8TH EDITION

INTERMEDIATE

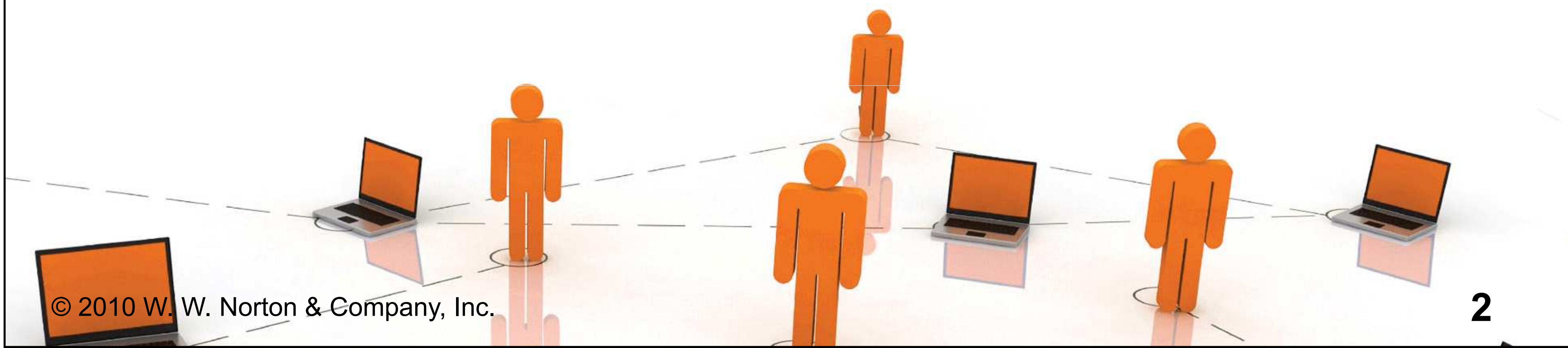
MICROECONOMICS

HAL R. VARIAN

19 Profit-Maximization

Economic Profit

- A firm uses inputs j = 1…,m to make products i = 1,…n.
- Output levels are $y_1,\dots,y_n$.
- Input levels are $x_1,\dots,x_m$.
- Product prices are $p_1,\dots,p_n$.
- Input prices are $w_1,\dots,w_m$.



The Competitive Firm

- The competitive firm takes all output prices $p_1,\ldots,p_n$ and all input prices $w_1,\ldots,w_m$ as given constants.

Economic Profit

- **The economic profit generated by the production plan $(x_1,\ldots,x_m,y_1,\ldots,y_n)$ is**

$$\Pi = p_1y_1 + \cdots + p_ny_n - w_1x_1 - \cdots - w_mx_m .$$

Economic Profit

- Output and input levels are typically flows.
- E.g. x_1 might be the number of labor units used per hour.
- And y_3 might be the number of cars produced per hour.
- Consequently, profit is typically a flow also; e.g. the number of dollars of profit earned per hour.

Economic Profit

- **How do we value a firm?**
- **Suppose the firm's stream of periodic economic profits is** Π_0, Π_1, Π_2, **… and r is the rate of interest.**
- **Then the present-value of the firm's economic profit stream is**

$$PV = \Pi_0 + \frac{\Pi_1}{1+r} + \frac{\Pi_2}{(1+r)^2} + \cdots$$

Economic Profit

- **A competitive firm seeks to maximize its present-value.**
- **How?**

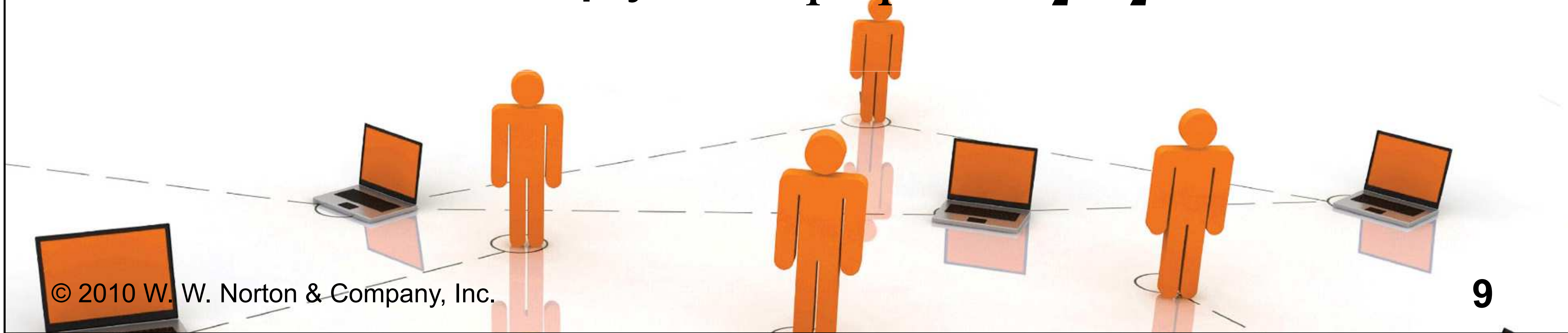
Economic Profit

- **Suppose the firm is in a short-run circumstance in which** $x_2 \equiv \tilde{x}_2$.
- **Its short-run production function is**

$$y = f(x_1, \tilde{x}_2).$$

Economic Profit

- Suppose the firm is in a short-run circumstance in which $x_2 \equiv \tilde{x}_2$.
- Its short-run production function is
$$y = f(x_1, \tilde{x}_2).$$
- The firm's fixed cost is $FC = w_2\tilde{x}_2$ and its profit function is
$$\Pi = py - w_1x_1 - w_2\tilde{x}_2.$$



Short-Run Iso-Profit Lines

- A $\$\Pi$ iso-profit line contains all the production plans that provide a profit level $\$\Pi$.
- A $\$\Pi$ iso-profit line's equation is

$$\Pi \equiv py - w_1x_1 - w_2\tilde{x}_2 .$$

Short-Run Iso-Profit Lines

- **A $\$\Pi$ iso-profit line contains all the production plans that yield a profit level of $\$\Pi$.**
- **The equation of a $\$\Pi$ iso-profit line is**

$$\Pi \equiv py - w_1 x_1 - w_2 \tilde{x}_2.$$

- **I.e.**

$$y = \frac{w_1}{p} x_1 + \frac{\Pi + w_2 \tilde{x}_2}{p}.$$

Short-Run Iso-Profit Lines

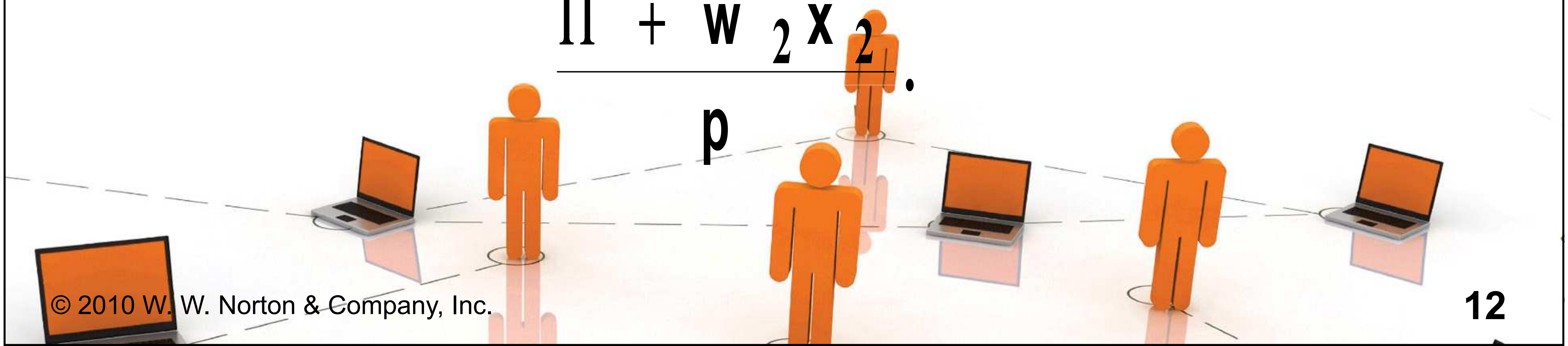
$$y = \frac{w_1}{p} x_1 + \frac{\Pi + w_2 \tilde{x}_2}{p}$$

has a slope of

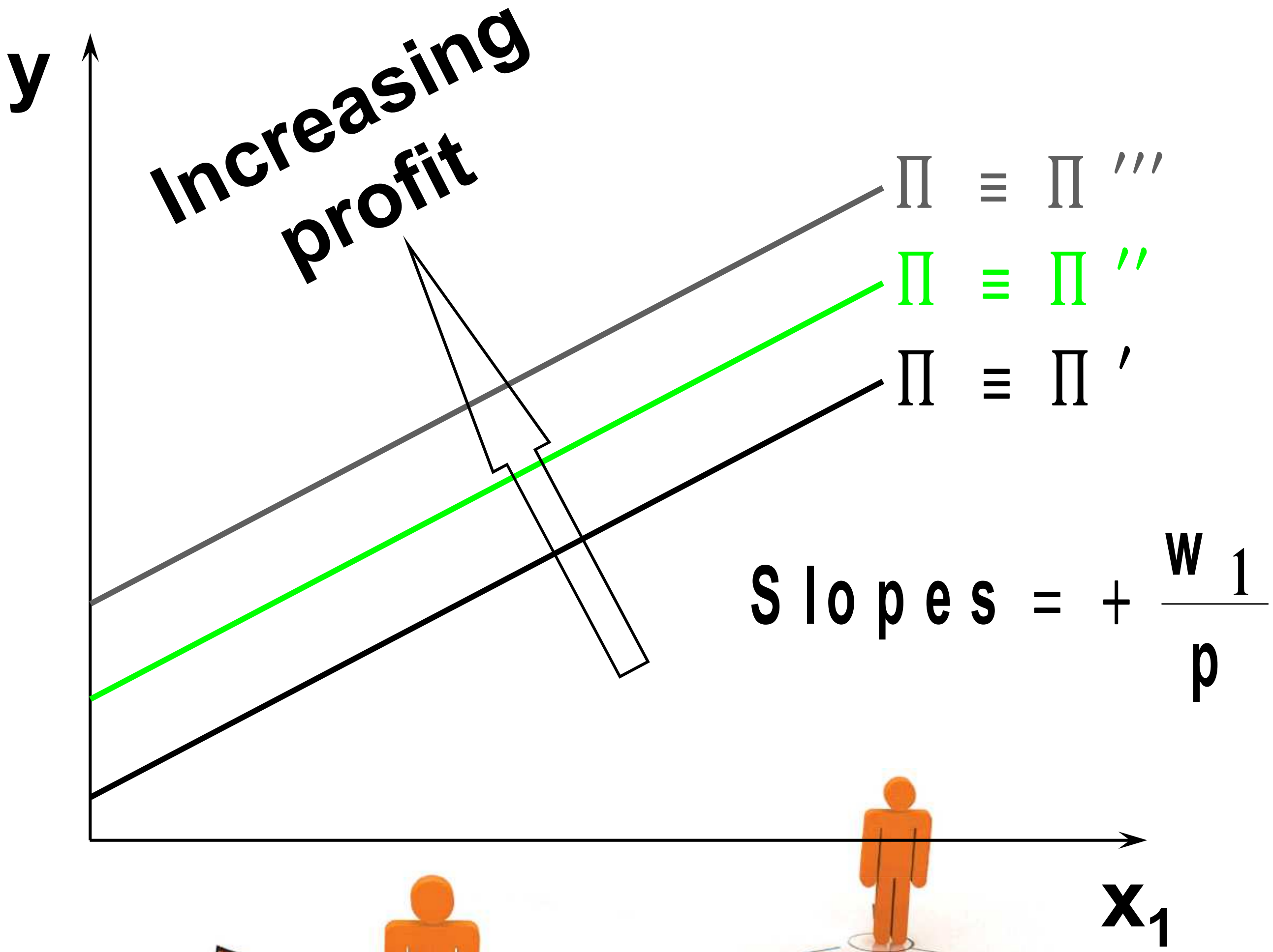
$$+\frac{w_1}{p}$$

and a vertical intercept of

$$\frac{\Pi + w_2 \tilde{x}_2}{p}.$$



Short-Run Iso-Profit Lines



Short-Run Profit-Maximization

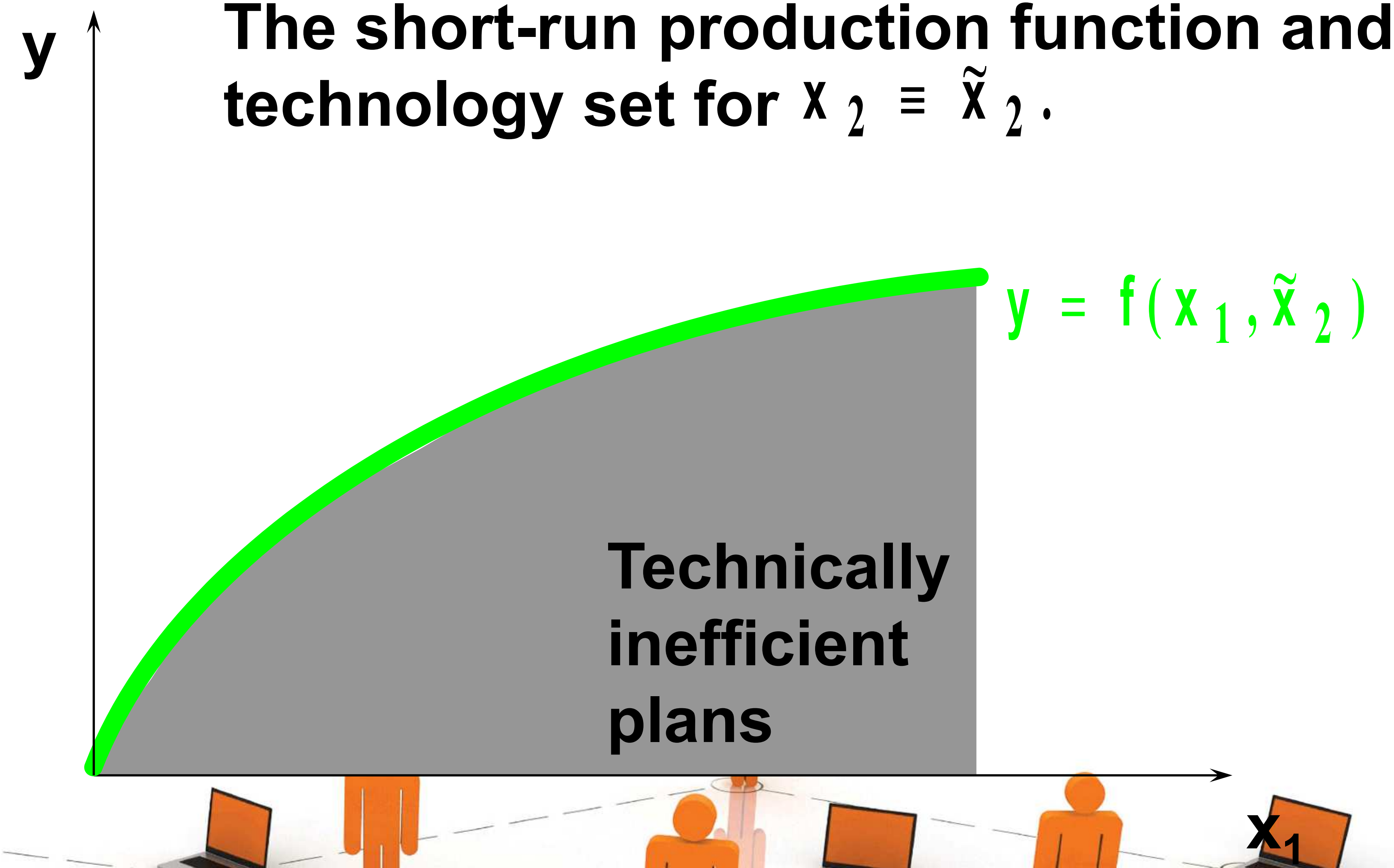
- **The firm's problem is to locate the production plan that attains the highest possible iso-profit line, given the firm's constraint on choices of production plans.**
- **Q: What is this constraint?**

Short-Run Profit-Maximization

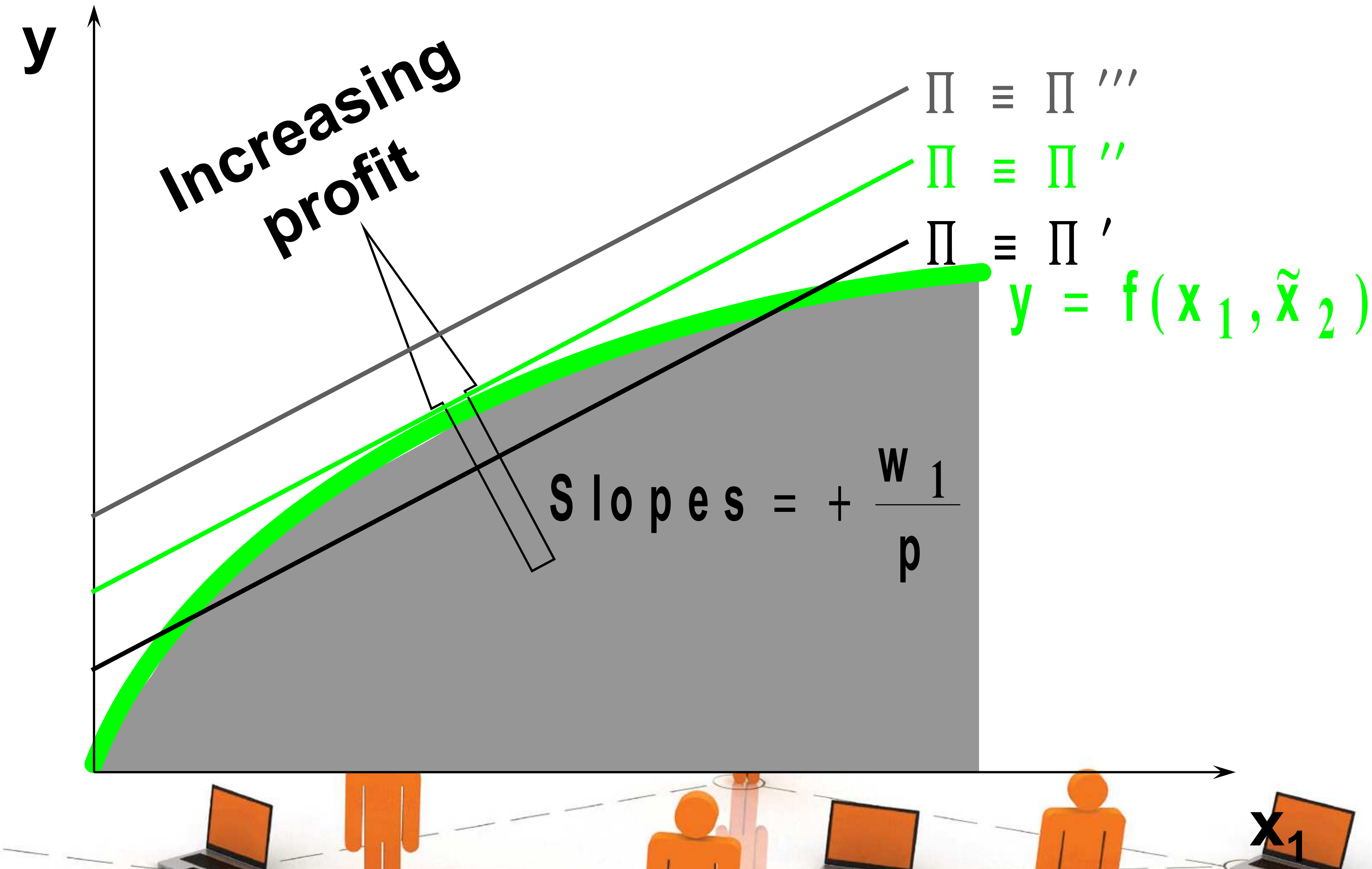
- **The firm's problem is to locate the production plan that attains the highest possible iso-profit line, given the firm's constraint on choices of production plans.**
- **Q: What is this constraint?**
- **A: The production function.**

Short-Run Profit-Maximization

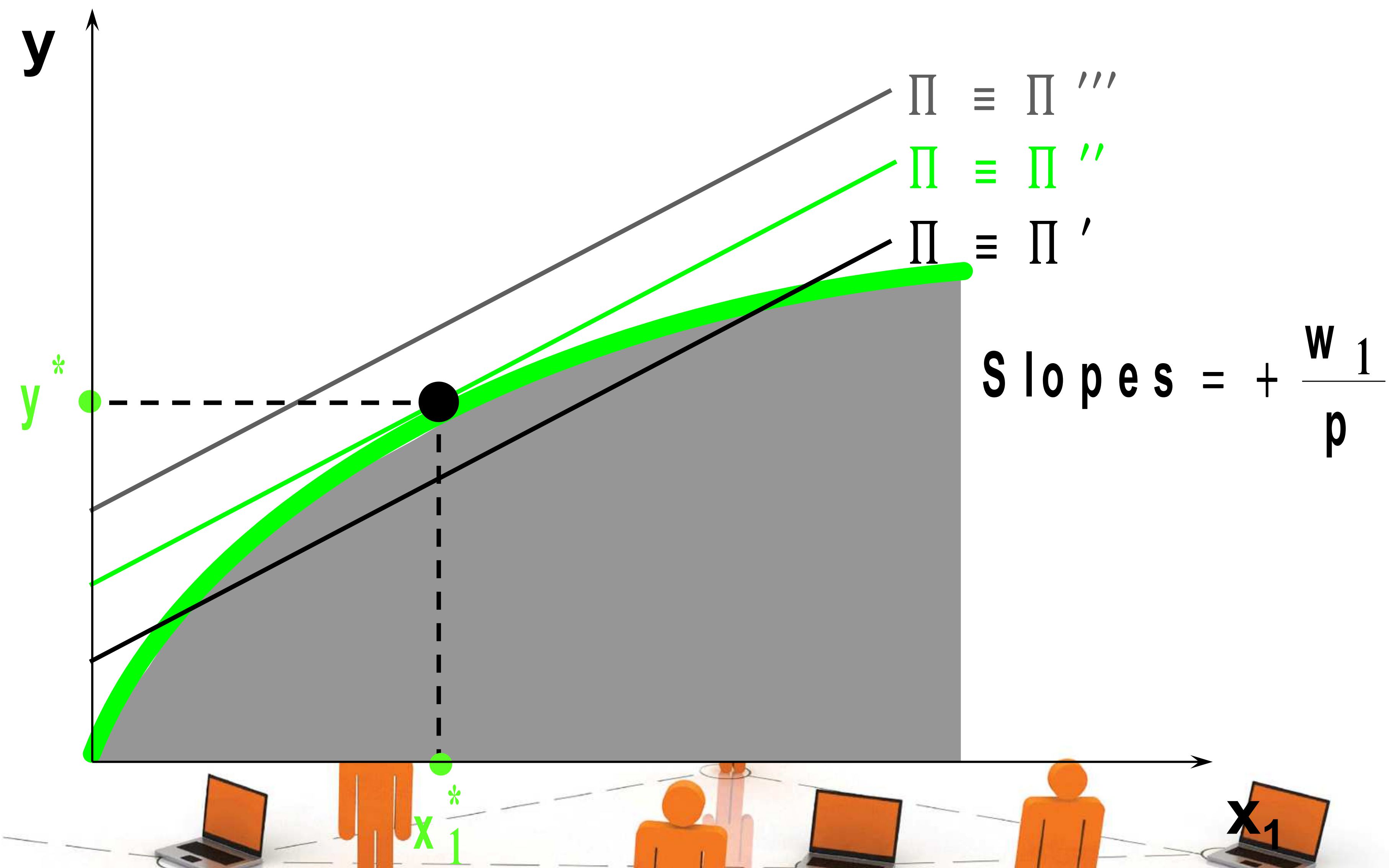
The short-run production function and technology set for $x_2 \equiv \tilde{x}_2$.



Short-Run Profit-Maximization

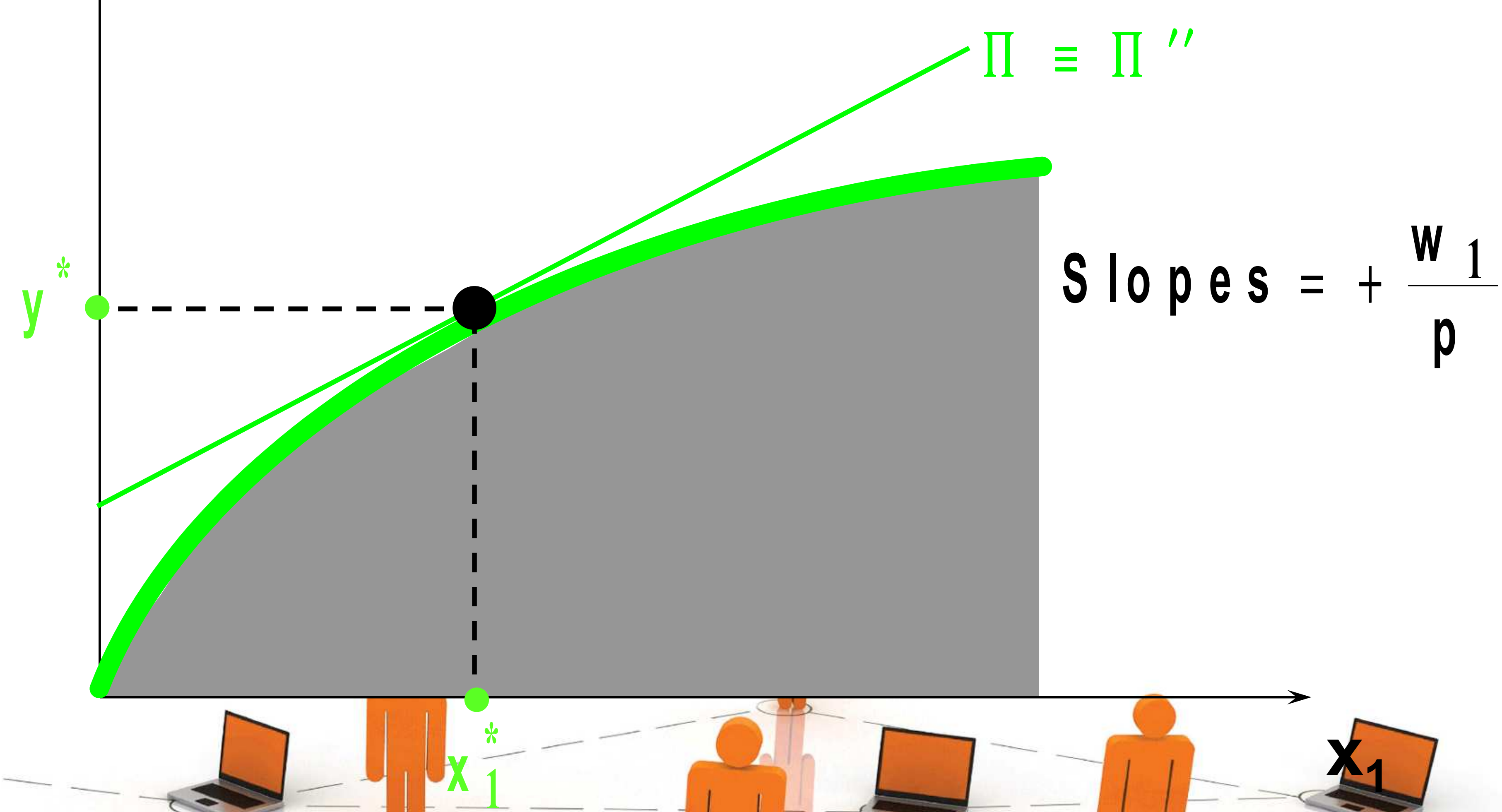


Short-Run Profit-Maximization



Short-Run Profit-Maximization

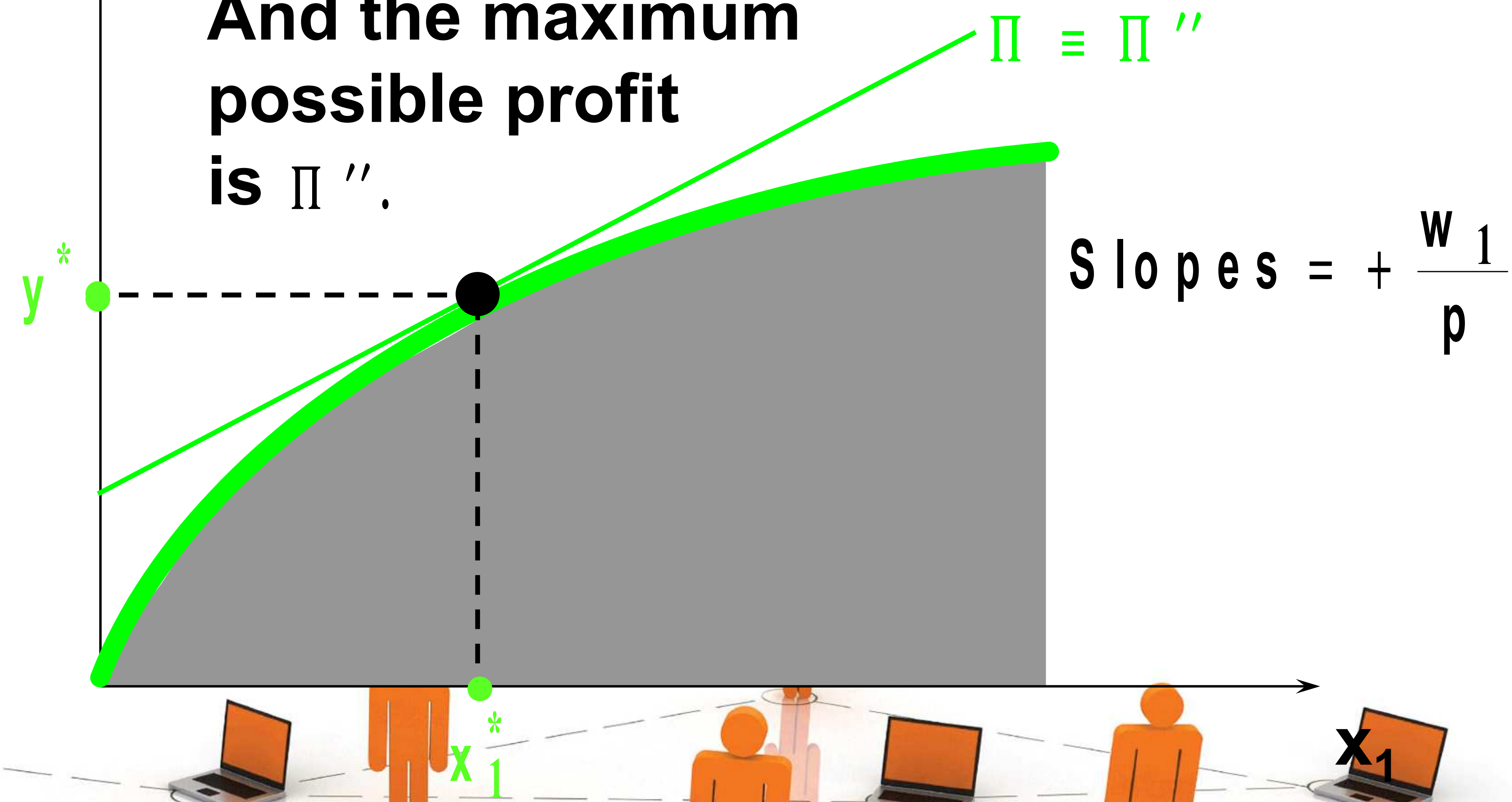
Given p, w_1 and $x_2 \equiv \tilde{x}_2$, the short-run profit-maximizing plan is $(x_1^*, \tilde{x}_2, y^*)$.



Short-Run Profit-Maximization

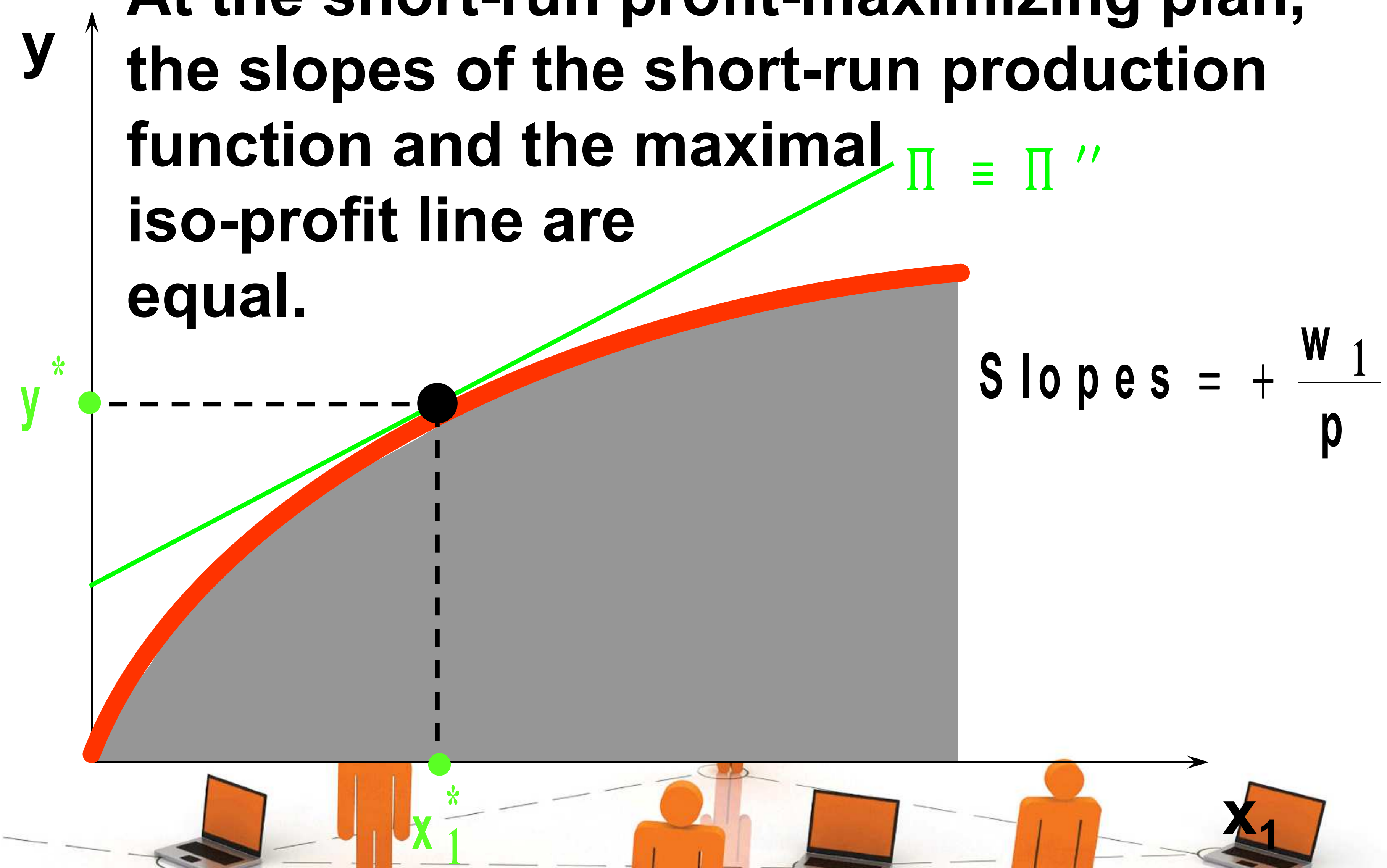
Given p, w_1 and $x_2 \equiv \tilde{x}_2$, the short-run profit-maximizing plan is $(x_1^*, \tilde{x}_2, y^*)$.

And the maximum possible profit is Π''.



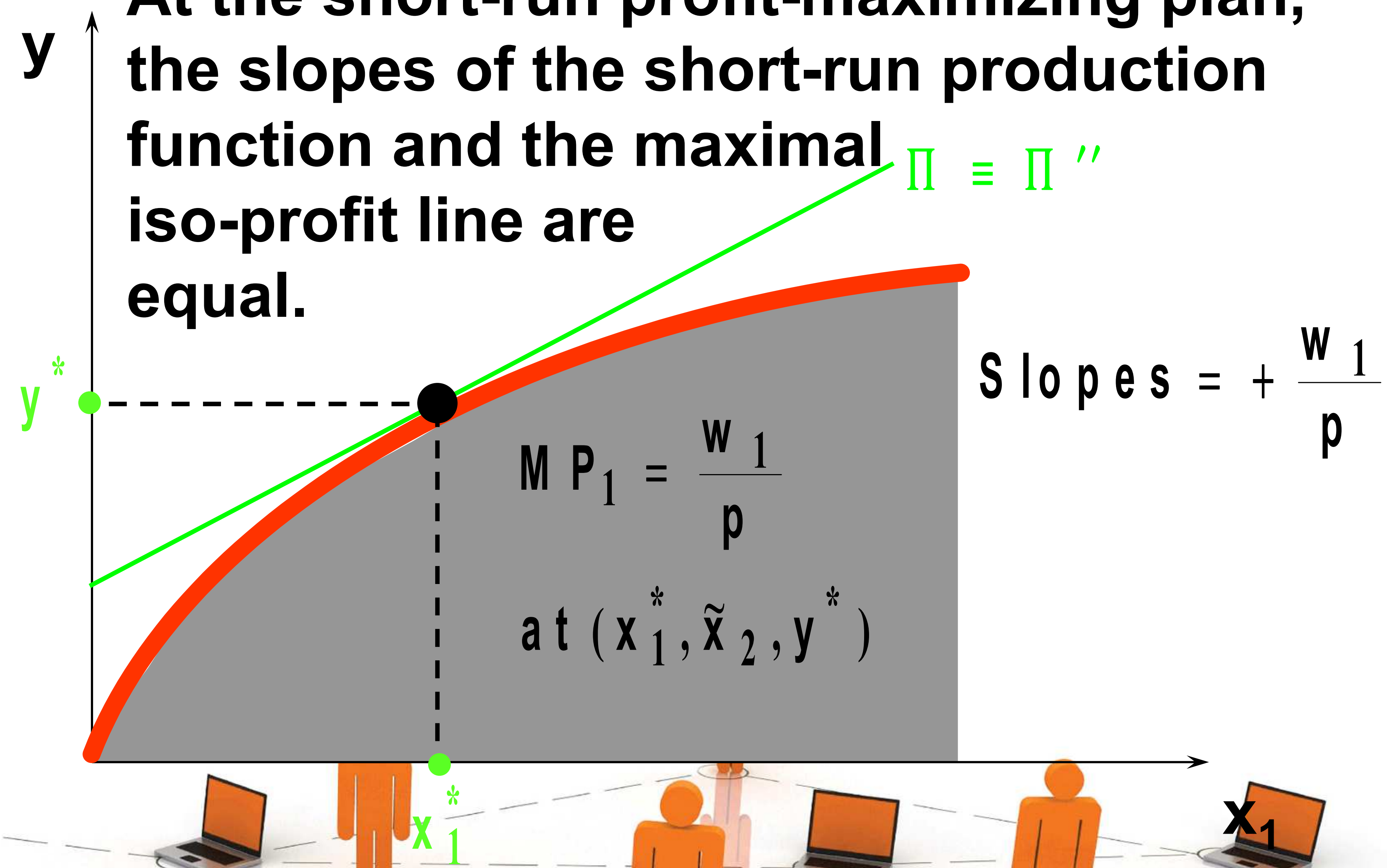
Short-Run Profit-Maximization

At the short-run profit-maximizing plan, the slopes of the short-run production function and the maximal iso-profit line are equal.



Short-Run Profit-Maximization

At the short-run profit-maximizing plan, the slopes of the short-run production function and the maximal iso-profit line are equal.



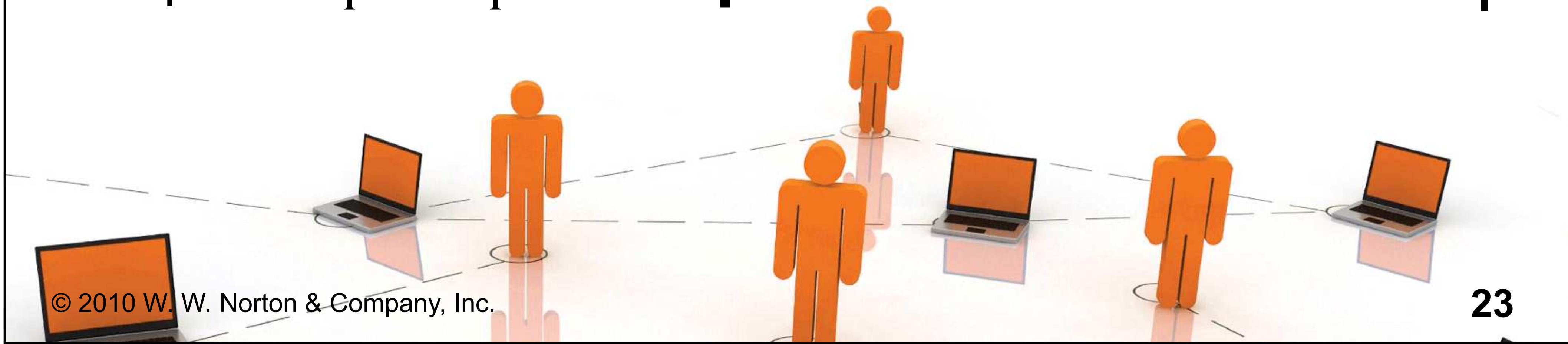
Short-Run Profit-Maximization

$$MP_1 = \frac{w_1}{p} \Leftrightarrow p \times MP_1 = w_1$$

$p \times MP_1$ is the marginal revenue product of input 1, the rate at which revenue increases with the amount used of input 1.

If $p \times MP_1 > w_1$ then profit increases with x_1.

If $p \times MP_1 < w_1$ then profit decreases with x_1.



Short-Run Profit-Maximization; A Cobb-Douglas Example

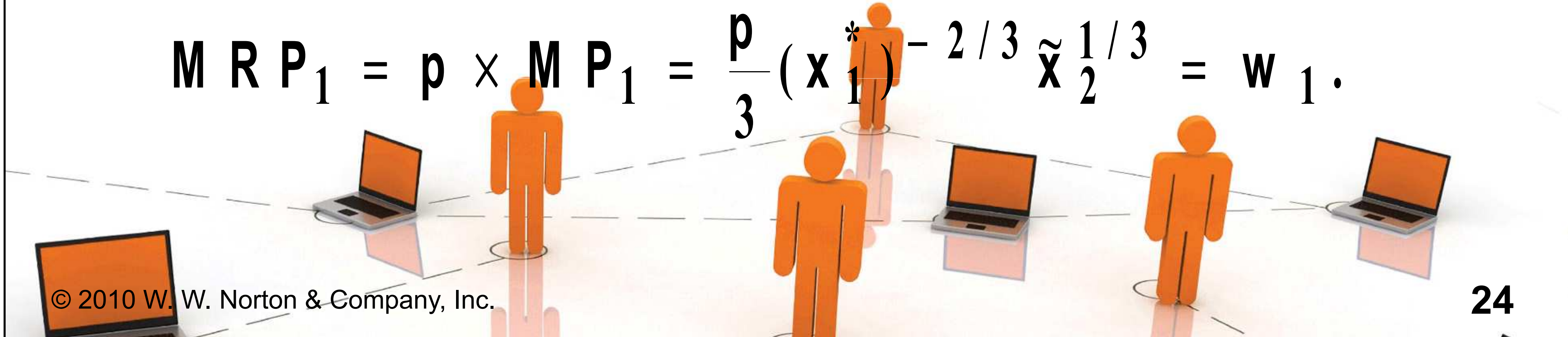
Suppose the short-run production function is $y = x_1^{1/3}\tilde{x}_2^{1/3}.$

The marginal product of the variable input 1 is

$$MP_1 = \frac{\partial y}{\partial x_1} = \frac{1}{3}x_1^{-2/3}\tilde{x}_2^{1/3}.$$

The profit-maximizing condition is

$$MRP_1 = p \times MP_1 = \frac{p}{3}(x_1^*)^{-2/3}\tilde{x}_2^{1/3} = w_1.$$



Short-Run Profit-Maximization; A Cobb-Douglas Example

Solving $\frac{p}{3}(x_1^*)^{-2/3}\tilde{x}_2^{1/3} = w_1$ **for x_1 gives**

$$(x_1^*)^{-2/3} = \frac{3w_1}{p\tilde{x}_2^{1/3}}.$$

Short-Run Profit-Maximization; A Cobb-Douglas Example

Solving $\frac{p}{3}(x_1^*)^{-2/3}\tilde{x}_2^{1/3} = w_1$ **for x_1 gives**

$$(x_1^*)^{-2/3} = \frac{3w_1}{p\tilde{x}_2^{1/3}}.$$

That is,

$$(x_1^*)^{2/3} = \frac{p\tilde{x}_2^{1/3}}{3w_1}$$

Short-Run Profit-Maximization; A Cobb-Douglas Example

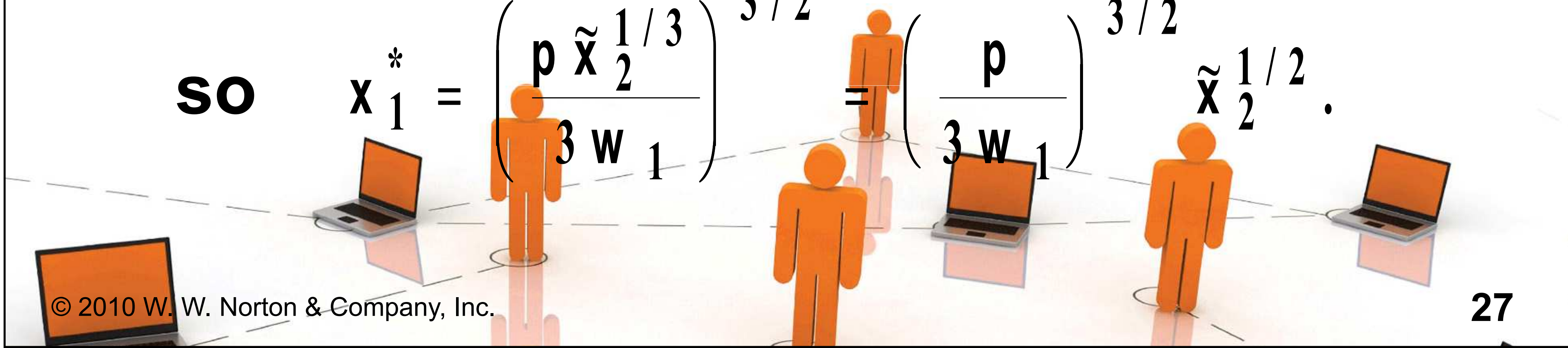
Solving $\frac{p}{3}(x_1^*)^{-2/3}\tilde{x}_2^{1/3} = w_1$ **for x_1 gives**

$$(x_1^*)^{-2/3} = \frac{3w_1}{p\tilde{x}_2^{1/3}}.$$

That is,

$$(x_1^*)^{2/3} = \frac{p\tilde{x}_2^{1/3}}{3w_1}$$

so $$x_1^* = \left(\frac{p\tilde{x}_2^{1/3}}{3w_1}\right)^{3/2} = \left(\frac{p}{3w_1}\right)^{3/2}\tilde{x}_2^{1/2}.$$



Short-Run Profit-Maximization; A Cobb-Douglas Example

$$x_1^* = \left(\frac{p}{3w_1}\right)^{3/2}\tilde{x}_2^{1/2}$$ **is the firm's short-run demand for input 1 when the level of input 2 is fixed at $\tilde{x}_2$ units.**

Short-Run Profit-Maximization; A Cobb-Douglas Example

$$x_1^* = \left(\frac{p}{3w_1}\right)^{3/2}\tilde{x}_2^{1/2}$$

is the firm's short-run demand for input 1 when the level of input 2 is fixed at $\tilde{x}_2$ units.

The firm's short-run output level is thus

$$y^* = (x_1^*)^{1/3}\tilde{x}_2^{1/3} = \left(\frac{p}{3w_1}\right)^{1/2}\tilde{x}_2^{1/2}.$$

Comparative Statics of Short-Run Profit-Maximization

- **What happens to the short-run profit-maximizing production plan as the output price p changes?**

Comparative Statics of Short-Run Profit-Maximization

The equation of a short-run iso-profit line is

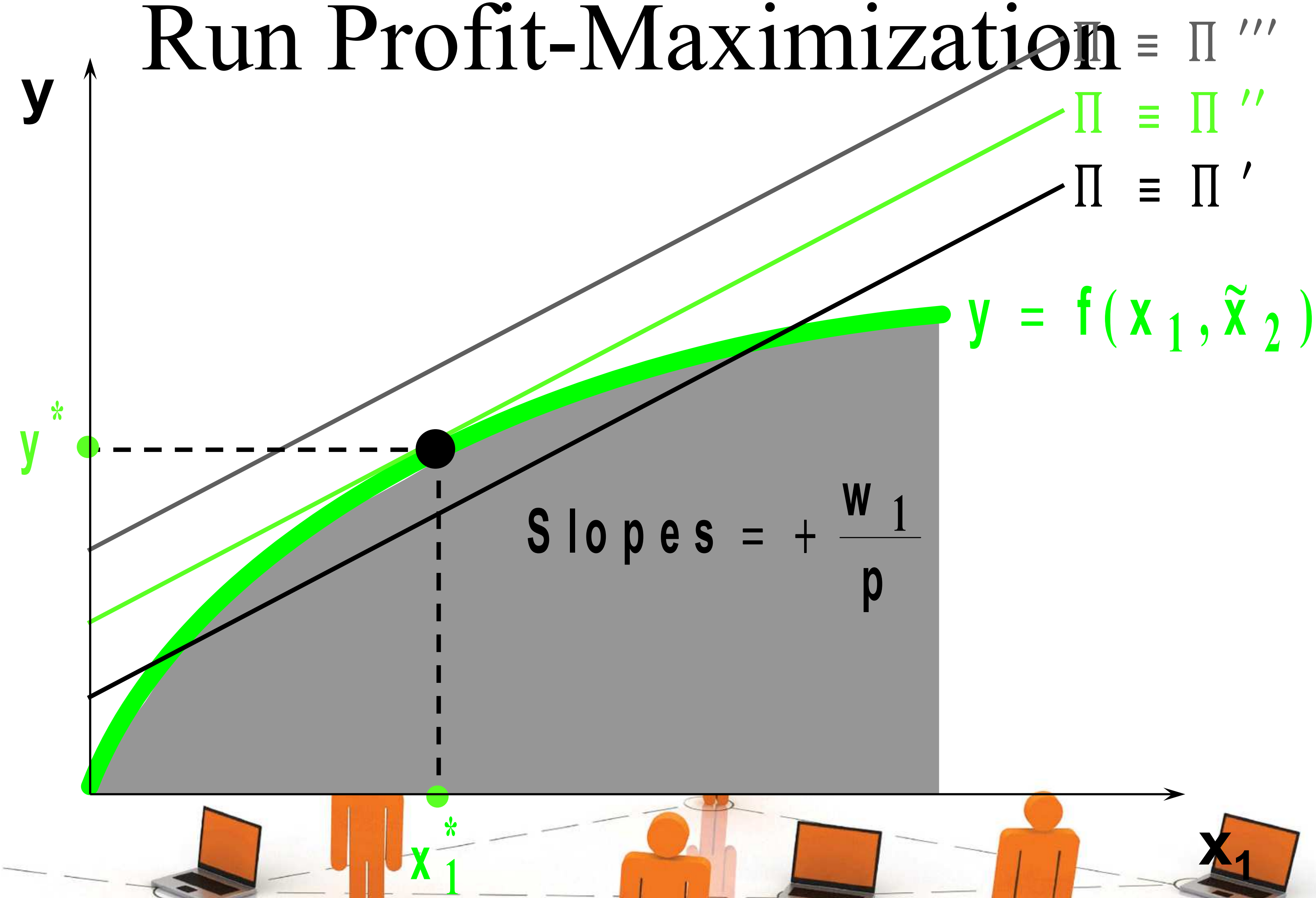
$$y = \frac{w_1}{p}x_1 + \frac{\Pi + w_2\tilde{x}_2}{p}$$

so an increase in p causes

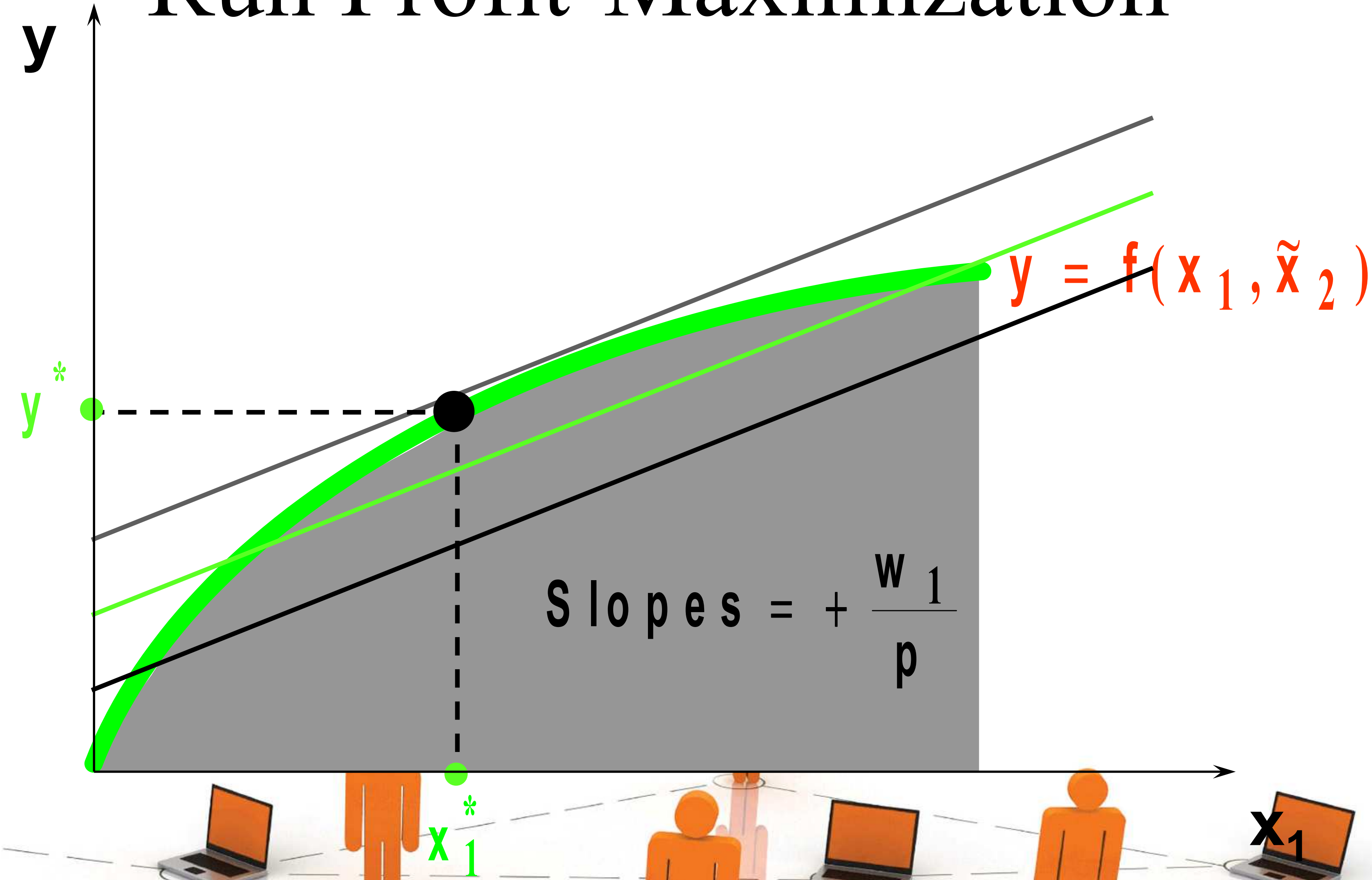
-- a reduction in the slope, and

-- a reduction in the vertical intercept.

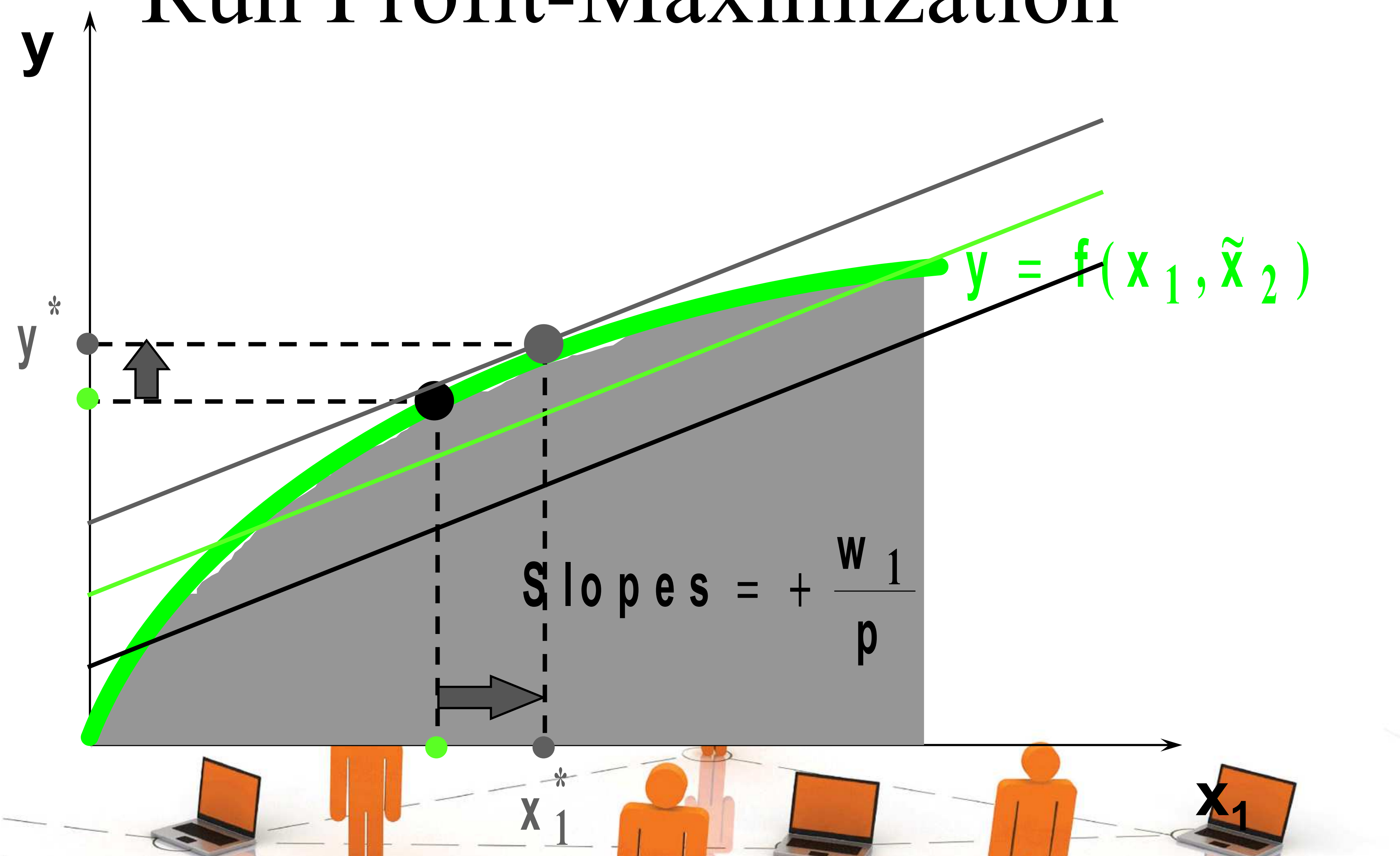
Comparative Statics of Short-Run Profit-Maximization



Comparative Statics of Short-Run Profit-Maximization



Comparative Statics of Short-Run Profit-Maximization



Comparative Statics of Short-Run Profit-Maximization

- **An increase in p, the price of the firm's output, causes**
  - **an increase in the firm's output level (the firm's supply curve slopes upward), and**
  - **an increase in the level of the firm's variable input (the firm's demand curve for its variable input shifts outward).**

Comparative Statics of Short-Run Profit-Maximization

The Cobb-Douglas example: When

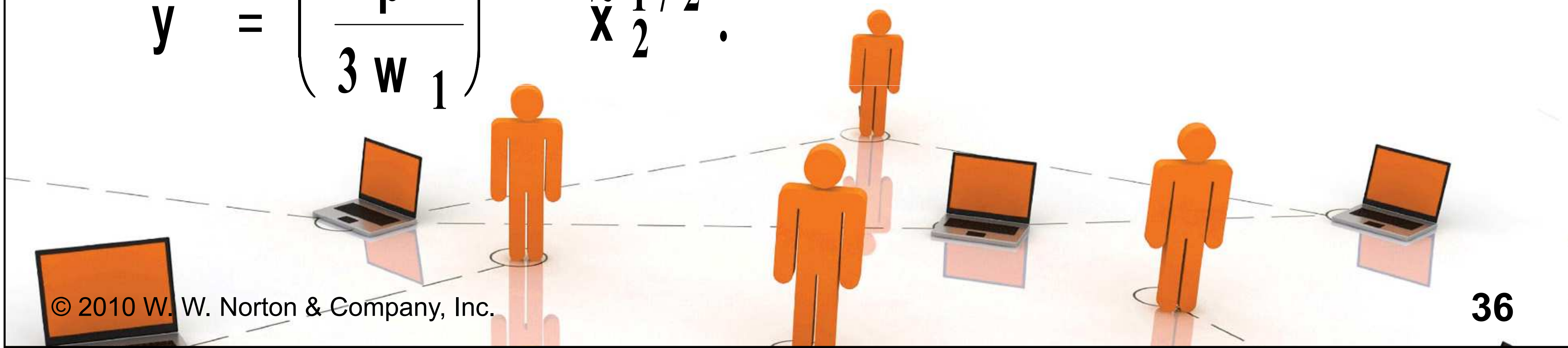
$$y = x_1^{1/3} \tilde{x}_2^{1/3}$$

then the firm's short-run demand for its variable input 1 is

$$x_1^* = \left(\frac{p}{3w_1}\right)^{3/2} \tilde{x}_2^{1/2}$$

and its short-run supply is

$$y^* = \left(\frac{p}{3w_1}\right)^{1/2} \tilde{x}_2^{1/2}.$$



Comparative Statics of Short-Run Profit-Maximization

The Cobb-Douglas example: When $y = x_1^{1/3}\tilde{x}_2^{1/3}$ then the firm's short-run demand for its variable input 1 is

$$x_1^* = \left(\frac{p}{3w_1}\right)^{3/2}\tilde{x}_2^{1/2}$$

and its short-run supply is

$$y^* = \left(\frac{p}{3w_1}\right)^{1/2}\tilde{x}_2^{1/2}.$$

x_1^* increases as p increases.

Comparative Statics of Short-Run Profit-Maximization

The Cobb-Douglas example: When $y = x_1^{1/3}\tilde{x}_2^{1/3}$ then the firm's short-run demand for its variable input 1 is

$$x_1^* = \left(\frac{p}{3w_1}\right)^{3/2}\tilde{x}_2^{1/2}$$

and its short-run supply is

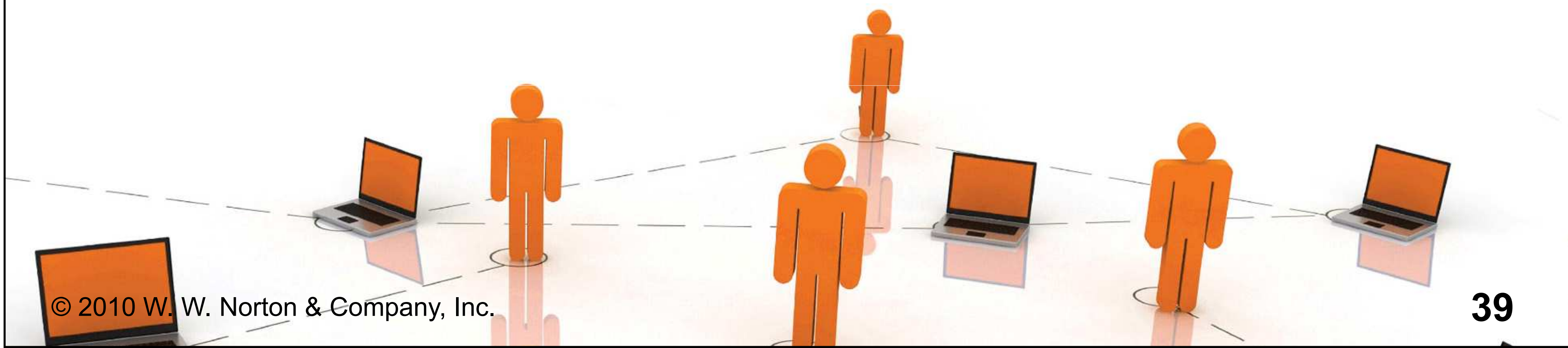
$$y^* = \left(\frac{p}{3w_1}\right)^{1/2}\tilde{x}_2^{1/2}.$$

x_1^* increases as p increases.

y^* increases as p increases.

Comparative Statics of Short-Run Profit-Maximization

- **What happens to the short-run profit-maximizing production plan as the variable input price w_1 changes?**



Comparative Statics of Short-Run Profit-Maximization

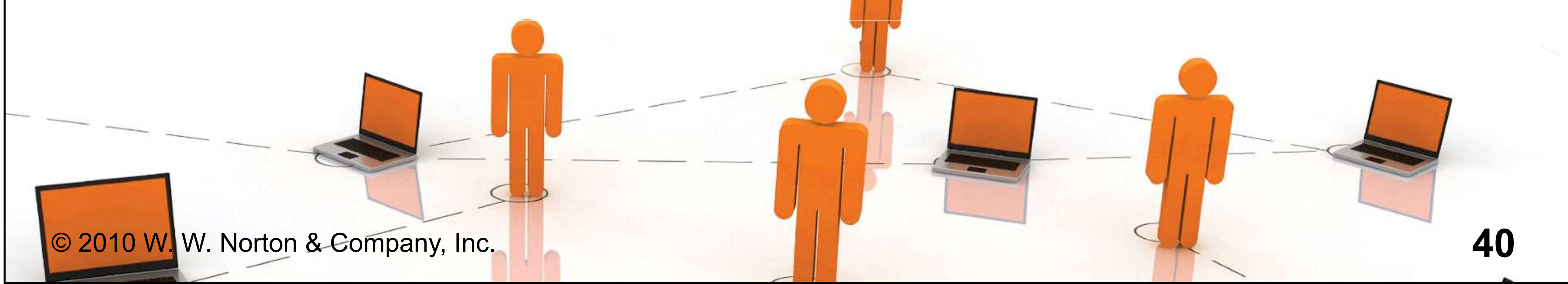
The equation of a short-run iso-profit line is

$$y = \frac{w_1}{p} x_1 + \frac{\Pi + w_2 \tilde{x}_2}{p}$$

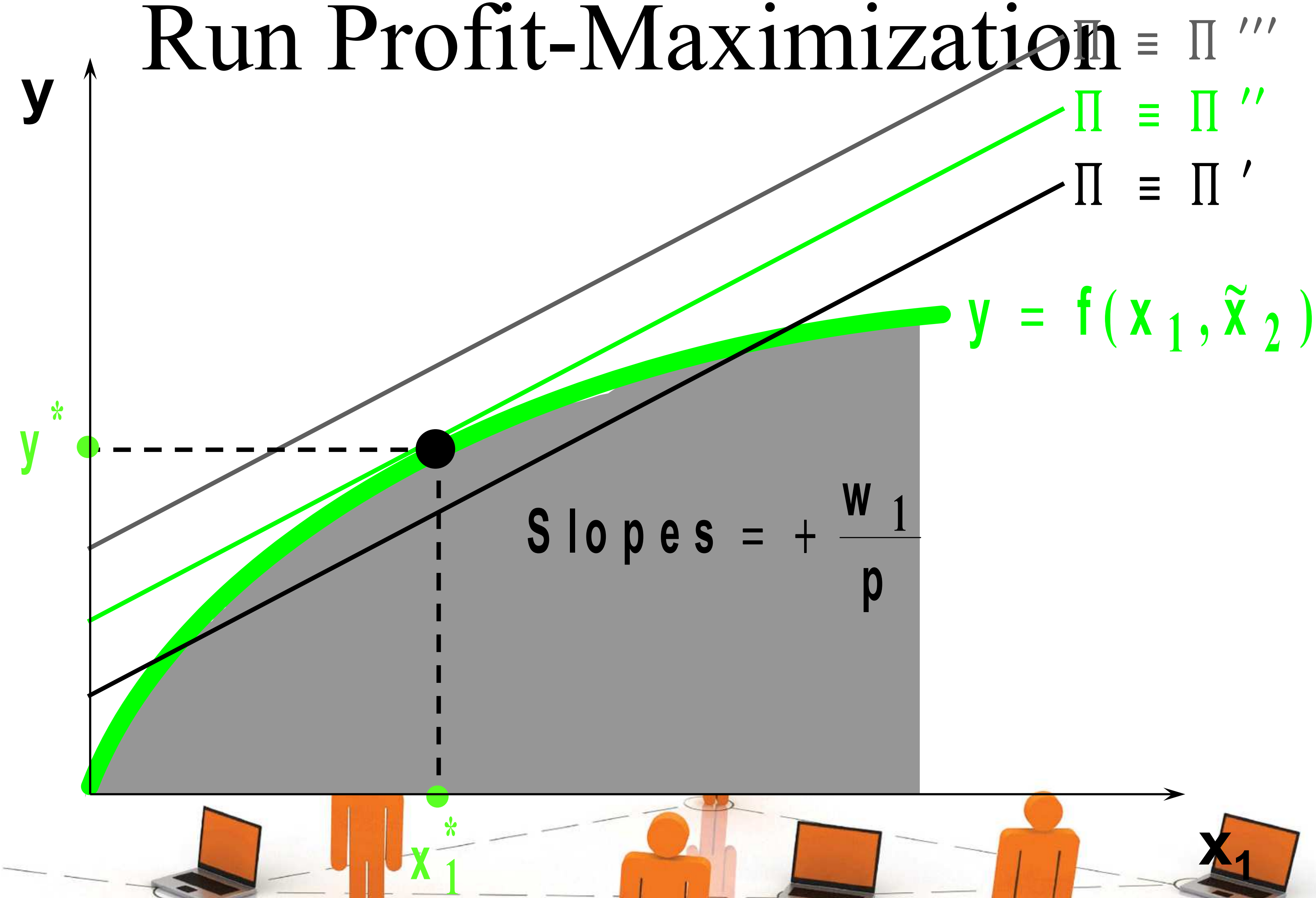
so an increase in w_1 causes

-- an increase in the slope, and

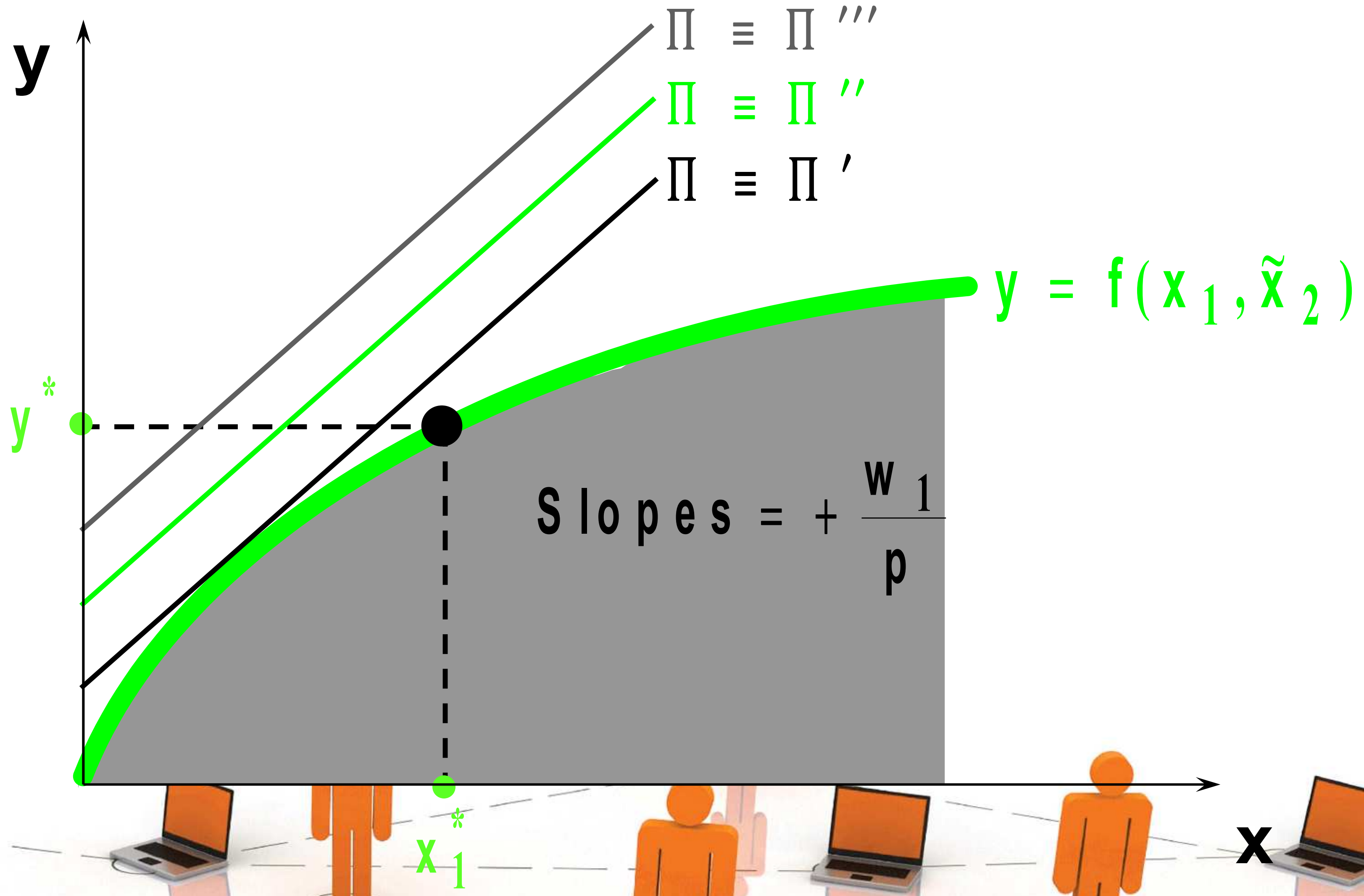
-- no change to the vertical intercept.



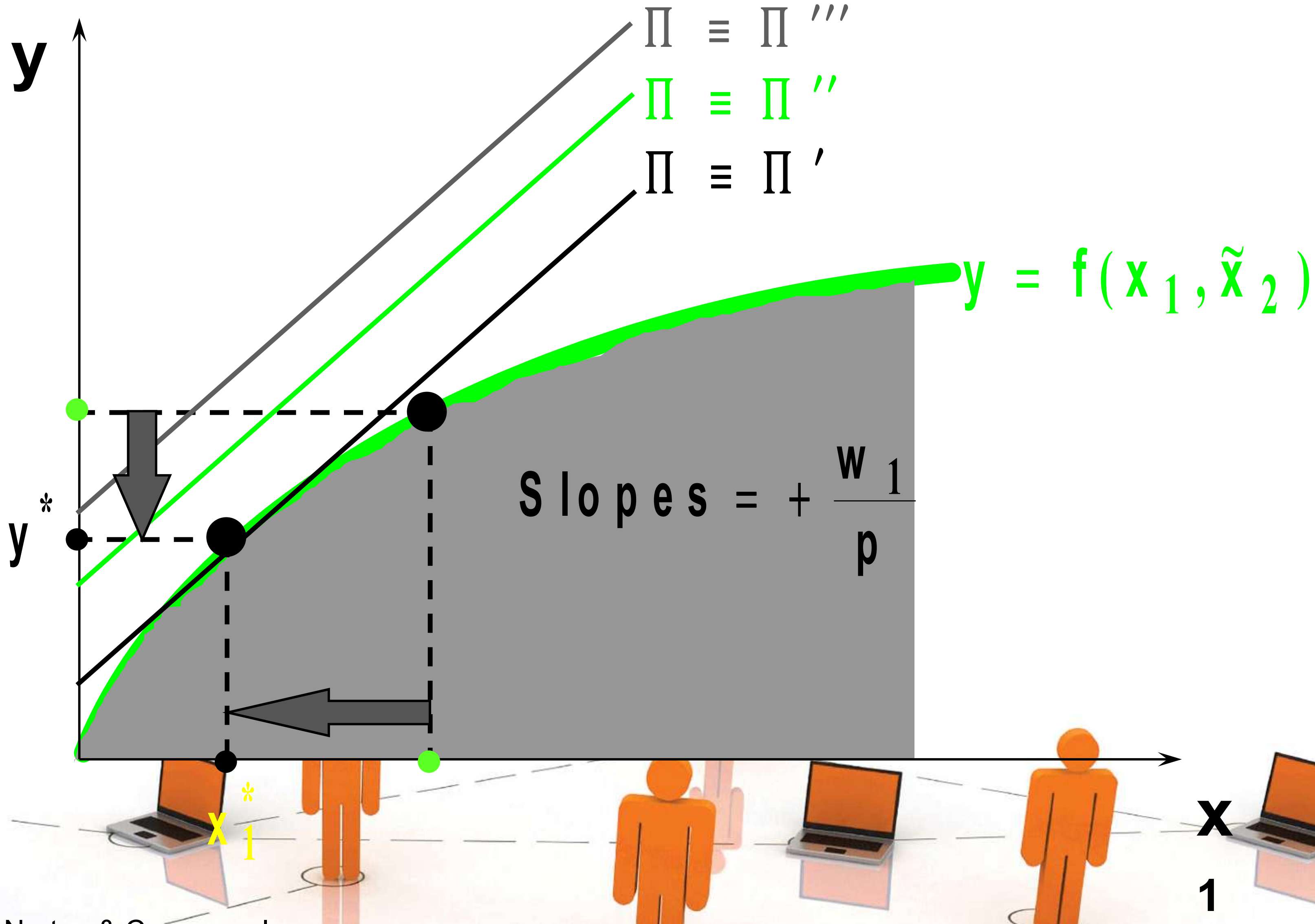
Comparative Statics of Short-Run Profit-Maximization



Comparative Statics of Short-Run Profit-Maximization



Comparative Statics of Short-Run Profit-Maximization



Comparative Statics of Short-Run Profit-Maximization

- **An increase in w_1, the price of the firm's variable input, causes**
  - **a decrease in the firm's output level (the firm's supply curve shifts inward), and**
  - **a decrease in the level of the firm's variable input (the firm's demand curve for its variable input slopes downward).**

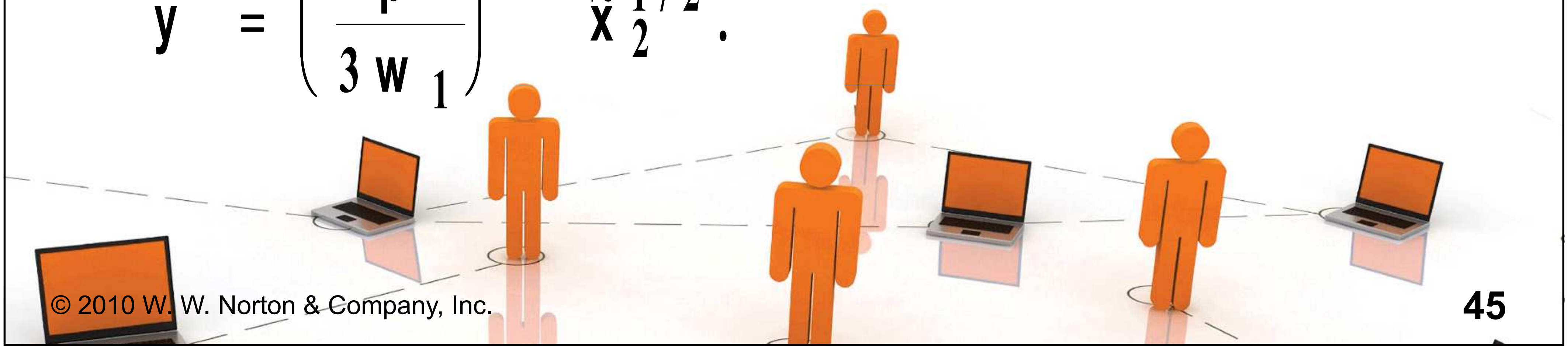
Comparative Statics of Short-Run Profit-Maximization

The Cobb-Douglas example: When $y = x_1^{1/3}\tilde{x}_2^{1/3}$ **then the firm's short-run demand for its variable input 1 is**

$$x_1^* = \left(\frac{p}{3w_1}\right)^{3/2}\tilde{x}_2^{1/2}$$

and its short-run supply is

$$y^* = \left(\frac{p}{3w_1}\right)^{1/2}\tilde{x}_2^{1/2}.$$



Comparative Statics of Short-Run Profit-Maximization

The Cobb-Douglas example: When $y = x_1^{1/3}\tilde{x}_2^{1/3}$ **then the firm's short-run demand for its variable input 1 is**

$$x_1^* = \left(\frac{p}{3w_1}\right)^{3/2}\tilde{x}_2^{1/2}$$

and its short-run supply is

$$y^* = \left(\frac{p}{3w_1}\right)^{1/2}\tilde{x}_2^{1/2}.$$

x_1^* **decreases as** w_1 **increases.**

Comparative Statics of Short-Run Profit-Maximization

The Cobb-Douglas example: When $y = x_1^{1/3}\tilde{x}_2^{1/3}$ then the firm's short-run demand for its variable input 1 is

$$x_1^* = \left(\frac{p}{3w_1}\right)^{3/2}\tilde{x}_2^{1/2}$$

and its short-run supply is

$$y^* = \left(\frac{p}{3w_1}\right)^{1/2}\tilde{x}_2^{1/2}.$$

x_1^* decreases as w_1 increases.

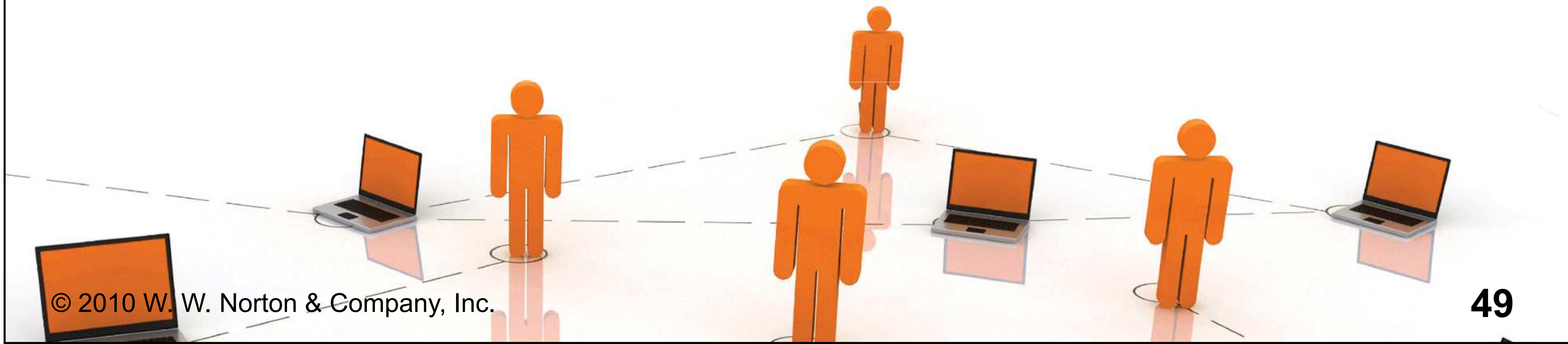
y^* decreases as w_1 increases.

Long-Run Profit-Maximization

- **Now allow the firm to vary both input levels.**
- **Since no input level is fixed, there are no fixed costs.**

Long-Run Profit-Maximization

- Both x_1 and x_2 are variable.
- Think of the firm as choosing the production plan that maximizes profits for a given value of x_2, and then varying x_2 to find the largest possible profit level.



Long-Run Profit-Maximization

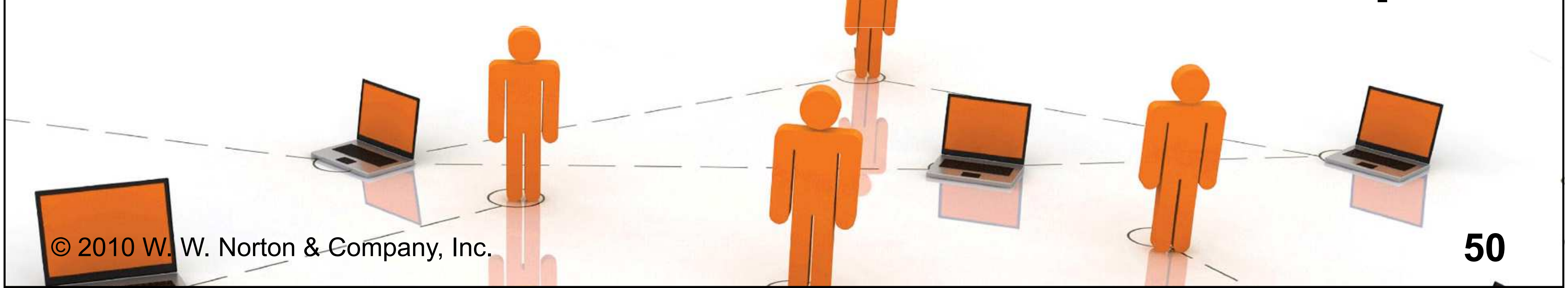
The equation of a long-run iso-profit line is

$$y = \frac{w_1}{p}x_1 + \frac{\Pi + w_2 x_2}{p}$$

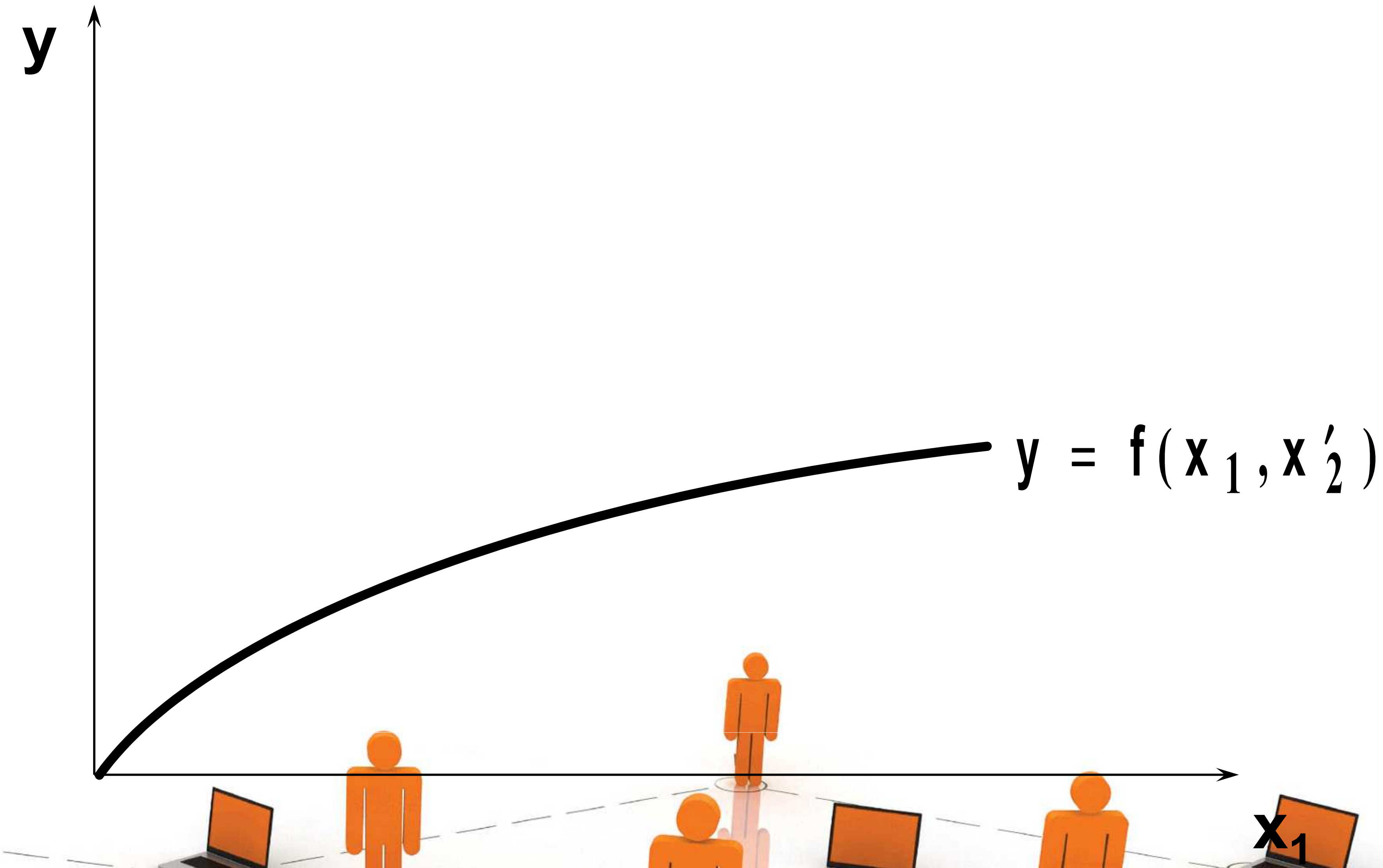
so an increase in x_2 causes

-- no change to the slope, and

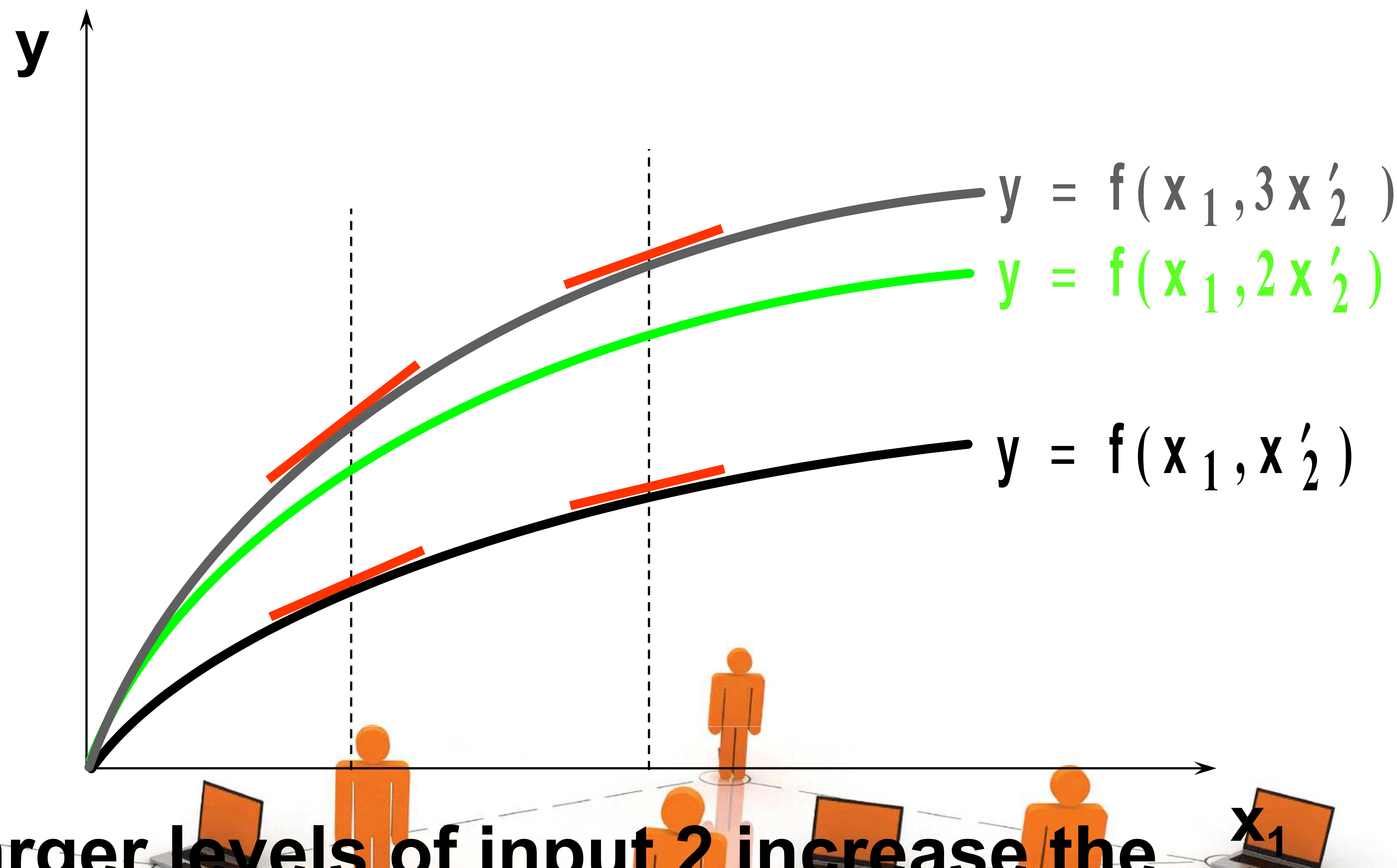
-- an increase in the vertical intercept.



Long-Run Profit-Maximization

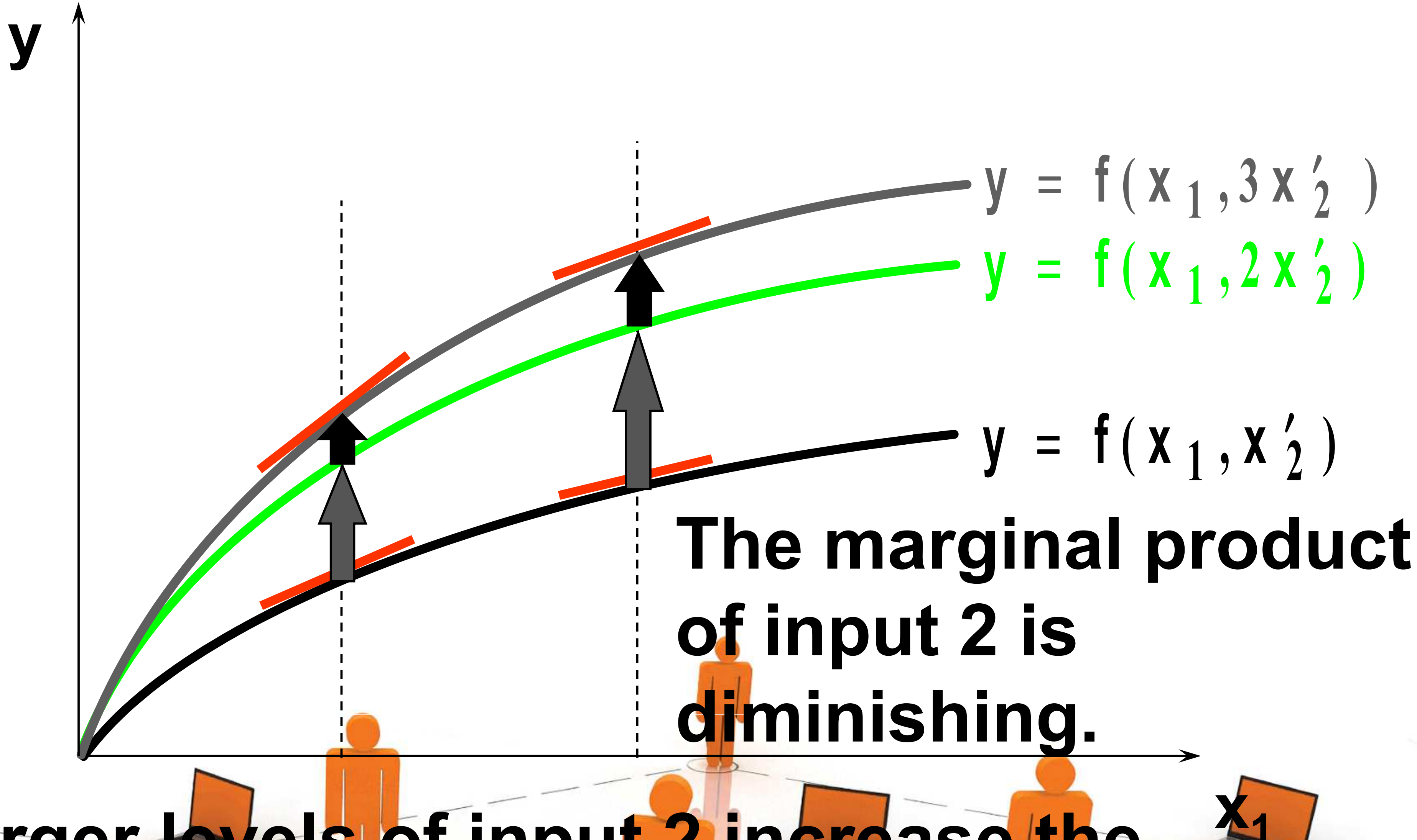


Long-Run Profit-Maximization



Larger levels of input 2 increase the productivity of input 1.

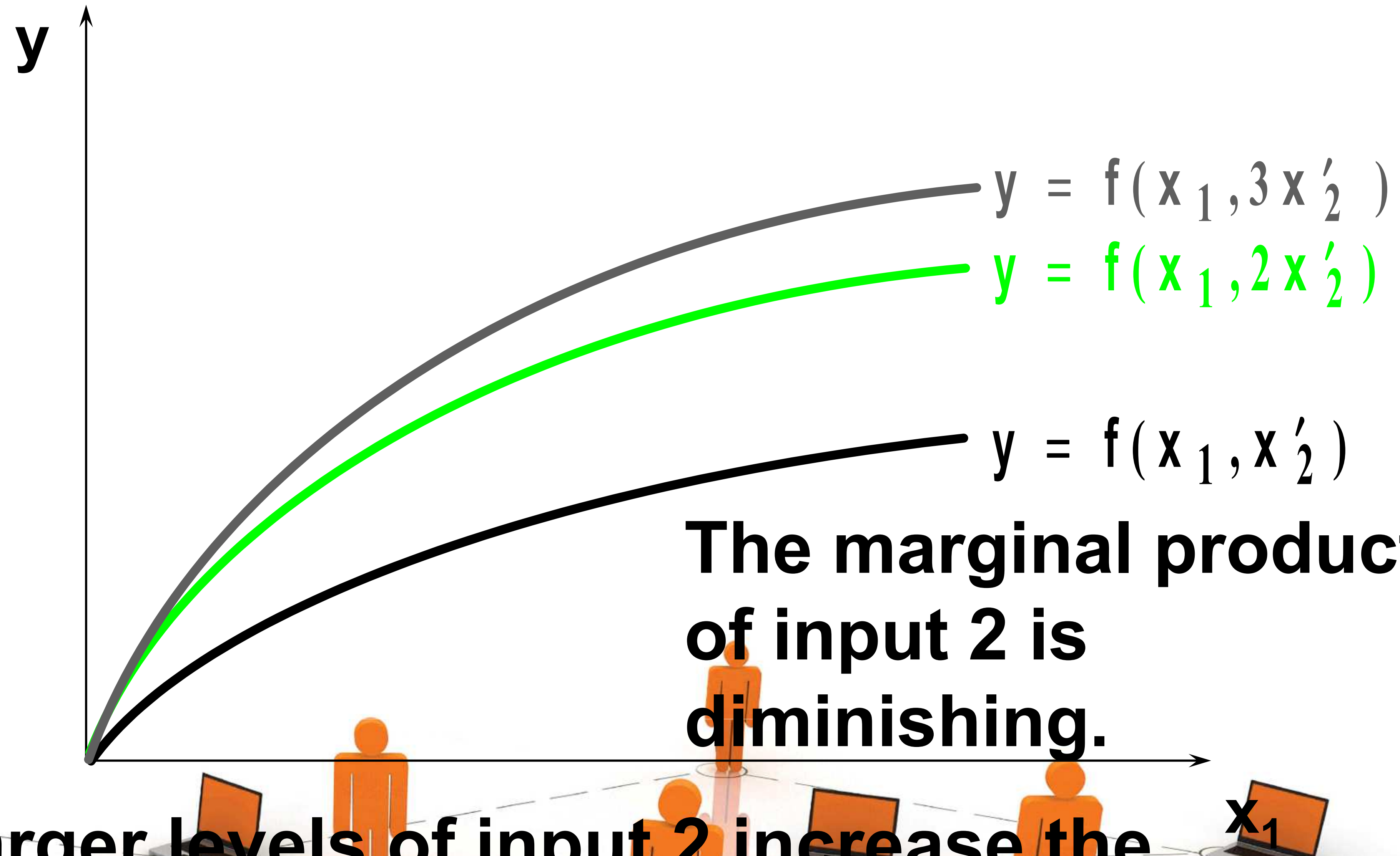
Long-Run Profit-Maximization



The marginal product of input 2 is diminishing.

Larger levels of input 2 increase the productivity of input 1.

Long-Run Profit-Maximization

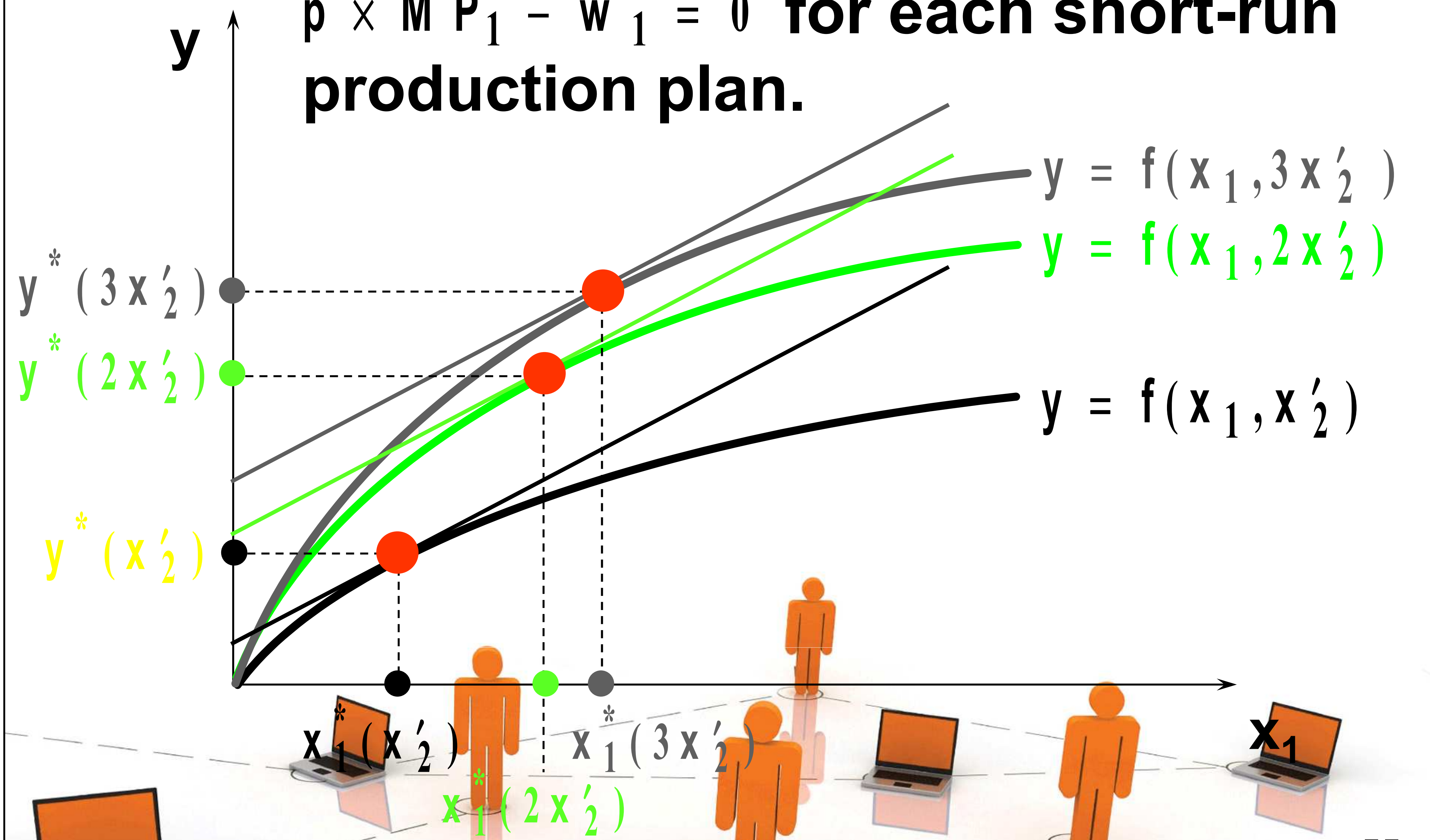


The marginal product of input 2 is diminishing.

Larger levels of input 2 increase the productivity of input 1.

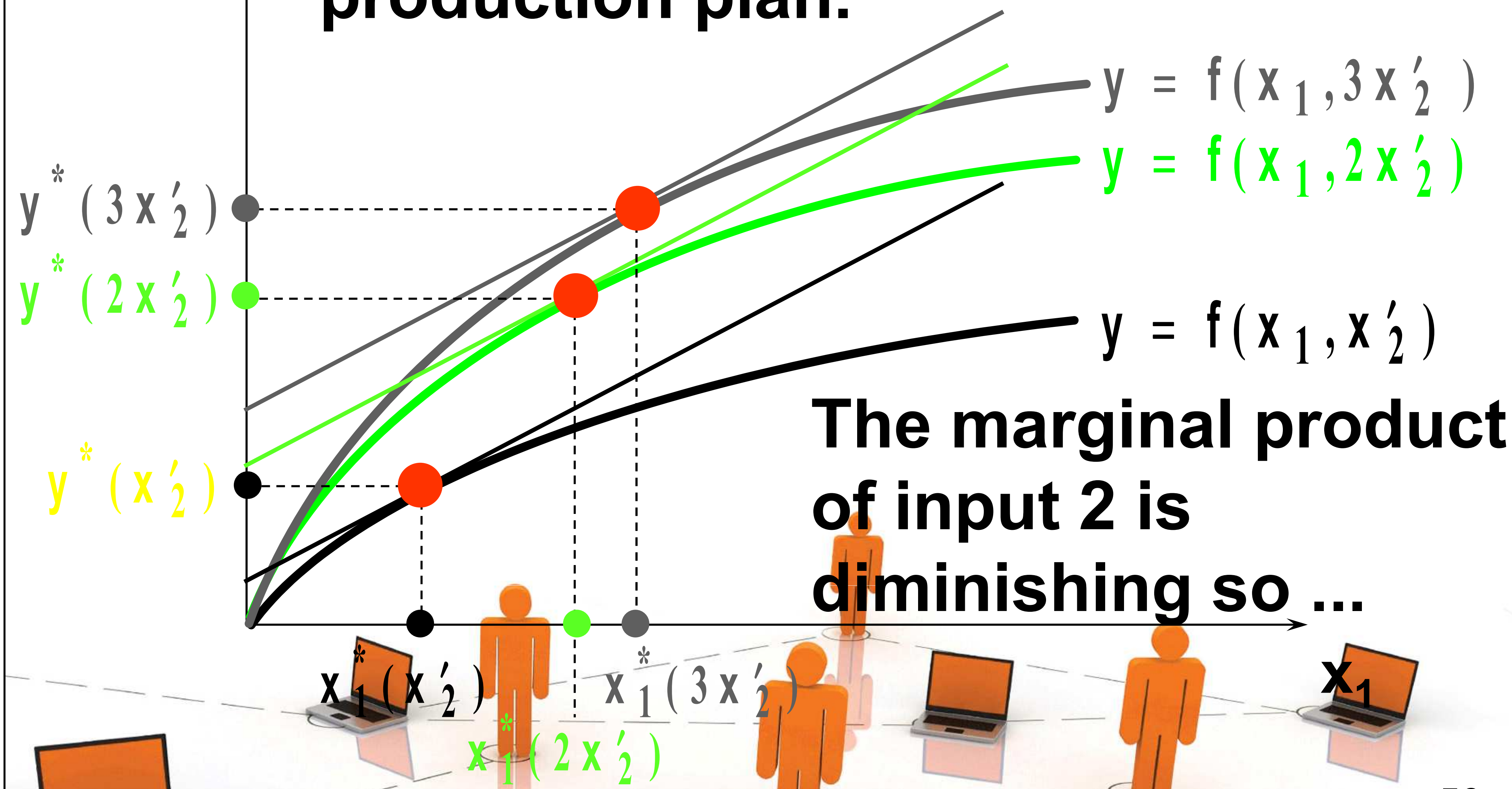
Long-Run Profit-Maximization

$p \times MP_1 - w_1 = 0$ **for each short-run production plan.**



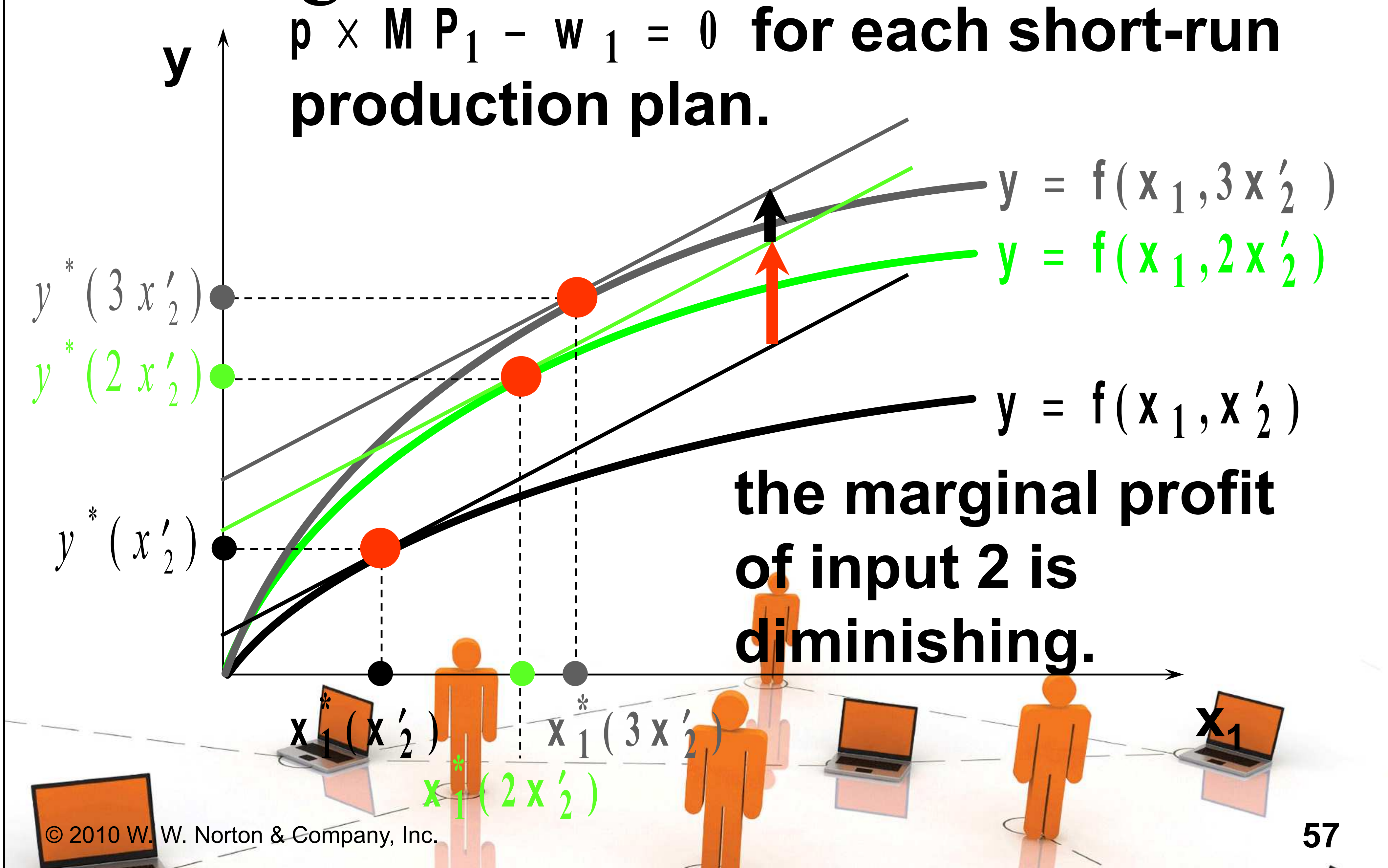
Long-Run Profit-Maximization

$p \times MP_1 - w_1 = 0$ **for each short-run production plan.**



The marginal product of input 2 is diminishing so ...

Long-Run Profit-Maximization



Long-Run Profit-Maximization

- Profit will increase as x_2 increases so long as the marginal profit of input 2

$$p \times MP_2 - w_2 > 0.$$

- The profit-maximizing level of input 2 therefore satisfies

$$p \times MP_2 - w_2 = 0.$$

Long-Run Profit-Maximization

- Profit will increase as x_2 increases so long as the marginal profit of input 2

$$p \times MP_2 - w_2 > 0.$$

- The profit-maximizing level of input 2 therefore satisfies

$$p \times MP_2 - w_2 = 0.$$

- And $p \times MP_1 - w_1 = 0$ is satisfied in any short-run, so ...

Long-Run Profit-Maximization

- The input levels of the long-run profit-maximizing plan satisfy

$p \times MP_1 - w_1 = 0$ **and** $p \times MP_2 - w_2 = 0.$

- That is, marginal revenue equals marginal cost for all inputs.

Long-Run Profit-Maximization

The Cobb-Douglas example: When $y = x_1^{1/3}\tilde{x}_2^{1/3}$ then the firm's short-run demand for its variable input 1 is

$$x_1^* = \left(\frac{p}{3w_1}\right)^{3/2}\tilde{x}_2^{1/2}$$

and its short-run supply is

$$y^* = \left(\frac{p}{3w_1}\right)^{1/2}\tilde{x}_2^{1/2}.$$

Short-run profit is therefore …

Long-Run Profit-Maximization

$$\Pi = py^{*} - w_1 x_1^{*} - w_2 \tilde{x}_2$$

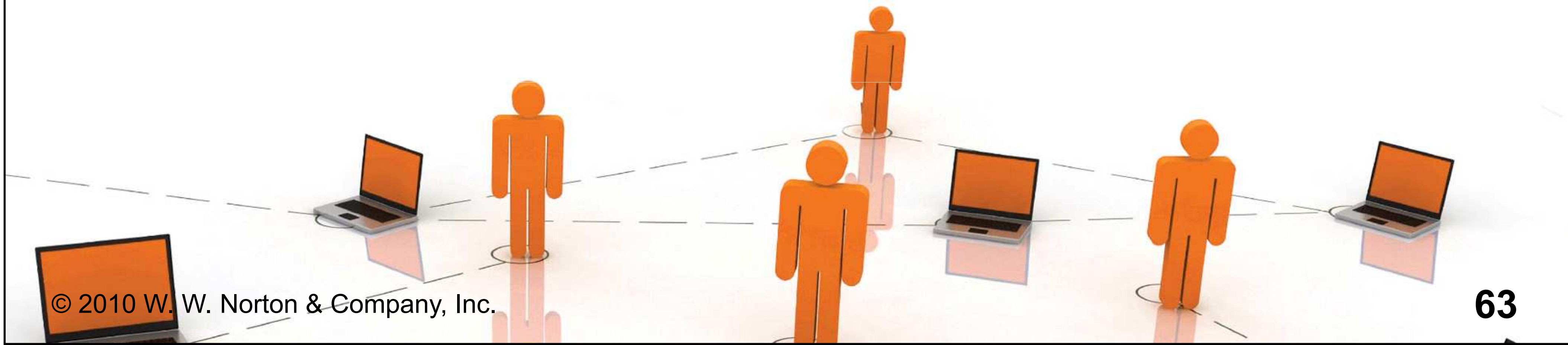
$$= p\left(\frac{p}{3w_1}\right)^{1/2} \tilde{x}_2^{1/2} - w_1\left(\frac{p}{3w_1}\right)^{3/2} \tilde{x}_2^{1/2} - w_2 \tilde{x}_2$$

Long-Run Profit-Maximization

$$\Pi = p y^* - w_1 x_1^* - w_2 \tilde{x}_2$$

$$= p\left(\frac{p}{3w_1}\right)^{1/2} \tilde{x}_2^{1/2} - w_1\left(\frac{p}{3w_1}\right)^{3/2} \tilde{x}_2^{1/2} - w_2 \tilde{x}_2$$

$$= p\left(\frac{p}{3w_1}\right)^{1/2} \tilde{x}_2^{1/2} - w_1 \frac{p}{3w_1}\left(\frac{p}{3w_1}\right)^{1/2} - w_2 \tilde{x}_2$$



Long-Run Profit-Maximization

$$\Pi = p y^{*} - w_1 x_1^{*} - w_2 \tilde{x}_2$$

$$= p\left(\frac{p}{3w_1}\right)^{1/2} \tilde{x}_2^{1/2} - w_1\left(\frac{p}{3w_1}\right)^{3/2} \tilde{x}_2^{1/2} - w_2 \tilde{x}_2$$

$$= p\left(\frac{p}{3w_1}\right)^{1/2} \tilde{x}_2^{1/2} - w_1 \frac{p}{3w_1}\left(\frac{p}{3w_1}\right)^{1/2} - w_2 \tilde{x}_2$$

$$= \frac{2p}{3}\left(\frac{p}{3w_1}\right)^{1/2} \tilde{x}_2^{1/2} - w_2 \tilde{x}_2$$

Long-Run Profit-Maximization

$$\Pi = p y^* - w_1 x_1^* - w_2 \tilde{x}_2$$

$$= p\left(\frac{p}{3w_1}\right)^{1/2} \tilde{x}_2^{1/2} - w_1\left(\frac{p}{3w_1}\right)^{3/2} \tilde{x}_2^{1/2} - w_2 \tilde{x}_2$$

$$= p\left(\frac{p}{3w_1}\right)^{1/2} \tilde{x}_2^{1/2} - w_1 \frac{p}{3w_1}\left(\frac{p}{3w_1}\right)^{1/2} - w_2 \tilde{x}_2$$

$$= \frac{2p}{3}\left(\frac{p}{3w_1}\right)^{1/2} \tilde{x}_2^{1/2} - w_2 \tilde{x}_2$$

$$= \left(\frac{4p^3}{27w_1}\right)^{1/2} \tilde{x}_2^{1/2} - w_2 \tilde{x}_2 .$$

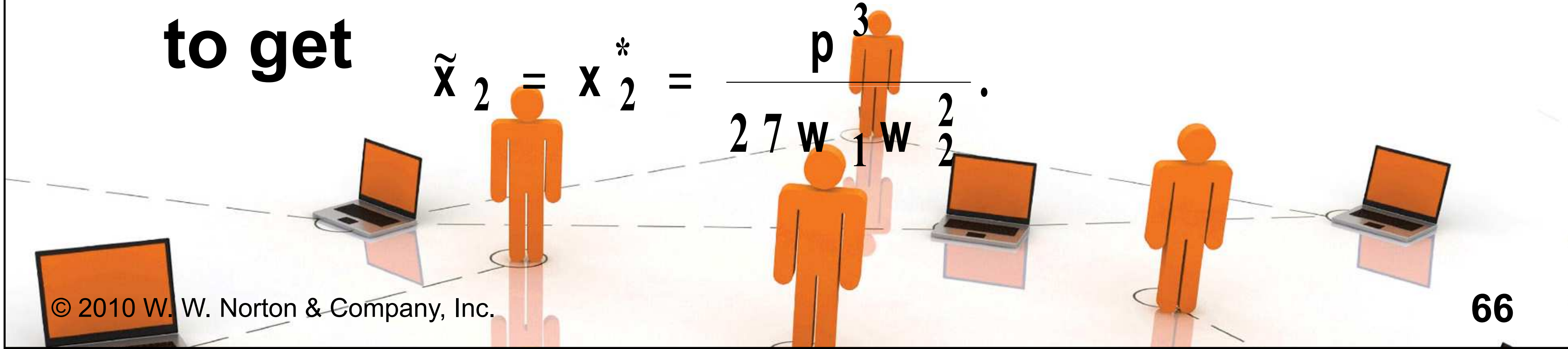
Long-Run Profit-Maximization

$$\Pi = \left(\frac{4p^3}{27w_1}\right)^{1/2} \tilde{x}_2^{1/2} - w_2\tilde{x}_2.$$

What is the long-run profit-maximizing level of input 2? Solve

$$0 = \frac{\partial \Pi}{\partial \tilde{x}_2} = \frac{1}{2}\left(\frac{4p^3}{27w_1}\right)^{1/2} \tilde{x}_2^{-1/2} - w_2$$

to get $\tilde{x}_2 = x_2^* = \dfrac{p^3}{27w_1w_2^2}.$



Long-Run Profit-Maximization

What is the long-run profit-maximizing input 1 level? Substitute

$$x_2^* = \frac{p^3}{27 w_1 w_2^2} \quad \text{into} \quad x_1^* = \left(\frac{p}{3w_1}\right)^{3/2} \tilde{x}_2^{1/2}$$

to get

Long-Run Profit-Maximization

What is the long-run profit-maximizing input 1 level? Substitute

$$x_2^* = \frac{p^3}{27 w_1 w_2^2} \quad \text{into} \quad x_1^* = \left(\frac{p}{3w_1}\right)^{3/2} \tilde{x}_2^{1/2}$$

to get

$$x_1^* = \left(\frac{p}{3w_1}\right)^{3/2} \left(\frac{p^3}{27 w_1 w_2^2}\right)^{1/2} = \frac{p^3}{27 w_1^2 w_2}.$$

Long-Run Profit-Maximization

What is the long-run profit-maximizing output level? Substitute

$$x_2^* = \frac{p^3}{27 w_1 w_2^2} \quad \text{into} \quad y^* = \left(\frac{p}{3w_1}\right)^{1/2} \tilde{x}_2^{1/2}$$

to get

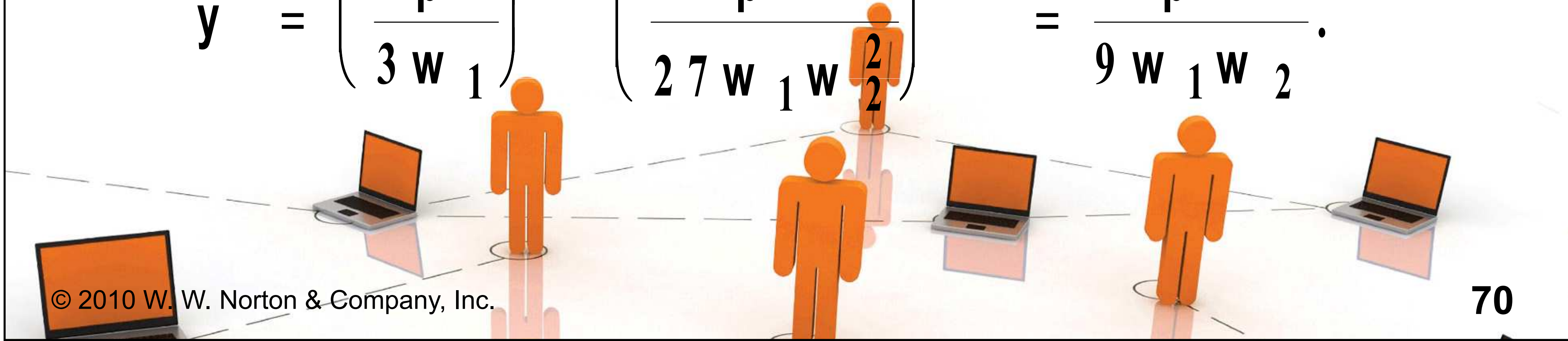
Long-Run Profit-Maximization

What is the long-run profit-maximizing output level? Substitute

$$x_2^* = \frac{p^3}{27 w_1 w_2^2} \quad \textbf{into} \quad y^* = \left(\frac{p}{3w_1}\right)^{1/2} \tilde{x}_2^{1/2}$$

to get

$$y^* = \left(\frac{p}{3w_1}\right)^{1/2} \left(\frac{p^3}{27 w_1 w_2^2}\right)^{1/2} = \frac{p^2}{9 w_1 w_2}.$$



Long-Run Profit-Maximization

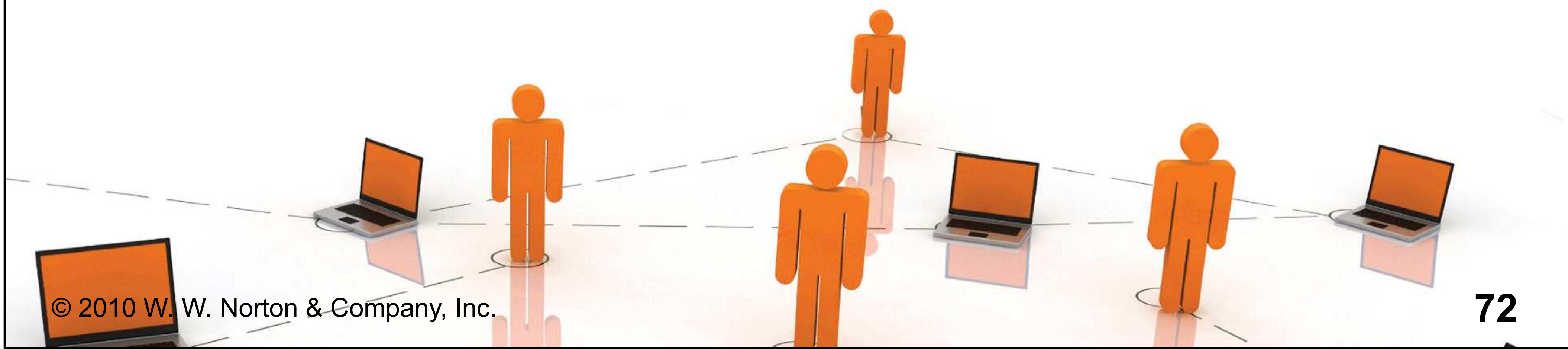
So given the prices p, w_1 and w_2, and the production function $y = x_1^{1/3} x_2^{1/3}$

the long-run profit-maximizing production plan is

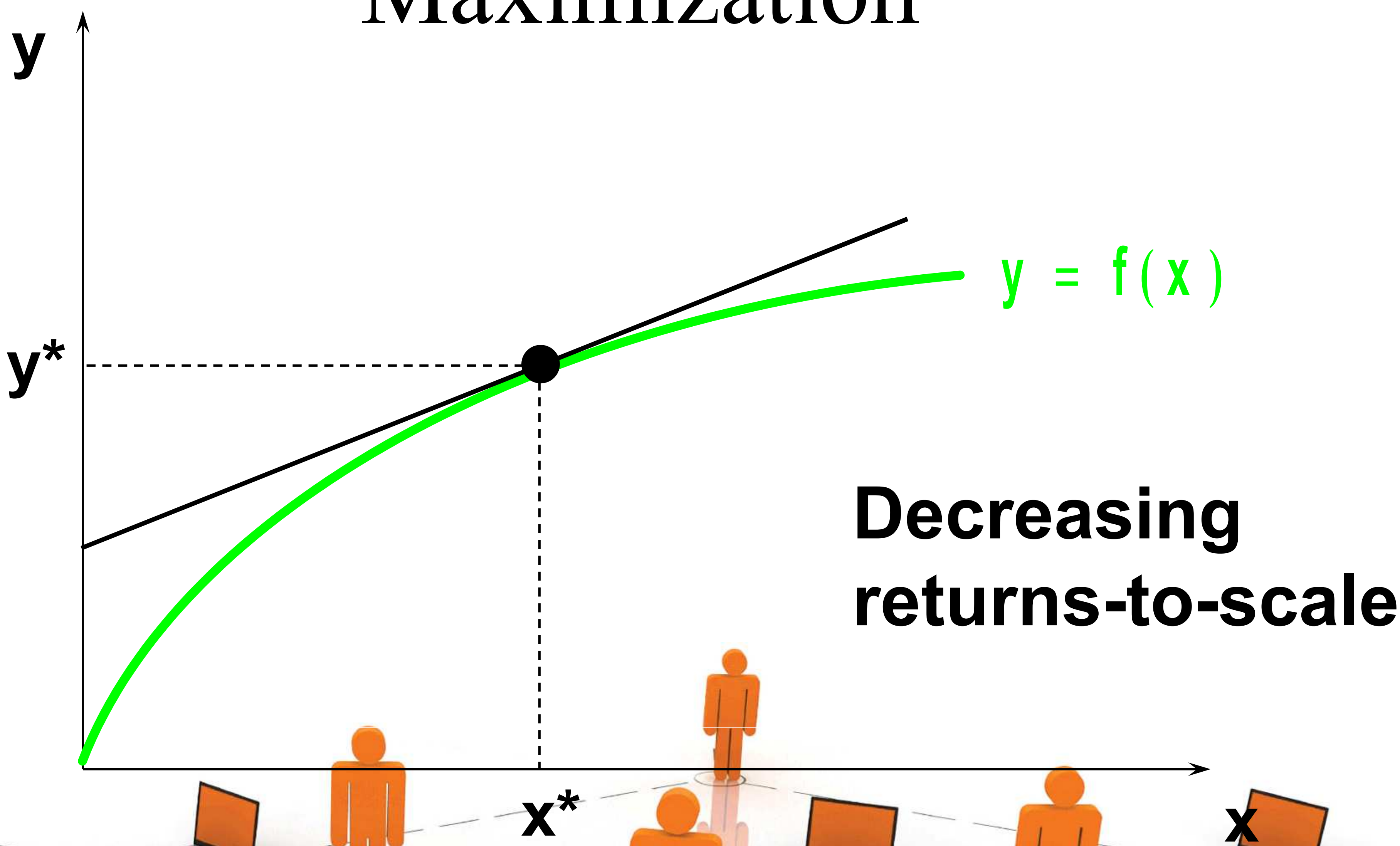
$$(x_1^*, x_2^*, y^*) = \left(\frac{p^3}{27 w_1^2 w_2}, \frac{p^3}{27 w_1 w_2^2}, \frac{p^2}{9 w_1 w_2} \right).$$

Returns-to-Scale and Profit-Maximization

- **If a competitive firm's technology exhibits decreasing returns-to-scale then the firm has a single long-run profit-maximizing production plan.**



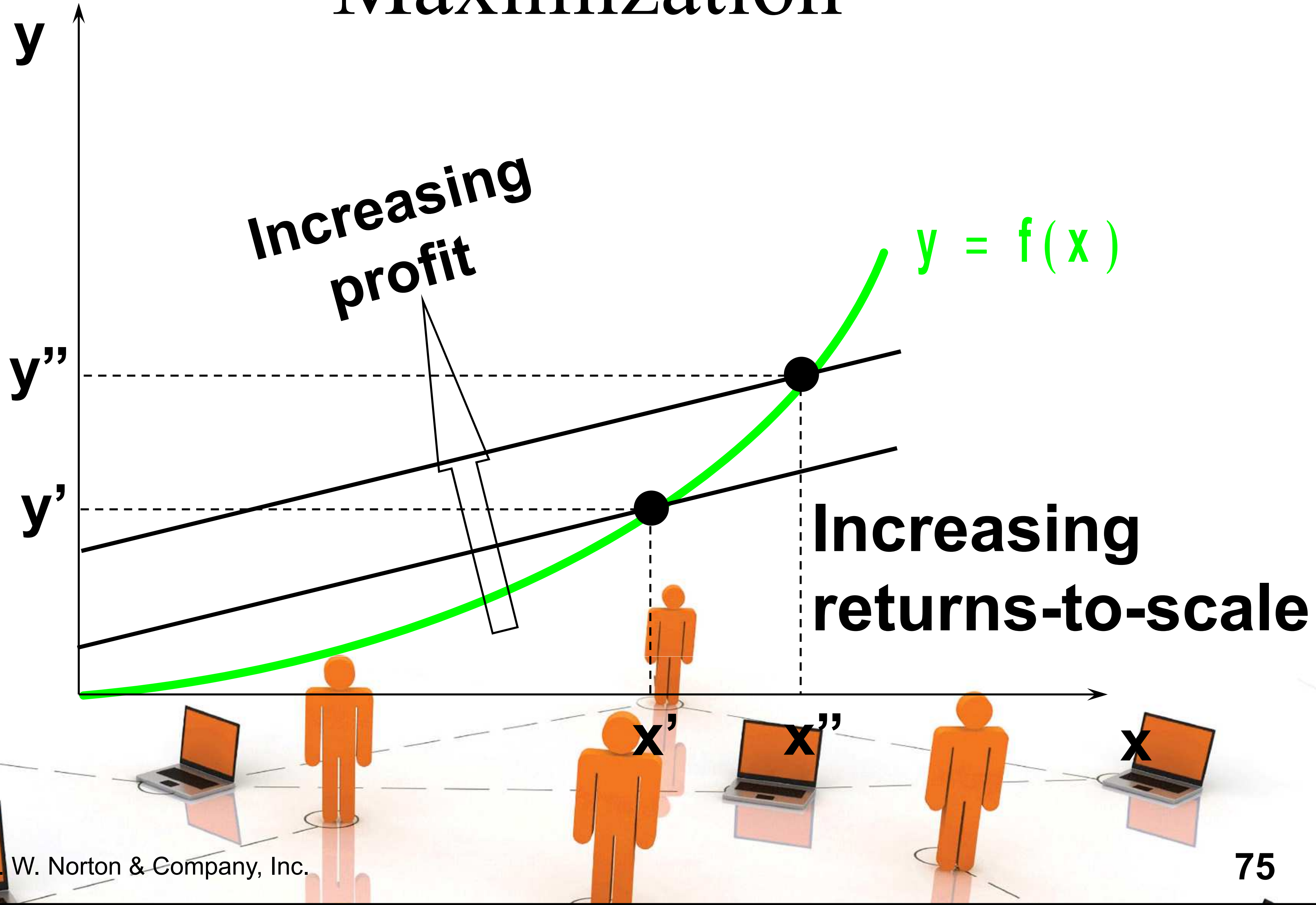
Returns-to Scale and Profit-Maximization



Returns-to-Scale and Profit-Maximization

- **If a competitive firm's technology exhibits exhibits increasing returns-to-scale then the firm does not have a profit-maximizing plan.**

Returns-to Scale and Profit-Maximization



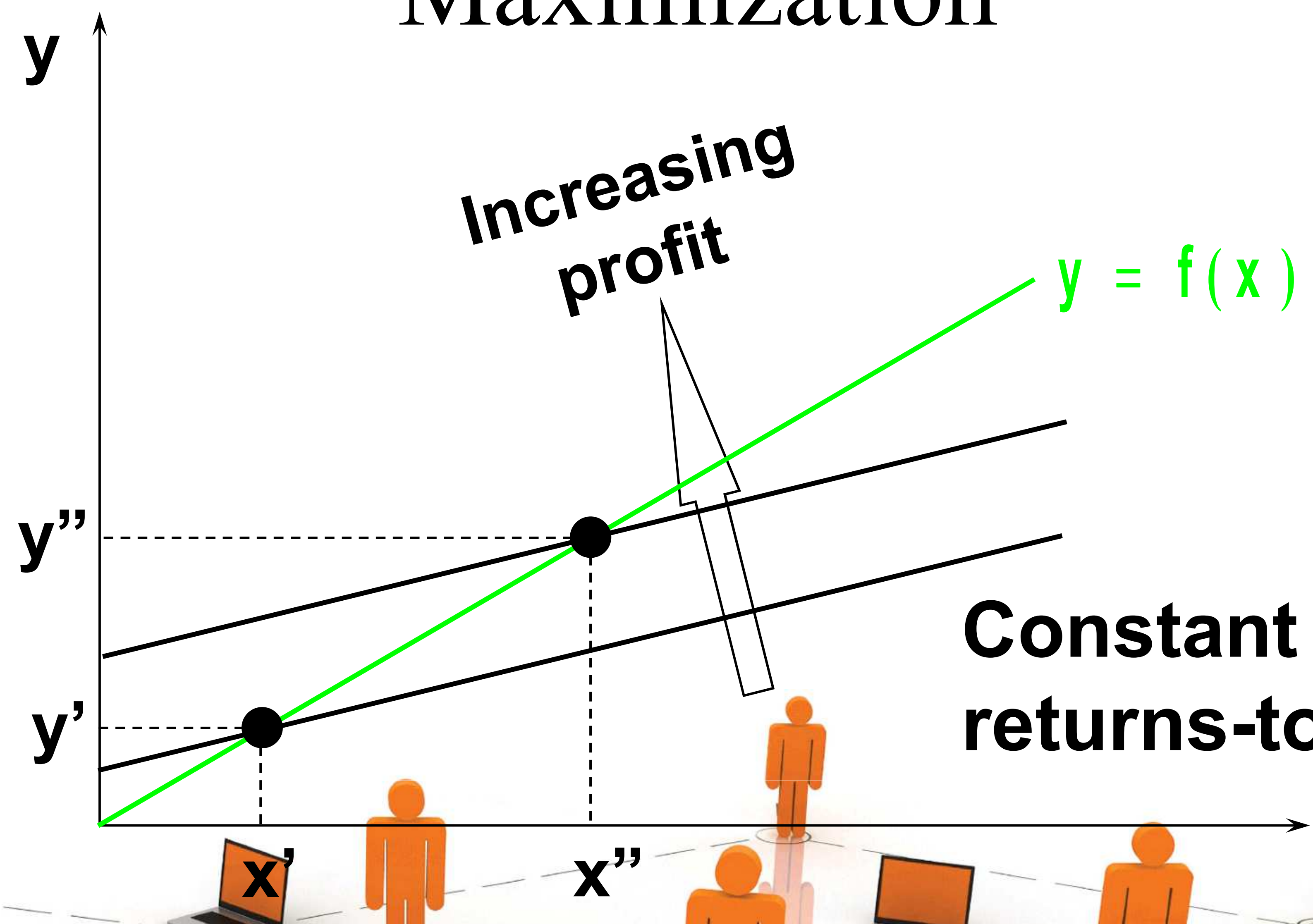
Returns-to-Scale and Profit-Maximization

- **So an increasing returns-to-scale technology is inconsistent with firms being perfectly competitive.**

Returns-to-Scale and Profit-Maximization

- **What if the competitive firm’s technology exhibits constant returns-to-scale?**

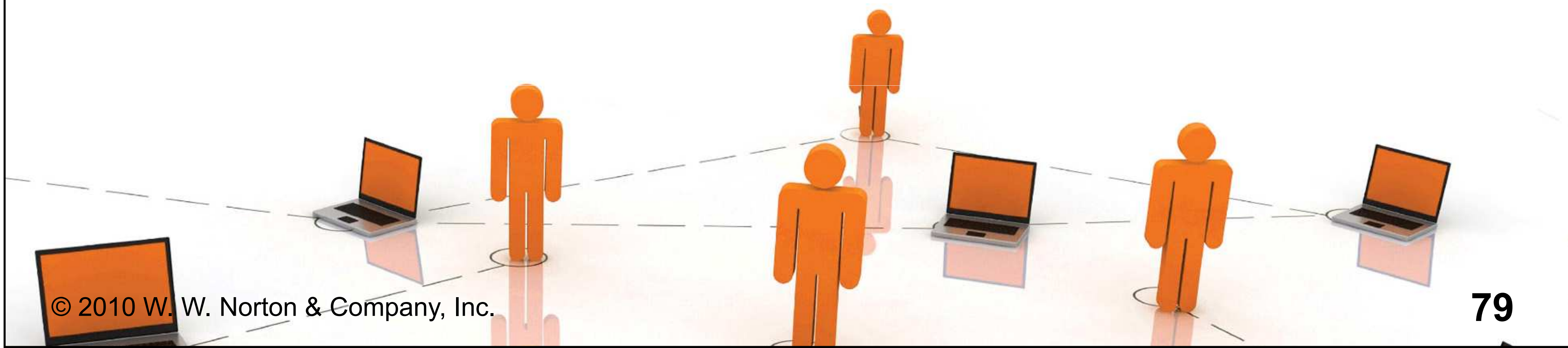
Returns-to Scale and Profit-Maximization



Constant returns-to-scale

Returns-to Scale and Profit-Maximization

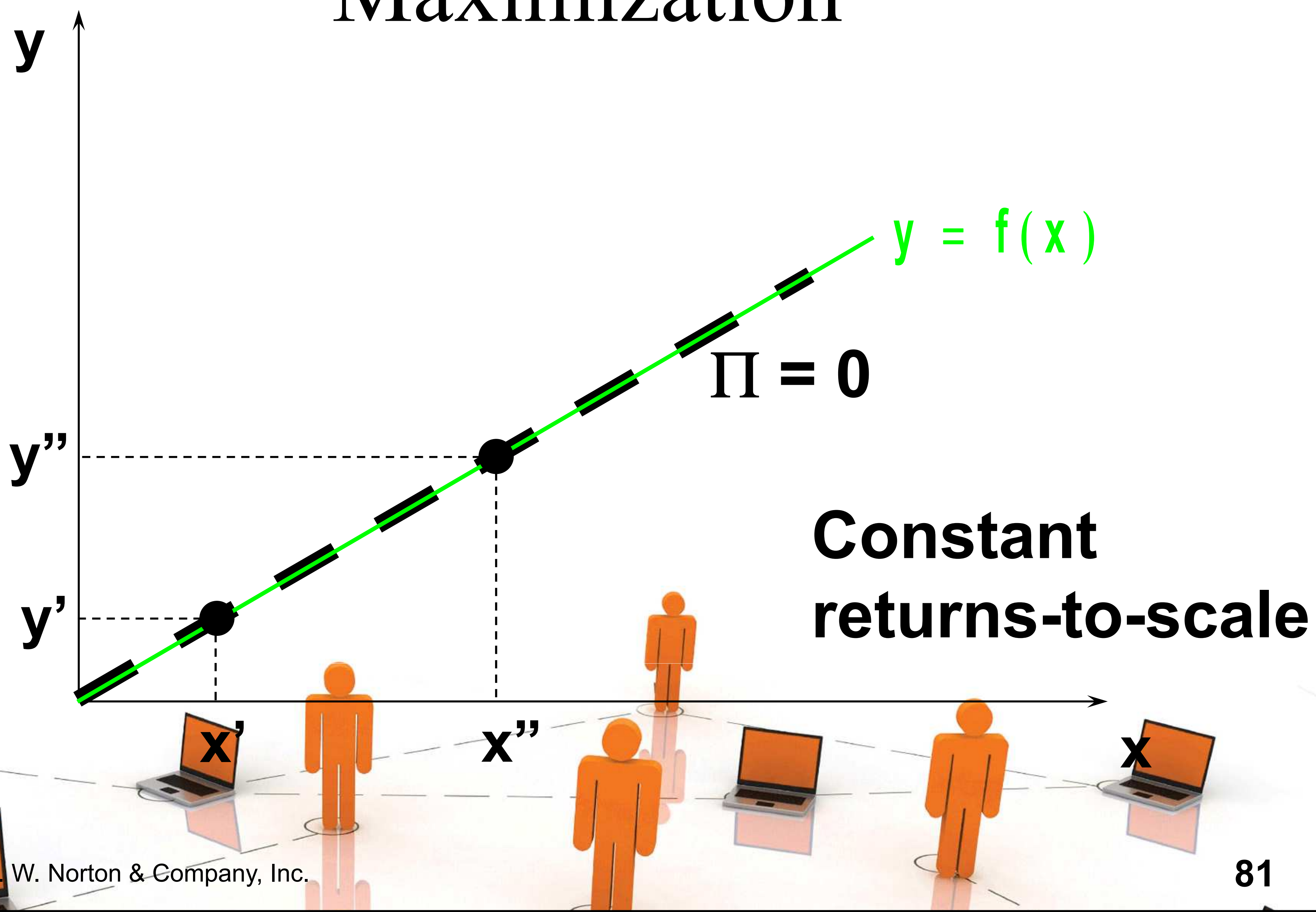
- So if any production plan earns a positive profit, the firm can double up all inputs to produce twice the original output and earn twice the original profit.



Returns-to Scale and Profit-Maximization

- Therefore, when a firm's technology exhibits constant returns-to-scale, earning a positive economic profit is inconsistent with firms being perfectly competitive.
- Hence constant returns-to-scale requires that competitive firms earn economic profits of zero.

Returns-to Scale and Profit-Maximization

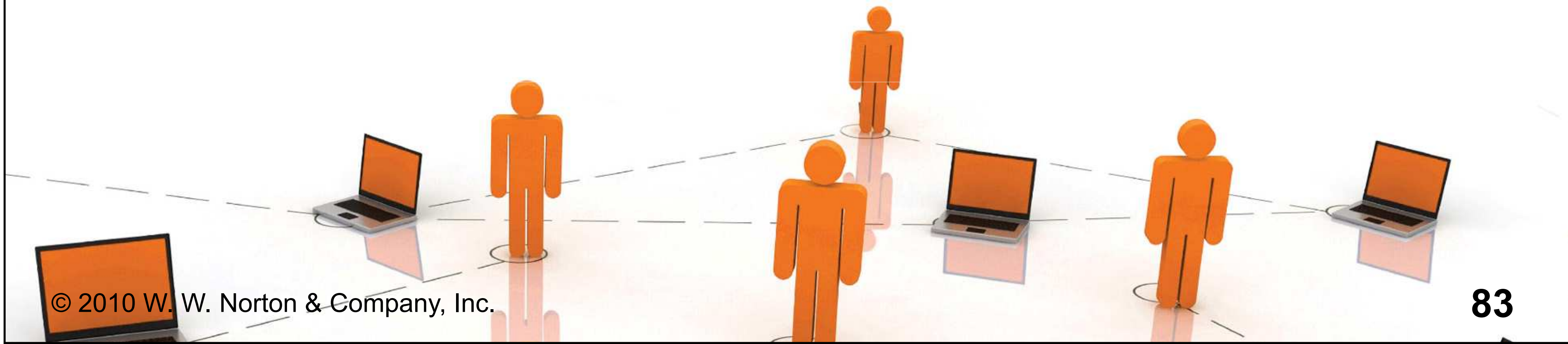


Revealed Profitability

- Consider a competitive firm with a technology that exhibits decreasing returns-to-scale.
- For a variety of output and input prices we observe the firm's choices of production plans.
- What can we learn from our observations?

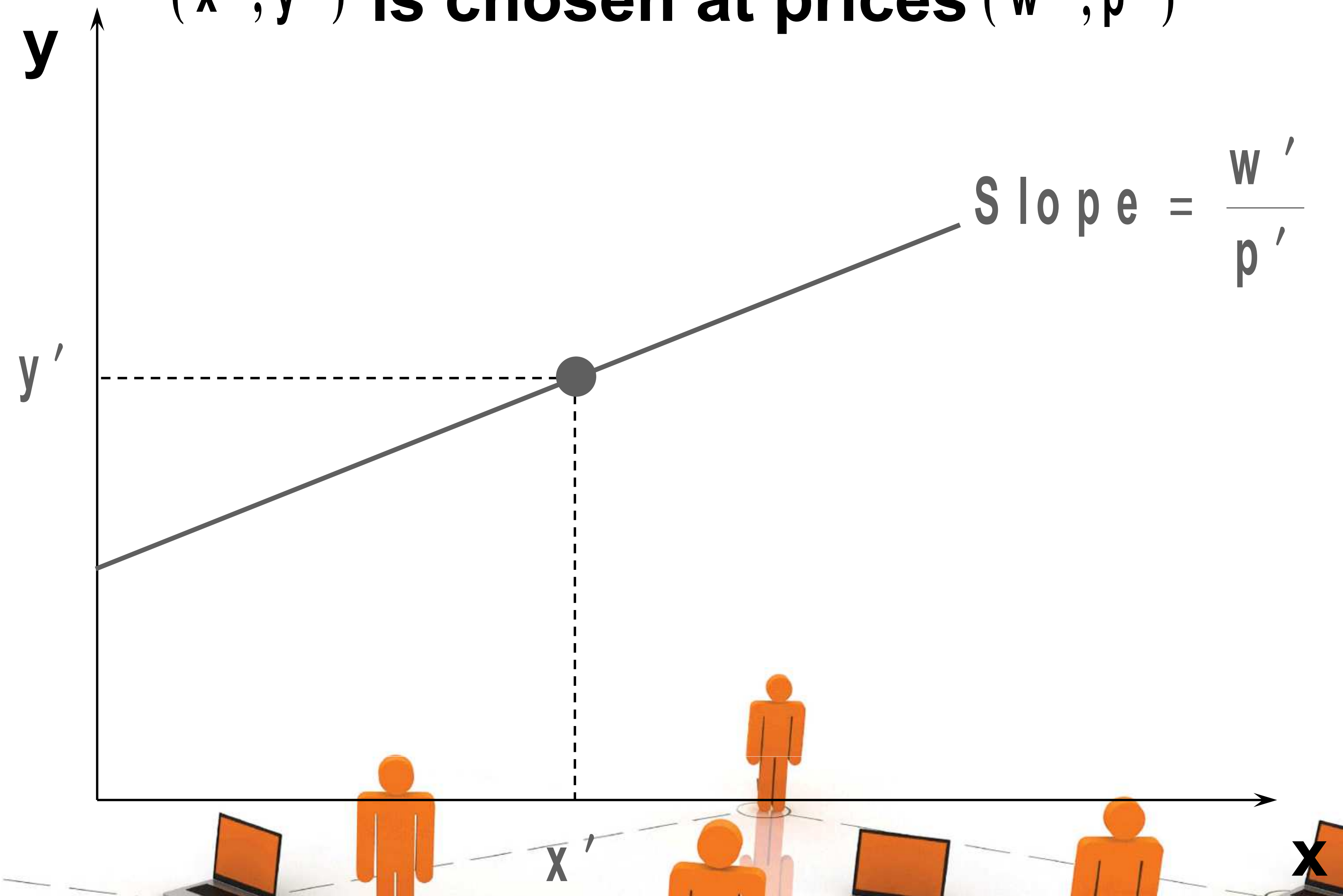
Revealed Profitability

- If a production plan (x’,y’) is chosen at prices (w’,p’) we deduce that the plan (x’,y’) is revealed to be profit-maximizing for the prices (w’,p’).



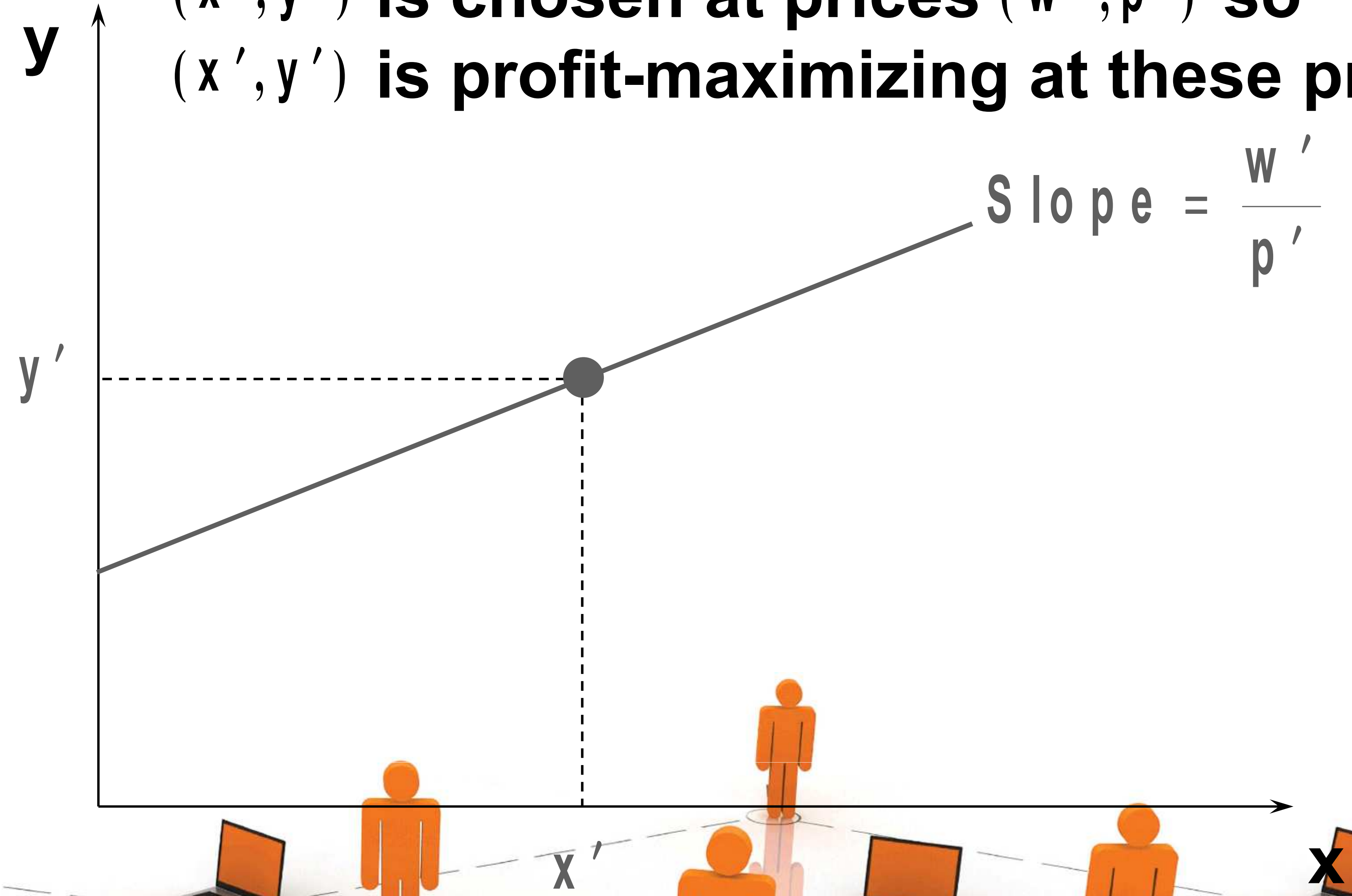
Revealed Profitability

(x',y') is chosen at prices (w',p')



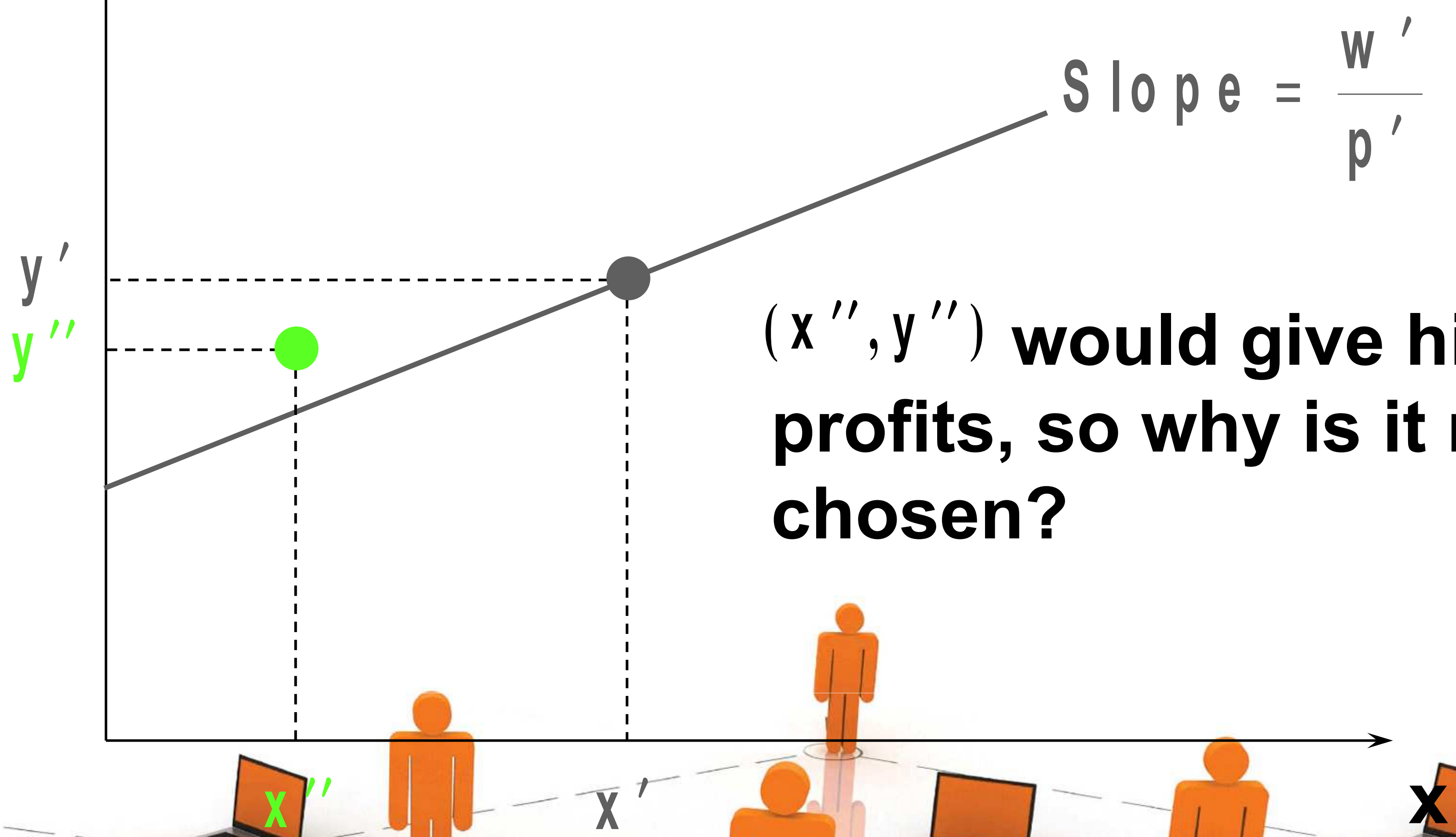
Revealed Profitability

(x', y') is chosen at prices (w', p') so (x', y') is profit-maximizing at these prices.



Revealed Profitability

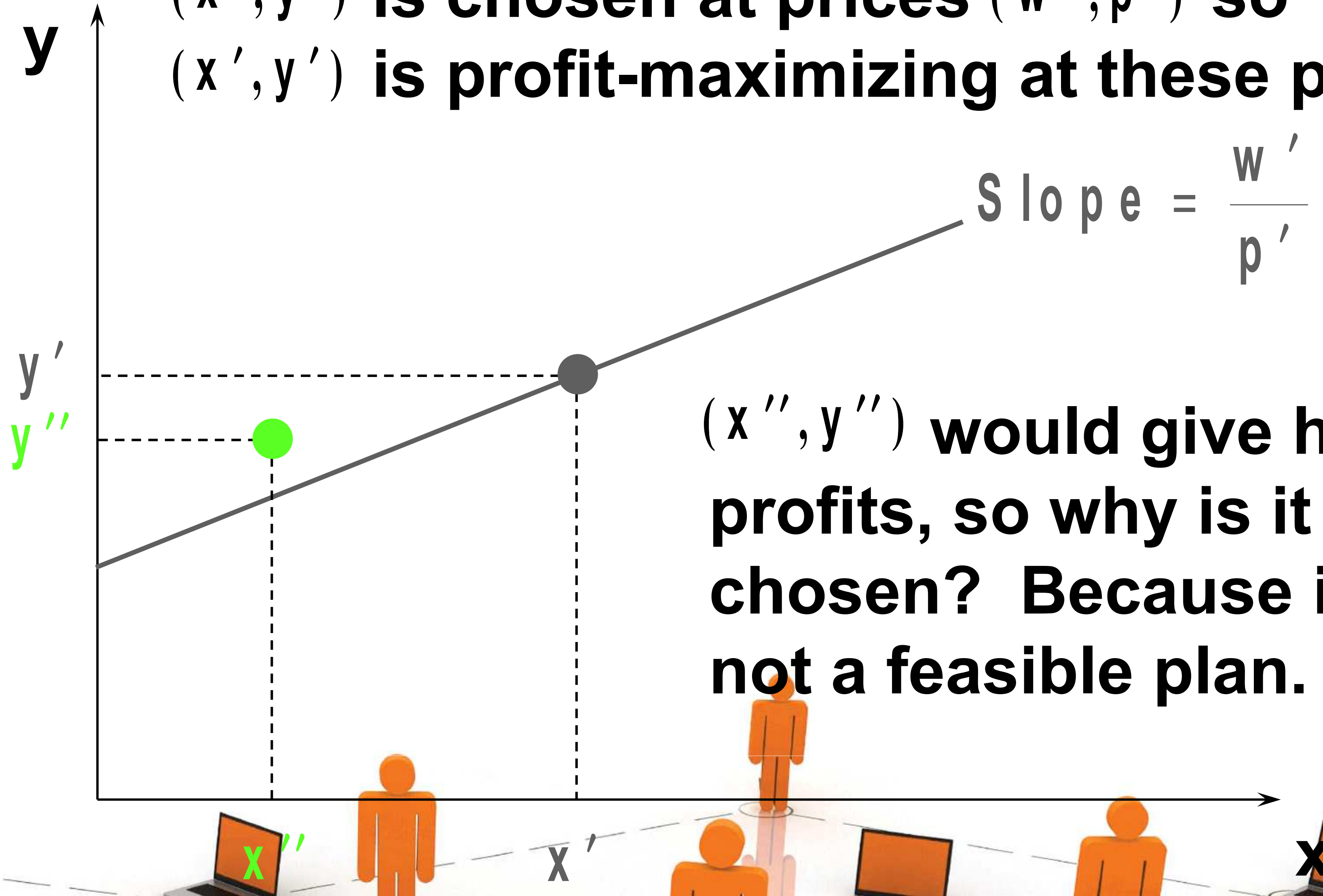
(x', y') is chosen at prices (w', p') so (x', y') is profit-maximizing at these prices.



(x'', y'') would give higher profits, so why is it not chosen?

Revealed Profitability

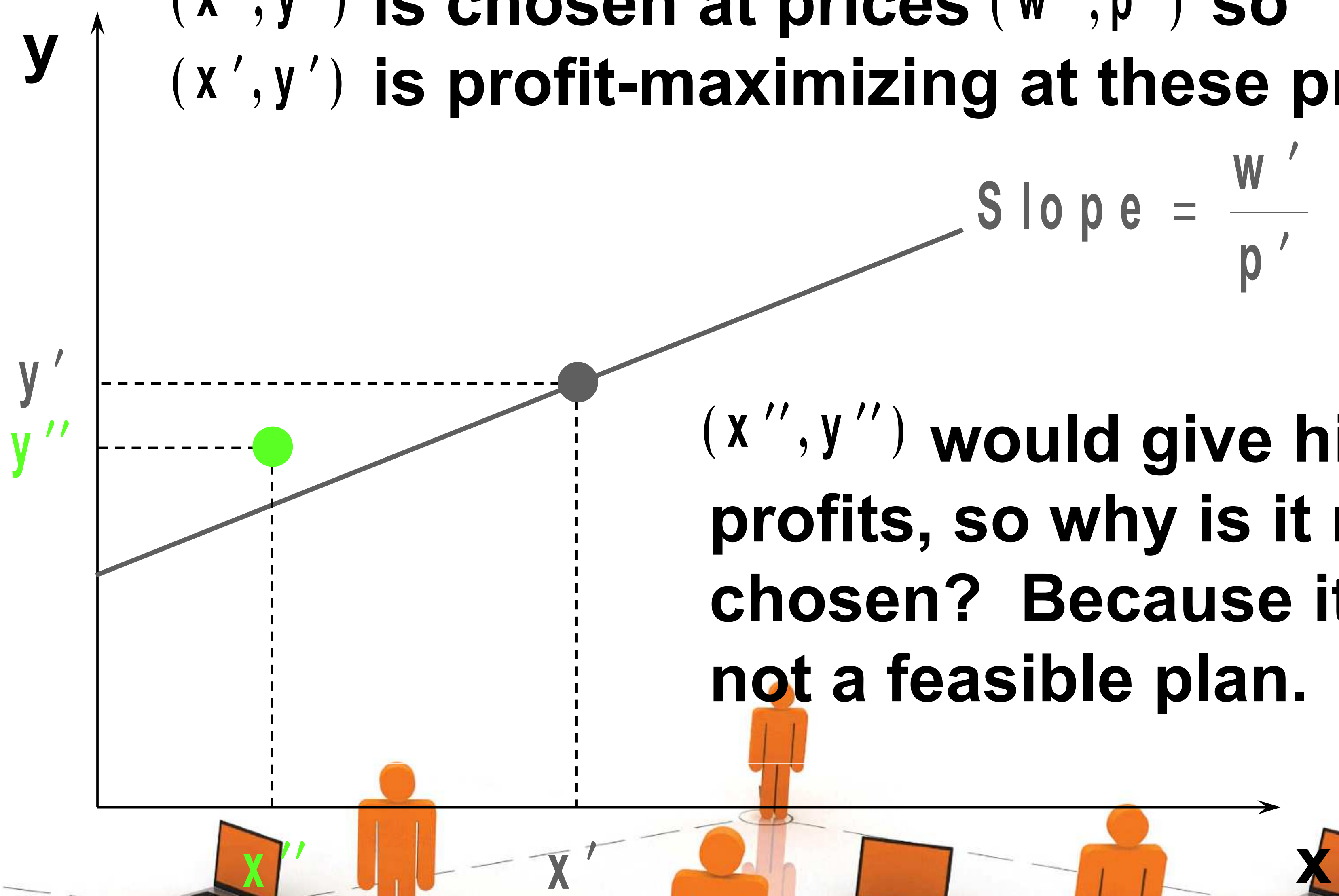
(x', y') **is chosen at prices** (w', p') **so** (x', y') **is profit-maximizing at these prices.**



(x'', y'') **would give higher profits, so why is it not chosen? Because it is not a feasible plan.**

Revealed Profitability

(x', y') is chosen at prices (w', p') so (x', y') is profit-maximizing at these prices.

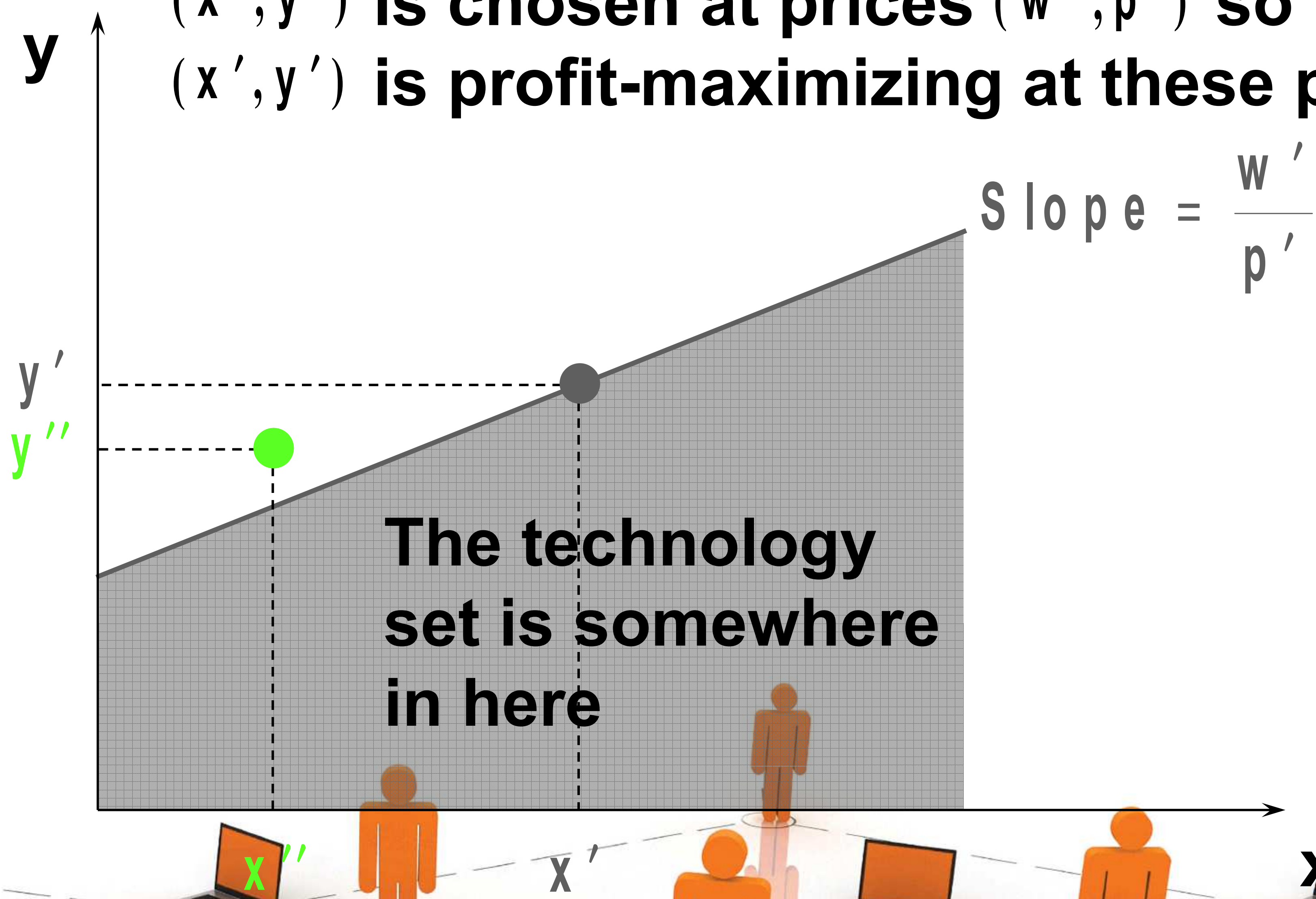


(x'', y'') would give higher profits, so why is it not chosen? Because it is not a feasible plan.

So the firm's technology set must lie under the iso-profit line.

Revealed Profitability

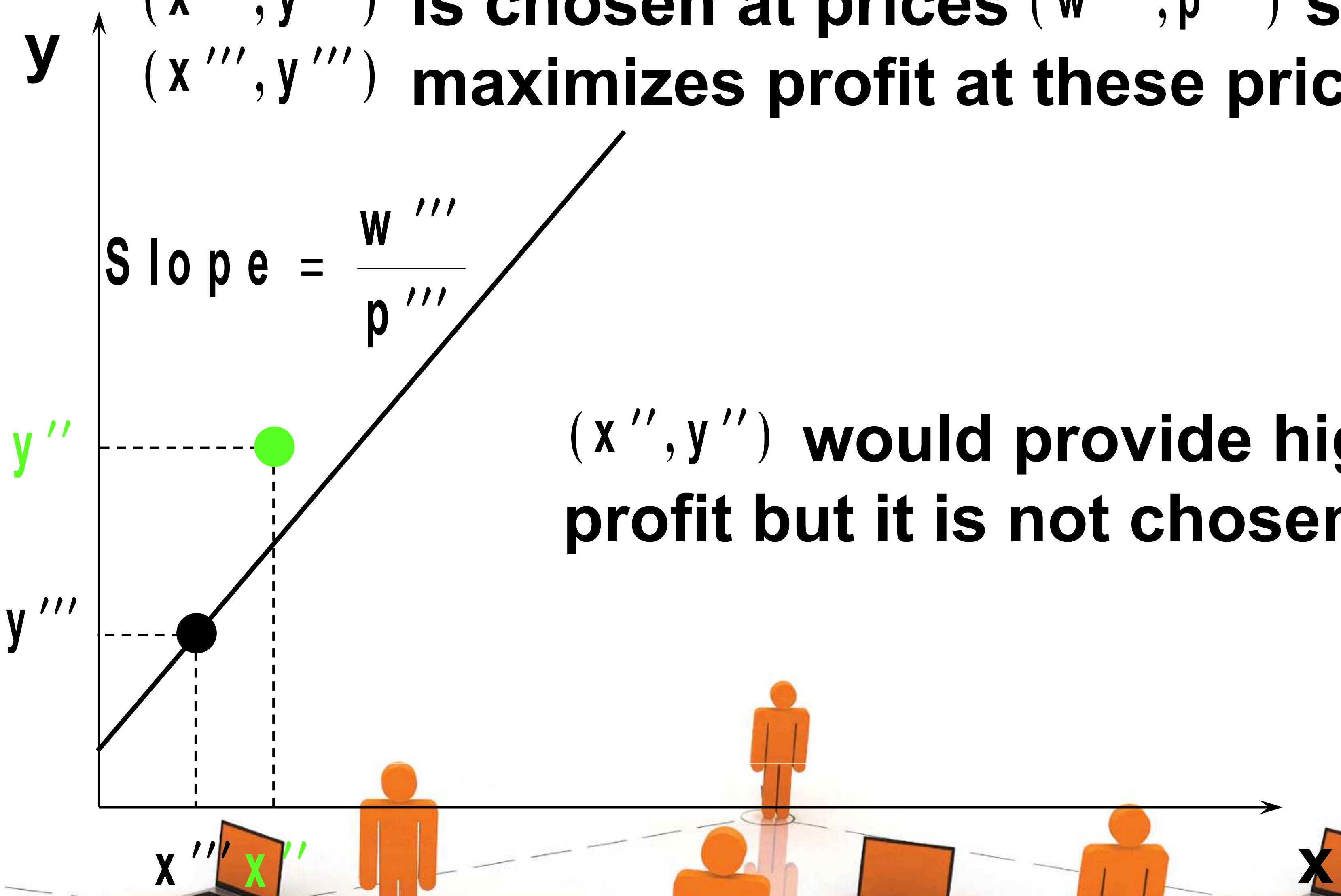
(x', y') is chosen at prices (w', p') so (x', y') is profit-maximizing at these prices.



So the firm's technology set must lie under the iso-profit line.

Revealed Profitability

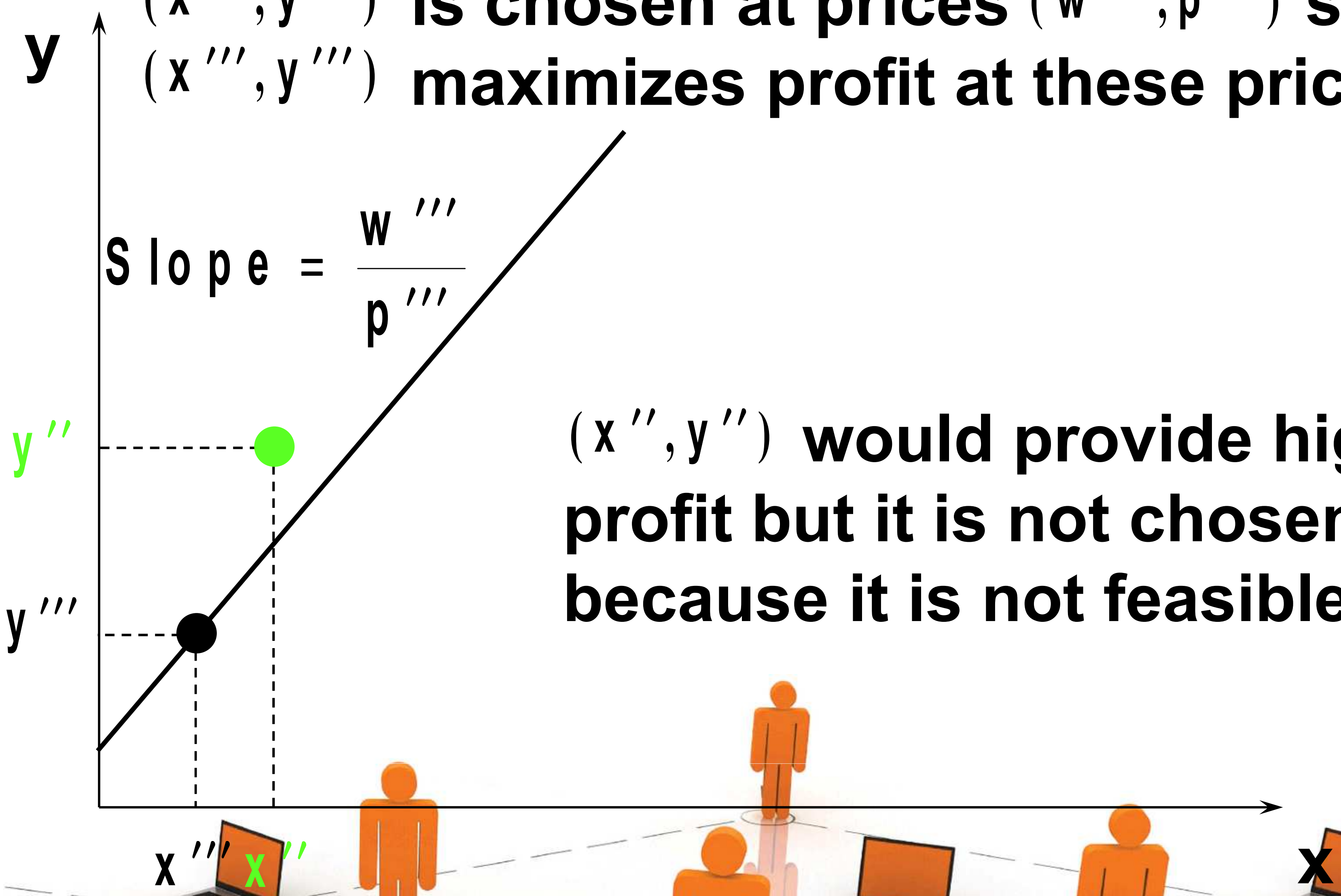
(x''', y''') **is chosen at prices** (w''', p''') **so** (x''', y''') **maximizes profit at these prices.**



(x'', y'') **would provide higher profit but it is not chosen**

Revealed Profitability

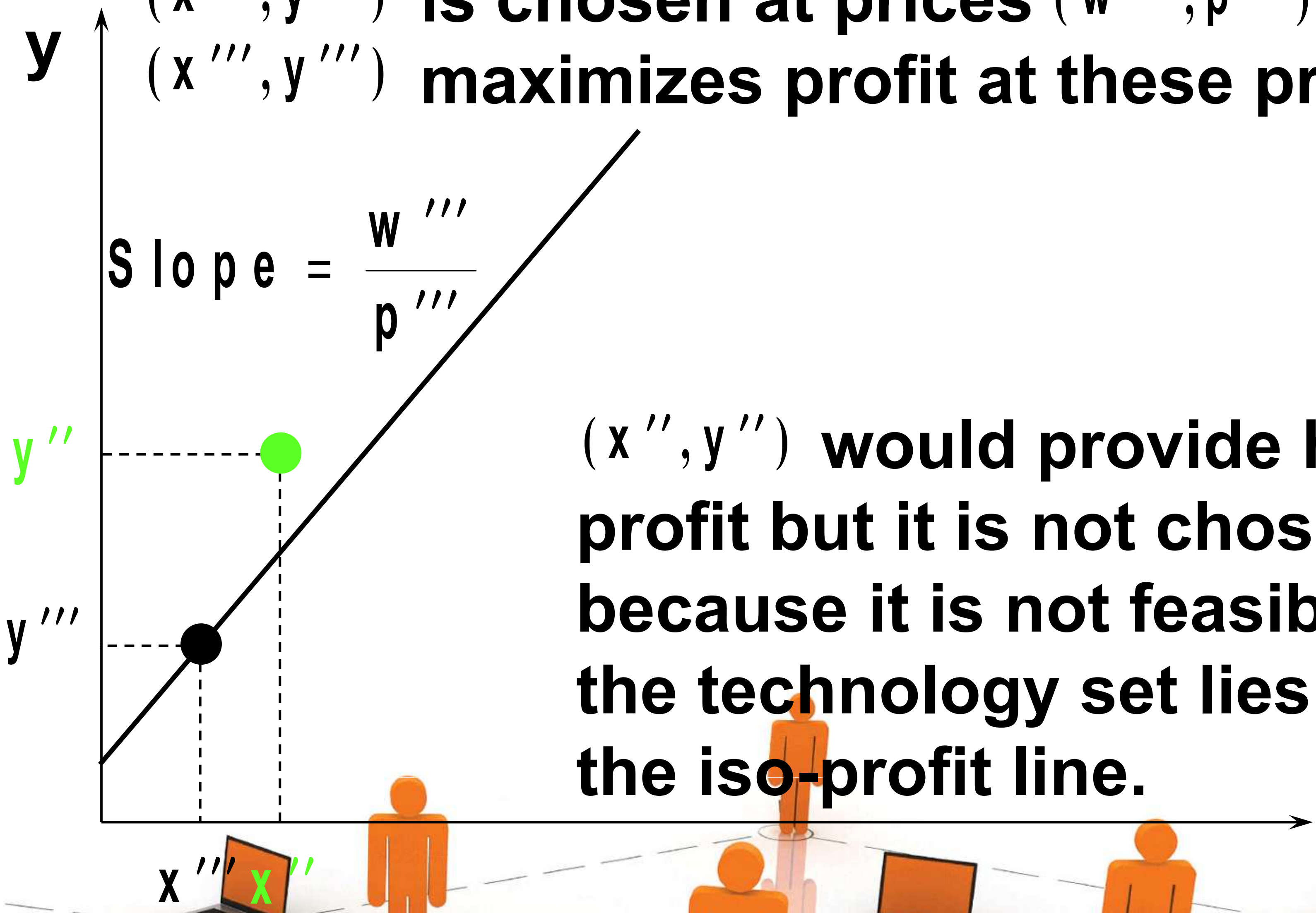
(x''',y''') **is chosen at prices** (w''',p''') **so** (x''',y''') **maximizes profit at these prices.**



(x'',y'') **would provide higher profit but it is not chosen because it is not feasible**

Revealed Profitability

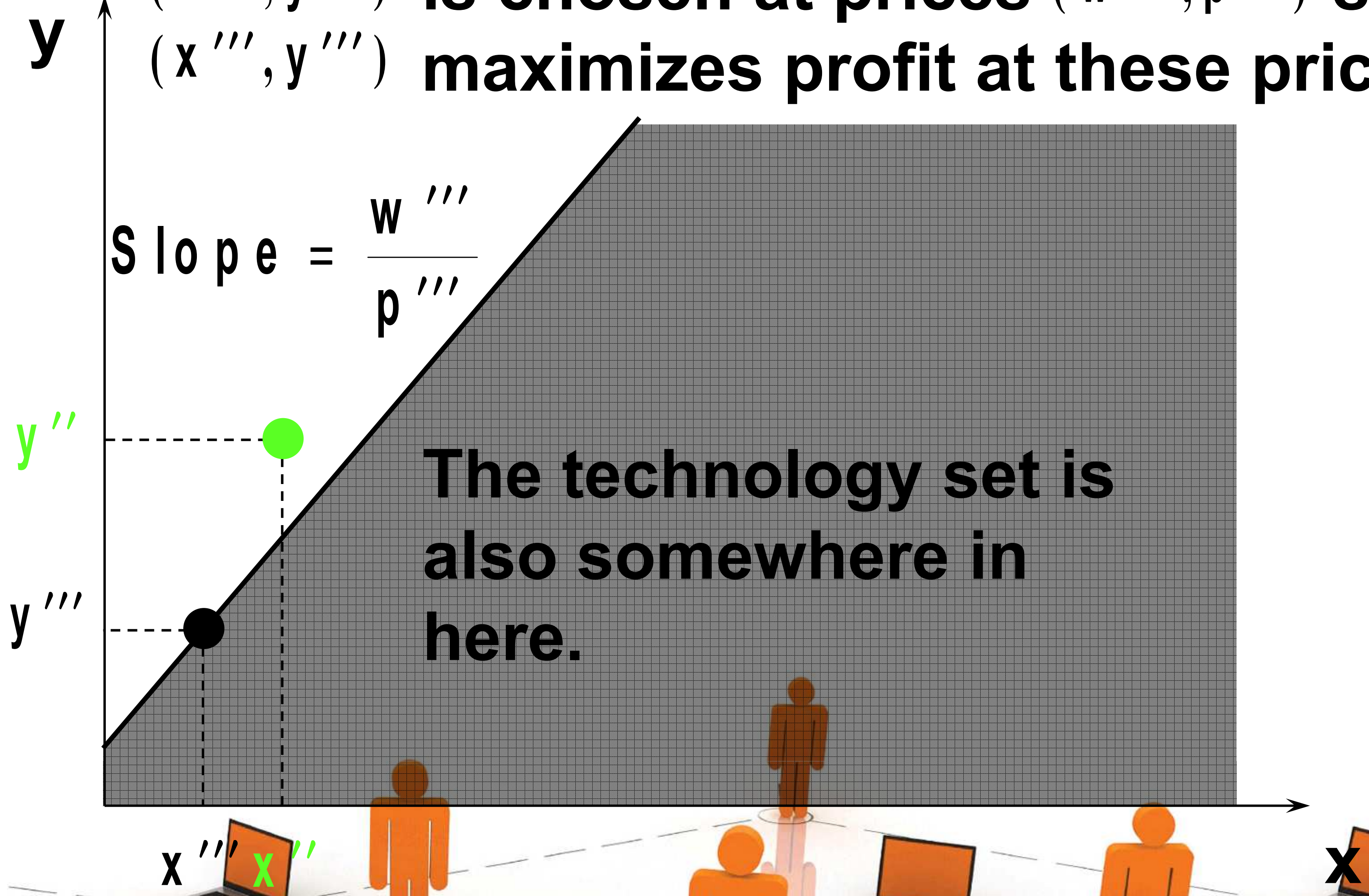
(x''', y''') **is chosen at prices** (w''', p''') **so** (x''', y''') **maximizes profit at these prices.**



(x'', y'') **would provide higher profit but it is not chosen because it is not feasible so the technology set lies under the iso-profit line.**

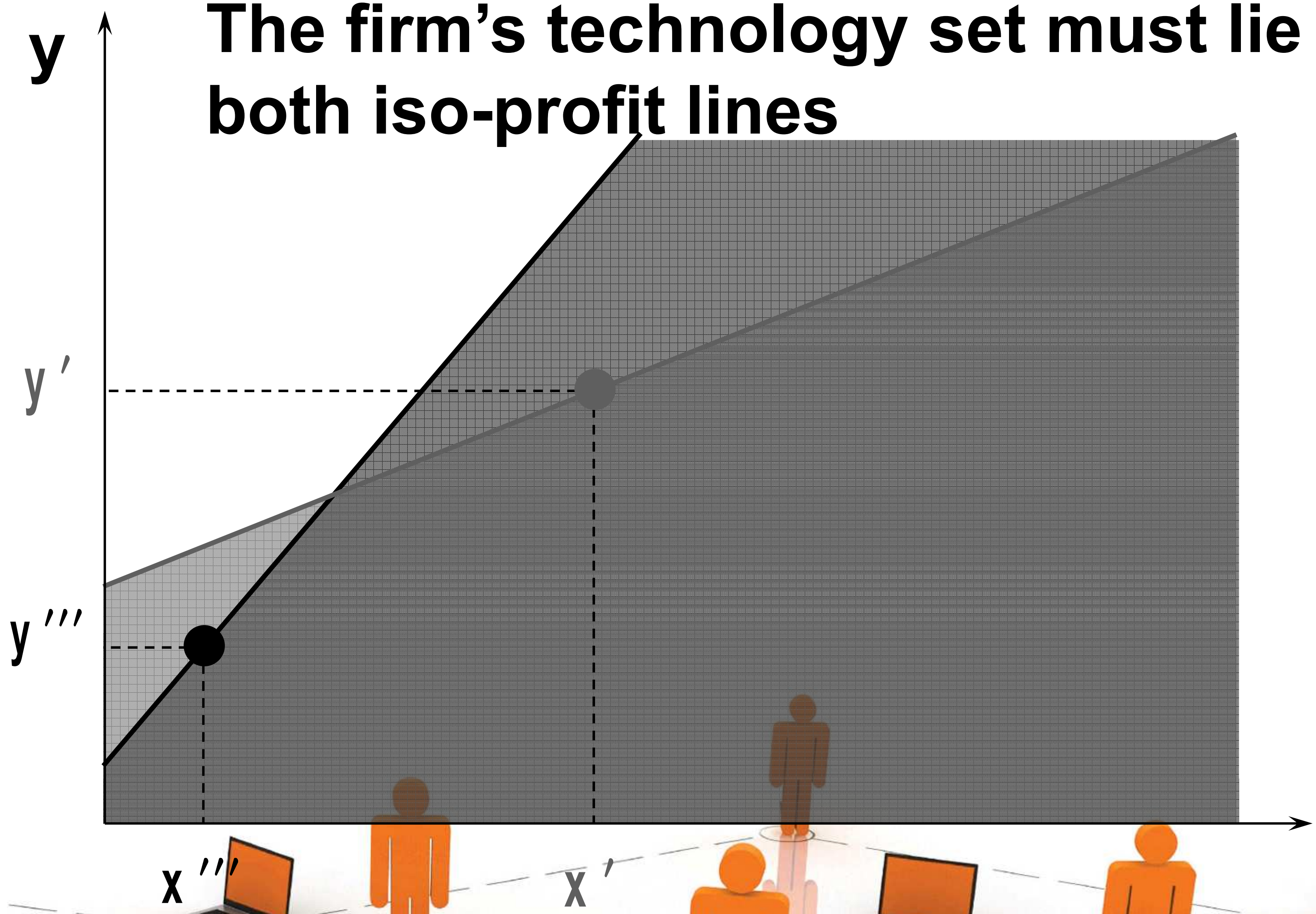
Revealed Profitability

(x''', y''') **is chosen at prices** (w''', p''') **so** (x''', y''') **maximizes profit at these prices.**

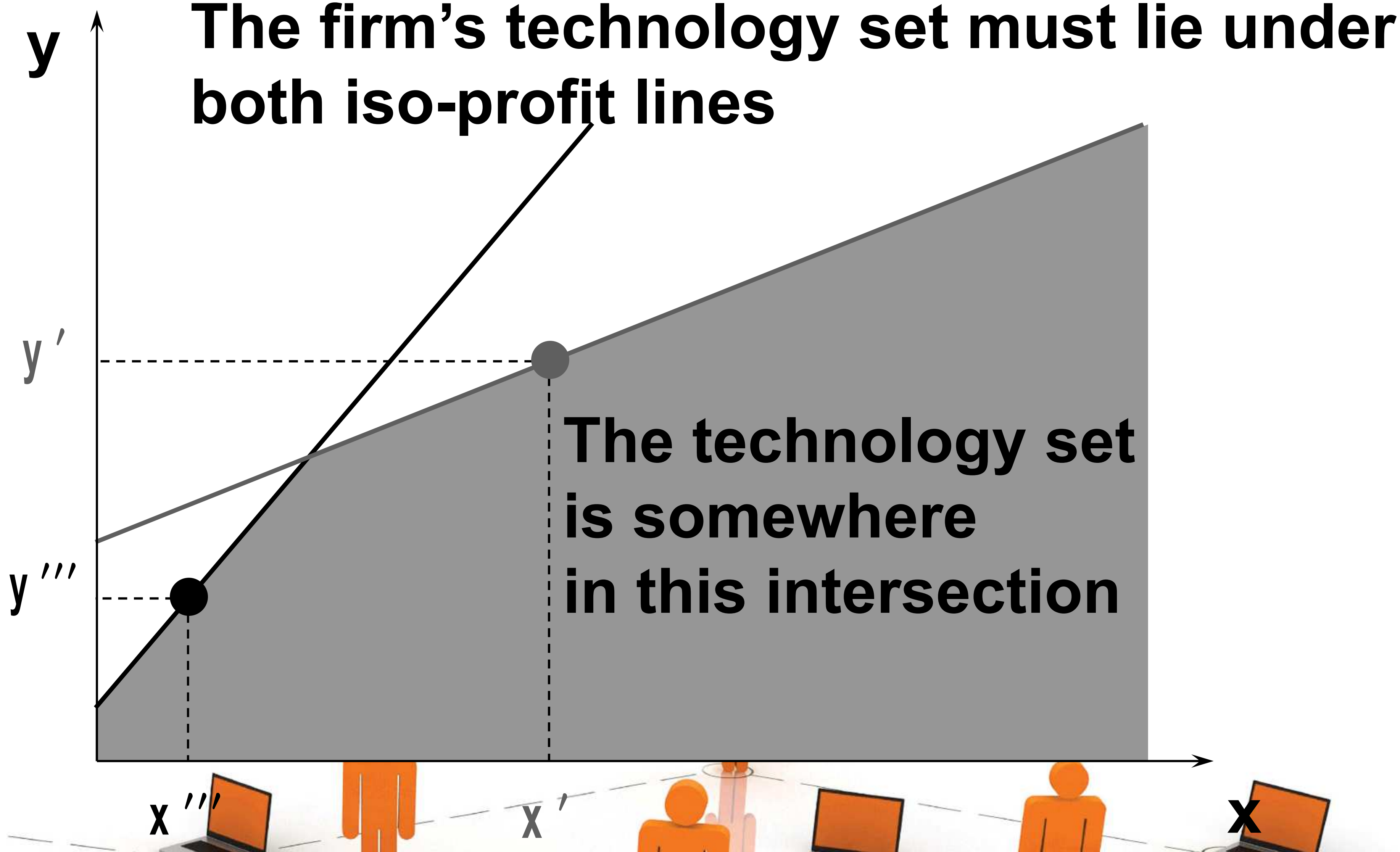


Revealed Profitability

The firm's technology set must lie under both iso-profit lines



Revealed Profitability

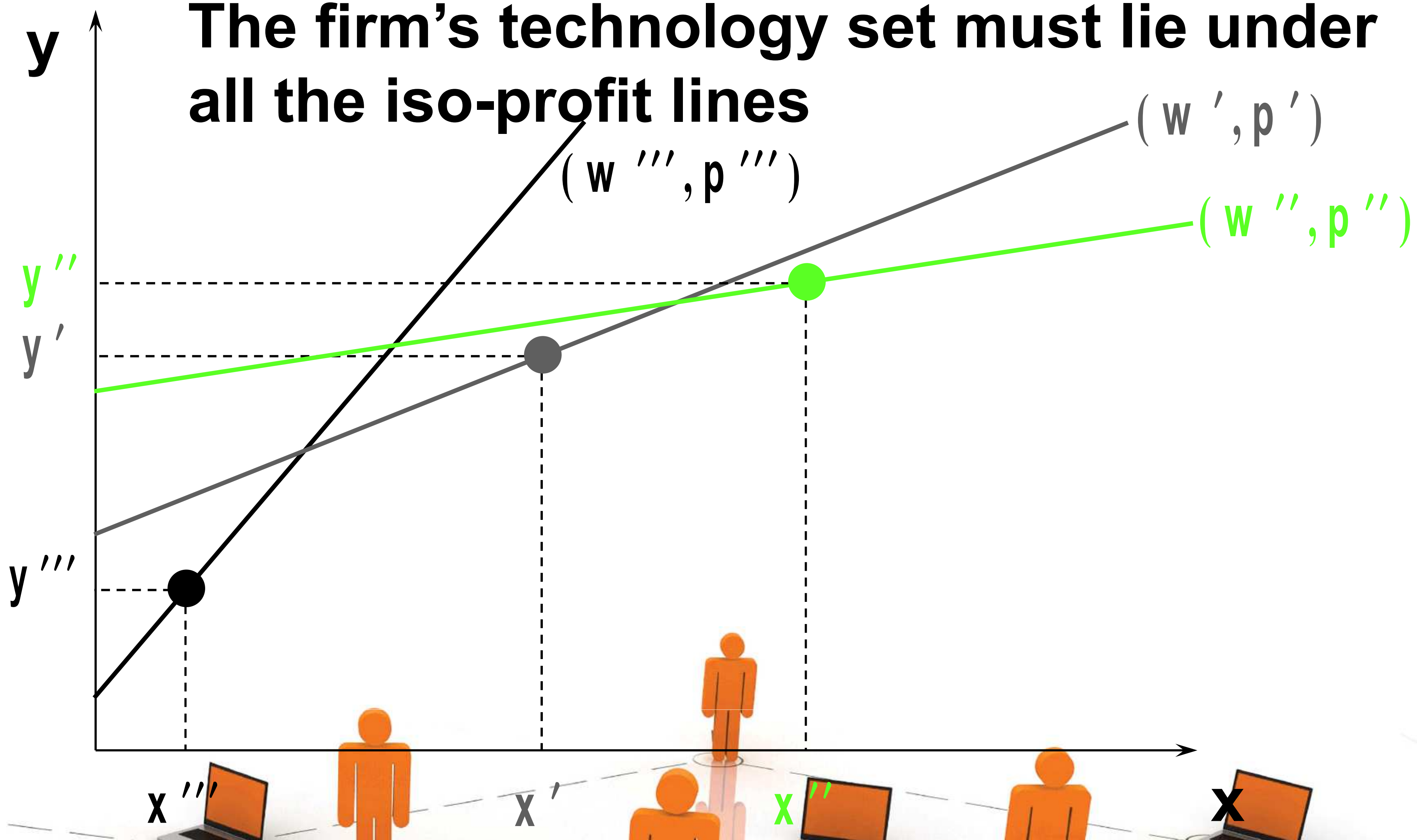


Revealed Profitability

- **Observing more choices of production plans by the firm in response to different prices for its input and its output gives more information on the location of its technology set.**

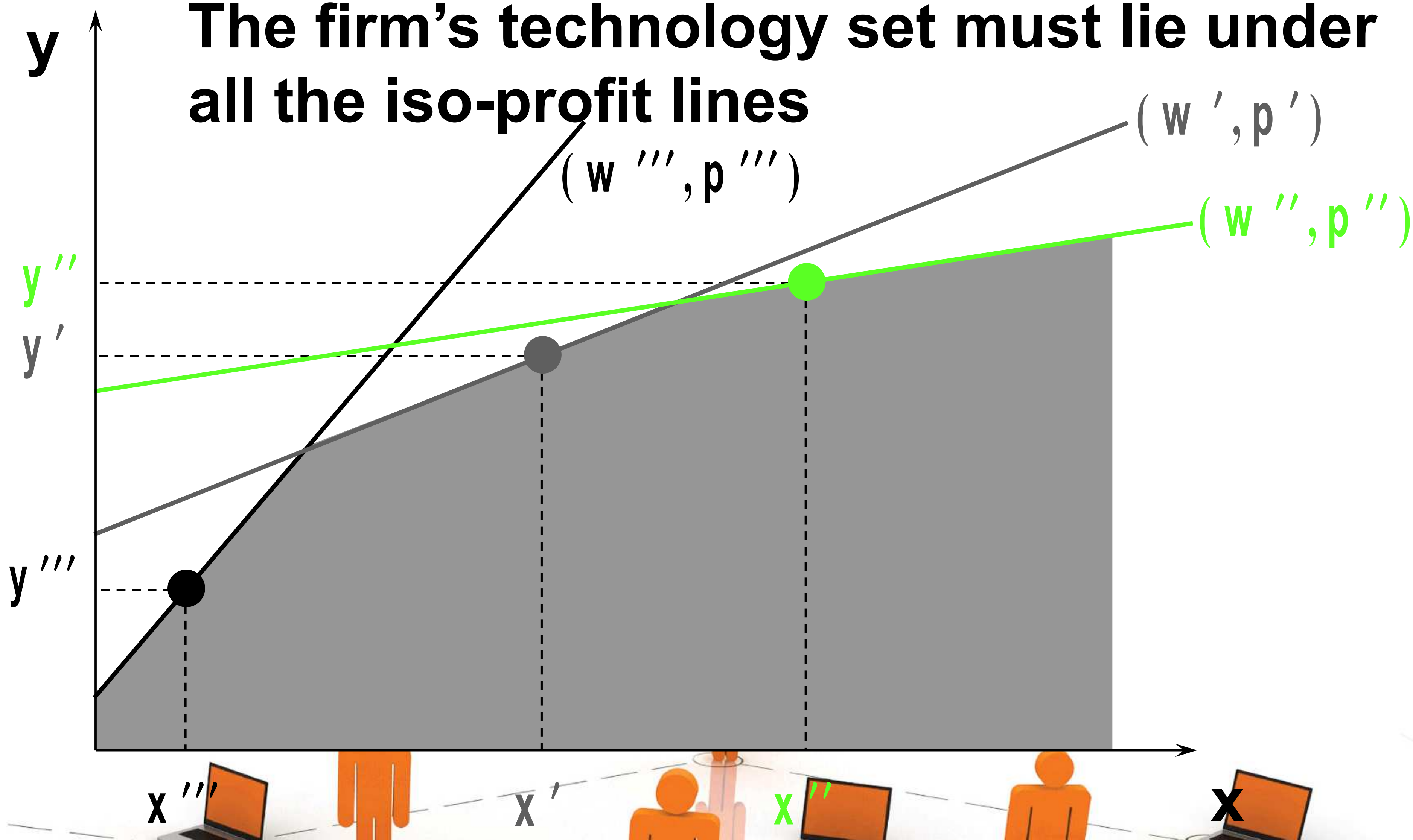
Revealed Profitability

The firm's technology set must lie under all the iso-profit lines



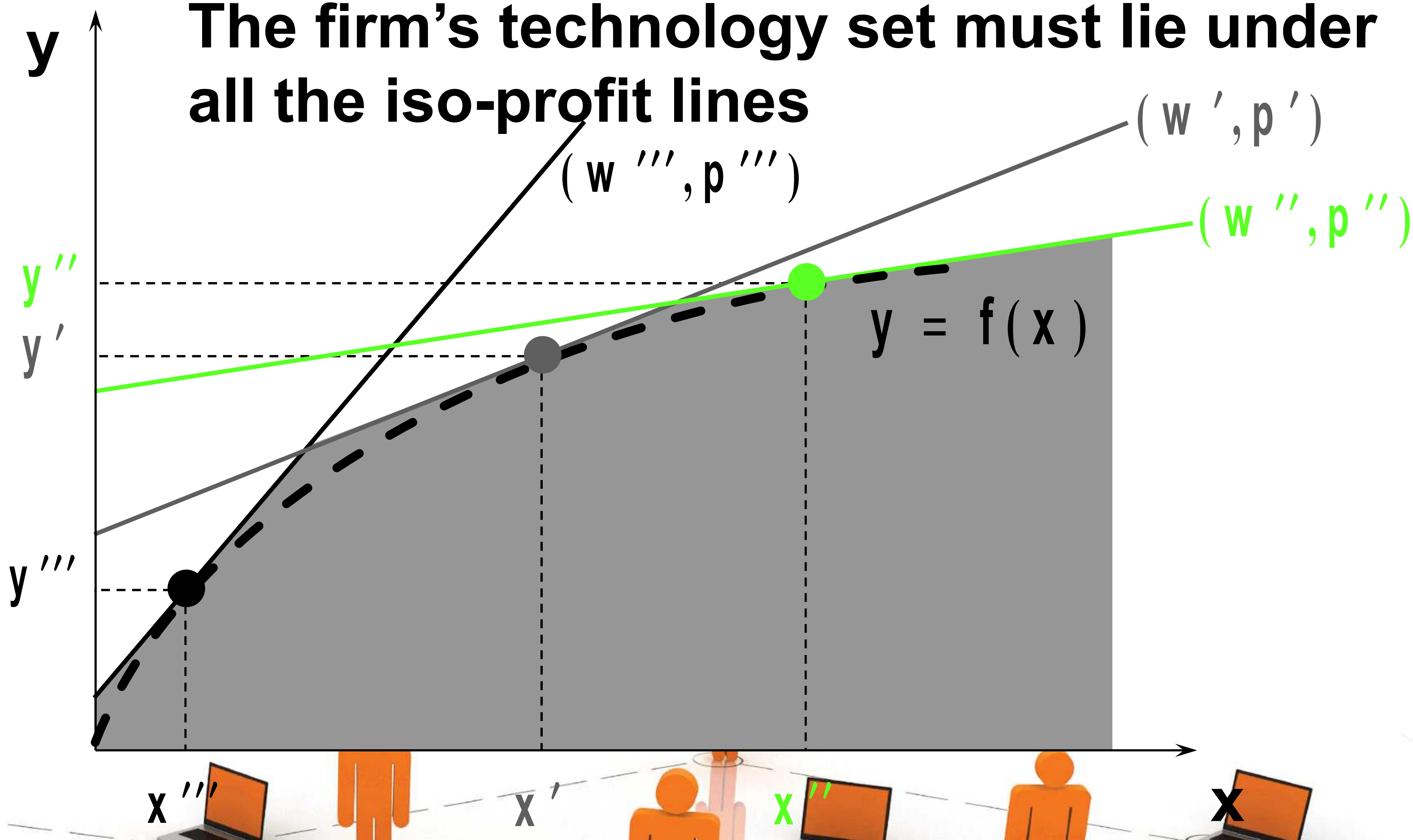
Revealed Profitability

The firm's technology set must lie under all the iso-profit lines



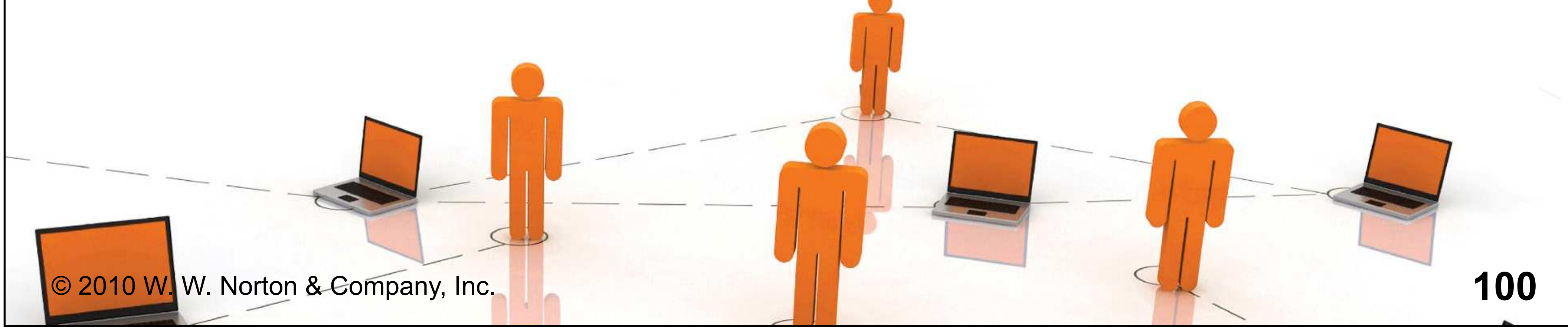
Revealed Profitability

The firm's technology set must lie under all the iso-profit lines



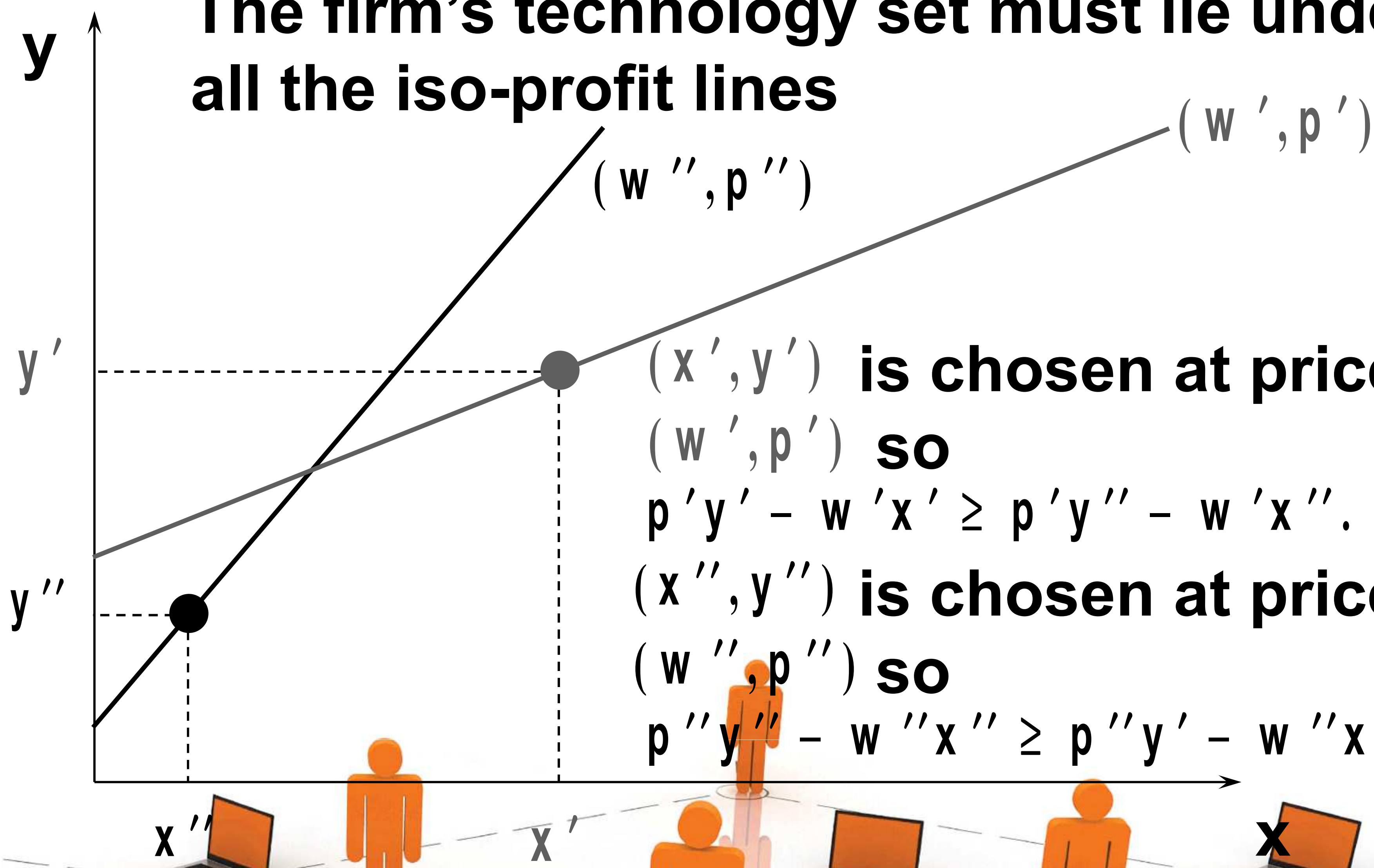
Revealed Profitability

- **What else can be learned from the firm's choices of profit-maximizing production plans?**



Revealed Profitability

The firm's technology set must lie under all the iso-profit lines



(x',y') **is chosen at prices** (w',p') **so**

$$p'y' - w'x' \geq p'y'' - w'x''.$$

(x'',y'') **is chosen at prices** (w'',p'') **so**

$$p''y'' - w''x'' \geq p''y' - w''x'.$$

Revealed Profitability

$$p'y' - w'x' \geq p'y'' - w'x''$$ **and**

$$p''y'' - w''x'' \geq p''y' - w''x'$$ **so**

$$p'y' - w'x' \geq p'y'' - w'x''$$ **and**

$$-p''y' + w''x' \geq -p''y'' + w''x''.$$

Adding gives

$$(p' - p'')y' - (w' - w'')x' \geq$$

$$(p' - p'')y'' - (w' - w'')x''.$$

Revealed Profitability

$$(p' - p'')y' - (w' - w'')x' \geq$$

$$(p' - p'')y'' - (w' - w'')x''$$

so

$$(p' - p'')(y' - y'') \geq (w' - w'')(x' - x'')$$

That is,

$$\Delta p \Delta y \geq \Delta w \Delta x$$

is a necessary implication of profit-maximization.

Revealed Profitability

$$\Delta p \Delta y \geq \Delta w \Delta x$$

is a necessary implication of profit-maximization.

Suppose the input price does not change. Then $\Delta w = 0$ and profit-maximization implies $\Delta p \Delta y \geq 0$; *i.e.*, a competitive firm's output supply curve cannot slope downward.

Revealed Profitability

$$\Delta p \Delta y \geq \Delta w \Delta x$$

is a necessary implication of profit-maximization.

Suppose the output price does not change. Then $\Delta p = 0$ and profit-maximization implies $0 \geq \Delta w \Delta x$; *i.e.*, a competitive firm's input demand curve cannot slope upward.