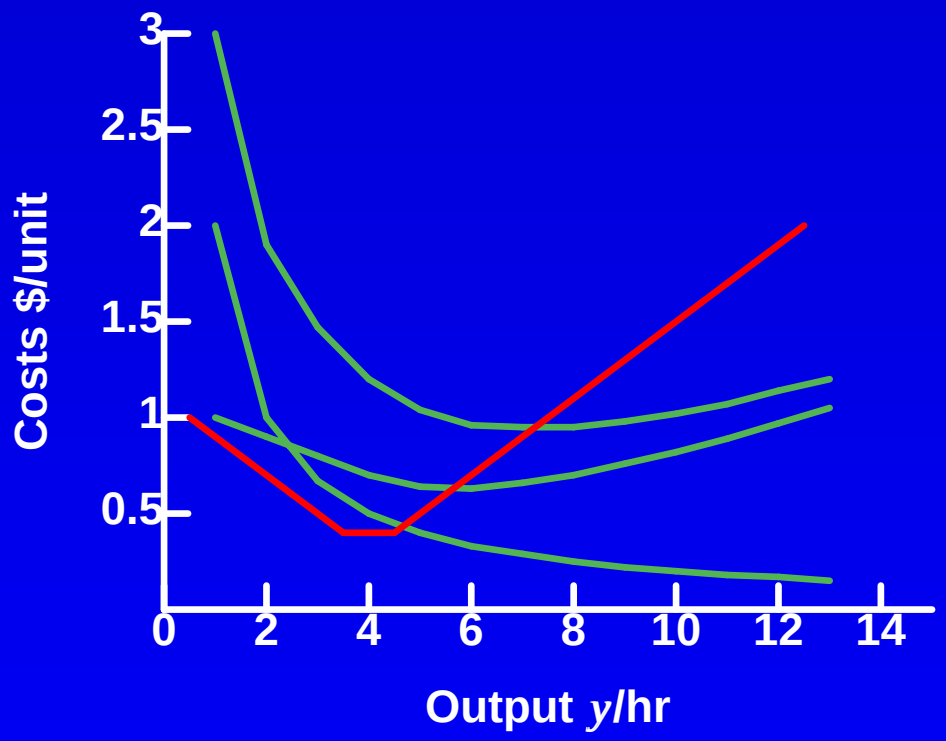

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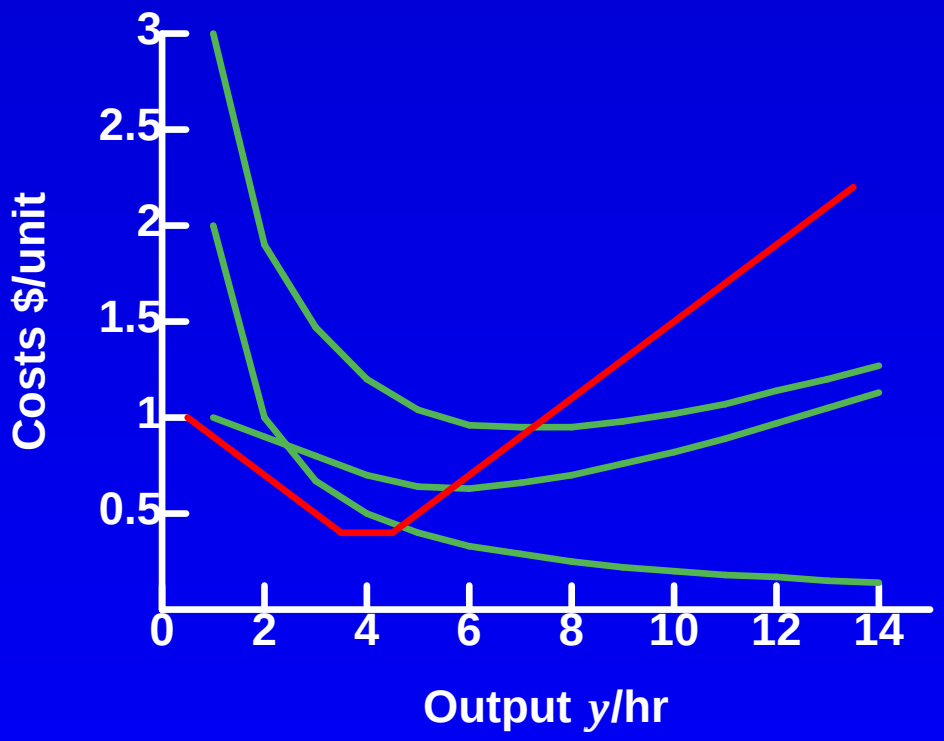

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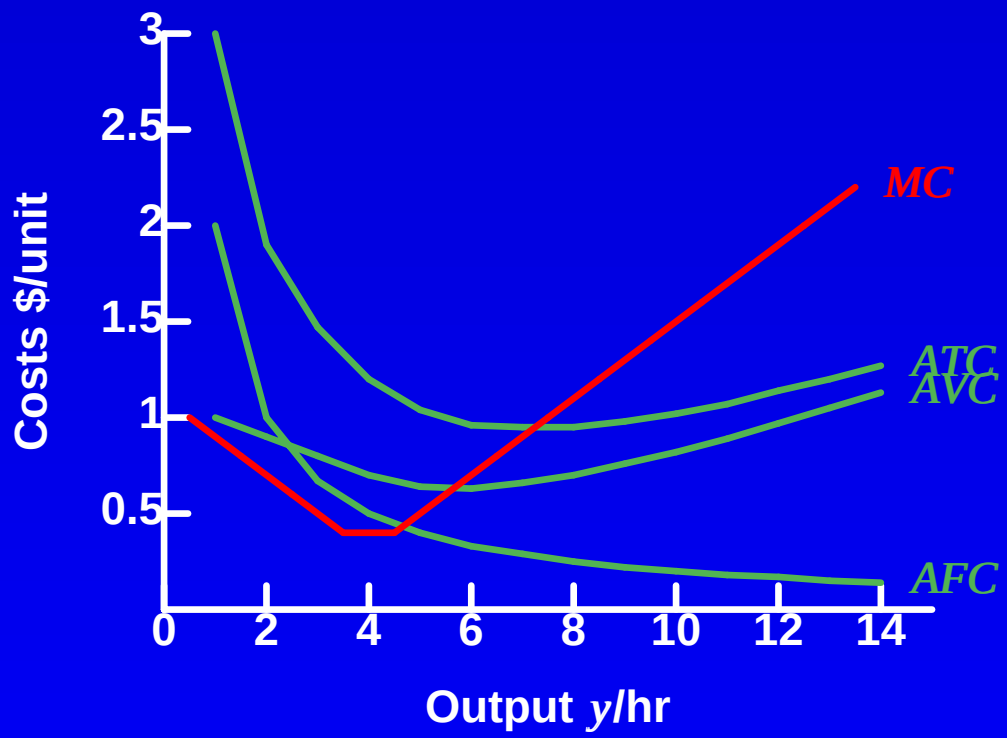

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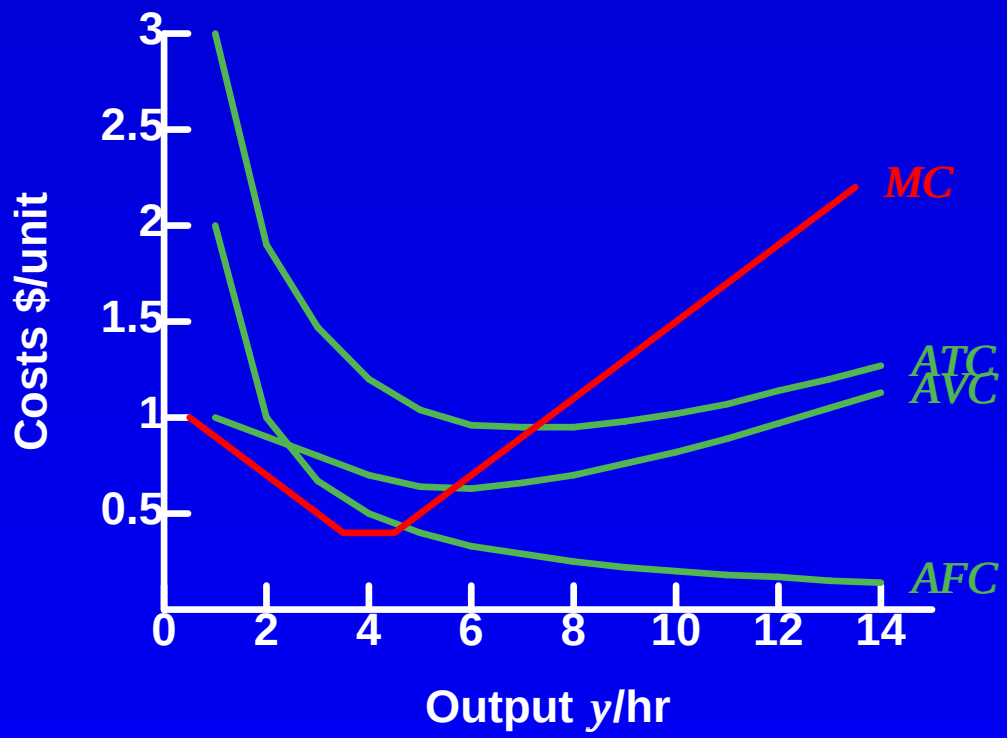
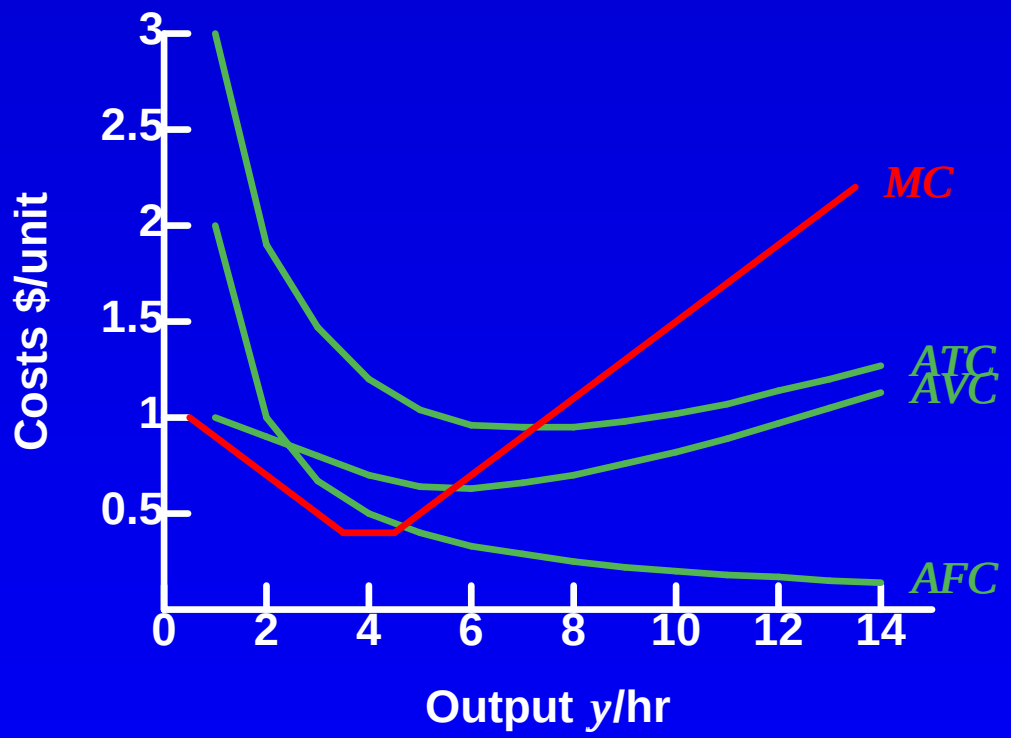



**Bob's *MC* eventually rises.**

# GRAPHICALLY




**Bob's *MC* eventually rises.**
**Bob's *ATC* is U-shaped.**

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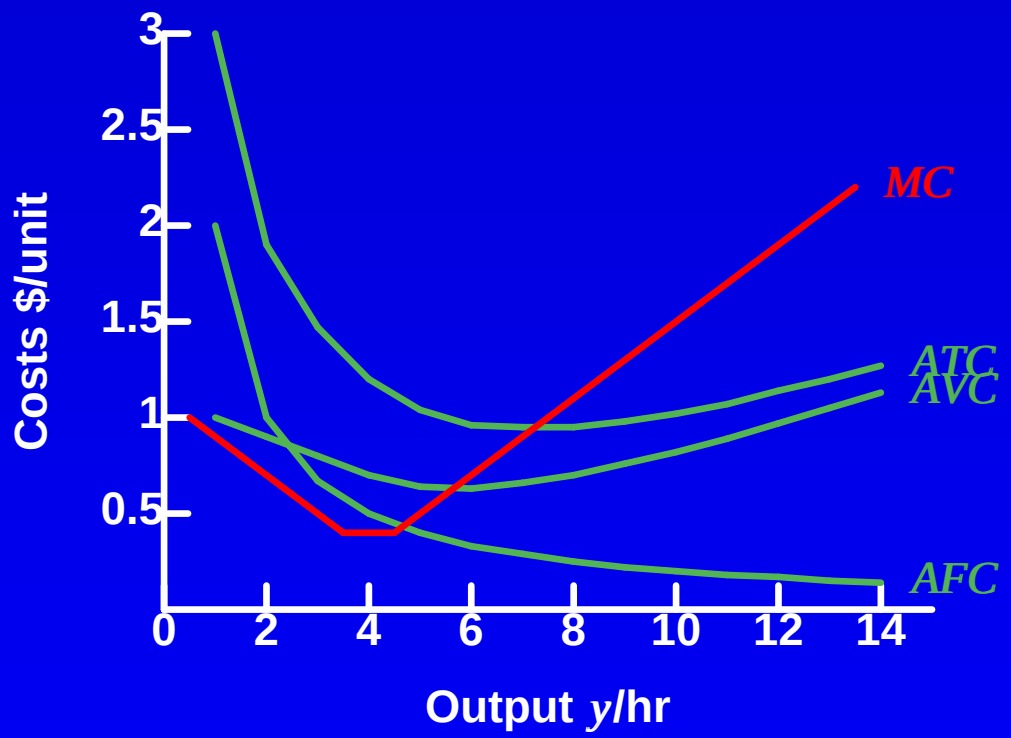


**Bob's *MC* eventually rises.**
**Bob's *ATC* is U-shaped.**
**Bob's *MC* = *ATC* at *y* with minimum *ATC***

# SHORT- AND LONG-RUN AVERAGE TOTAL COST

**The long-run *ATC* curve reflects the ability of the firm to invest in new fixed assets (such as factories) given a longer horizon.**

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**When is the long run?**

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**$\therefore$ In the long run, costs previously fixed become variable.**

**$\therefore$ The long-run *AC* curve is a much flatter U-shaped curve than the short-run *AC* curve, because of greater flexibility.**

**When is the long run? Depends on the firm: its willingness and ability to adjust its production facilities.**

# RETURNS TO SCALE

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***Specialisation* at first v. *coordination problems* later as scale of production grows large? Finite inputs?**

**The firm faces the long-run *ATC* curve before committing to the size of facility.**

# SUNK COSTS

***Sunk Costs*: costs already incurred *and* which cannot be recovered.**

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**Q: You see an advert for shirts on special 20 km away, at prices much lower than locally.**

**Since you "need" new shirts, and the prices advertised are much lower, you drive over.**

**But when you get there, none of the shirts on special is your size. The shop stocks your sized shirts, but at prices only slightly lower than your local.**

# SUNK COST EXAMPLE

***What should you do?***

a. **Should you refuse to buy any shirts because they are not cheap enough to justify the expense of the twenty-km drive?**

# SUNK COST EXAMPLE

***What should you do?***

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c. **Should you buy large numbers of shirts so that the total savings offset the cost of driving over?**

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a. **Should you refuse to buy any shirts because they are not cheap enough to justify the expense of the twenty-km drive?**

b. **Should you buy some shirts anyway?**

c. **Should you buy large numbers of shirts so that the total savings offset the cost of driving over?**

d. **What if your sized shirts are more expensive there than at your local shop? Should you buy them anyway, since you might as well get something for your trip?**

# SUNK COST EXAMPLE

***Answers:***

**a. No. Ignores sunk costs already incurred and unrecoverable.**

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***Answers:***

**a. No. Ignores sunk costs already incurred and unrecoverable.**

**b. Yes. You should buy some shirts anyway—you've already incurred the cost of driving over (and back): it's sunk.**

# SUNK COST EXAMPLE

***Answers:***

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c. **Depends if you like them and if you think they won't go out of style or size.**

# SUNK COST EXAMPLE

*Answers:*

a. No. Ignores sunk costs already incurred and unrecoverable.

b. Yes. You should buy some shirts anyway—you've already incurred the cost of driving over (and back): it's sunk.

c. Depends if you like them and if you think they won't go out of style or size.

d. No. You'd be throwing good money after bad.

# SUNK COST EXAMPLE

*Answers:*

a. No. Ignores sunk costs already incurred and unrecoverable.

b. Yes. You should buy some shirts anyway—you've already incurred the cost of driving over (and back): it's sunk.

c. Depends if you like them and if you think they won't go out of style or size.

d. No. You'd be throwing good money after bad.

Irrelevance of Sunk Costs: bygones are bygones. "No use crying over spilt milk."

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**Sunk costs important for analysing:**

- **rivalry among firms,**
- **firms' entry and exit decisions from markets, and**
- **firms' decisions to adopt new technology.**

# SUMMARY

1. Economists' profit does not include the opportunity cost of capital: part of Total Costs.
2. Marginal Product of any input often falls with output.
3. Fixed v. Variable costs; Average v. Marginal costs — *MC* eventually rises; Sunk Costs are bygones.
4. Efficient scale of production at minimum *AC* = *MC*.
5. Returns to Scale: CRTS, DRTS, IRTS.