8TH EDITION

INTERMEDIATE MICROECONOMICS

HAL R. VARIAN

2 Budgetary and Other Constraints on Choice

Consumption Choice Sets

- **A consumption choice set is the collection of all consumption choices available to the consumer.**
- **What constrains consumption choice?**
  - **Budgetary, time and other resource limitations.**

Budget Constraints

- A consumption bundle containing x_1 units of commodity 1, x_2 units of commodity 2 and so on up to x_n units of commodity n is denoted by the vector $(x_1, x_2, \ldots, x_n)$.
- Commodity prices are $p_1, p_2, \ldots, p_n$.

Budget Constraints

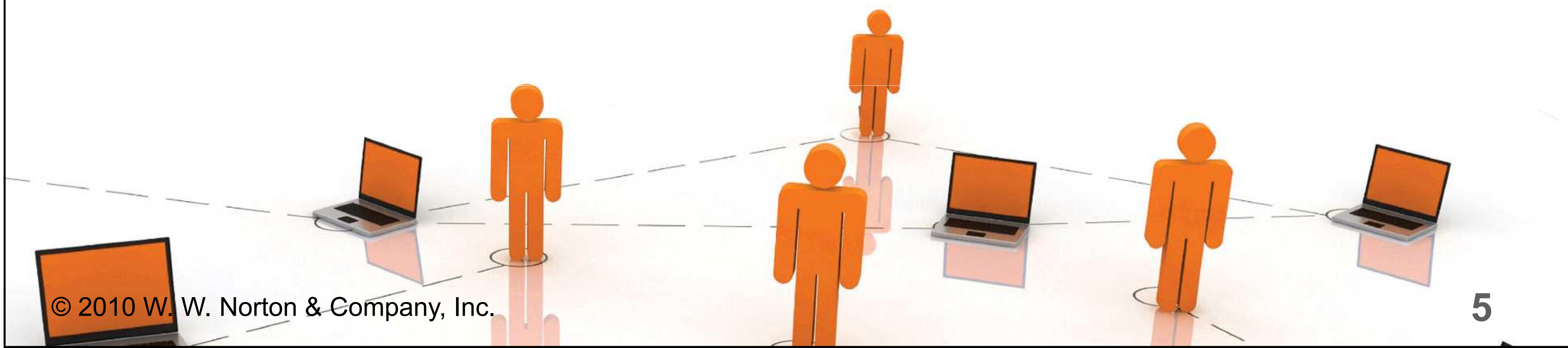
- Q: When is a consumption bundle $(x_1, \ldots, x_n)$ affordable at given prices $p_1, \ldots, p_n$?

Budget Constraints

- Q: When is a bundle $(x_1, \ldots , x_n)$ affordable at prices $p_1, \ldots , p_n$?
- A: When

$$p_1x_1 + \ldots + p_nx_n \leq m$$

where *m* is the consumer's (disposable) income.



Budget Constraints

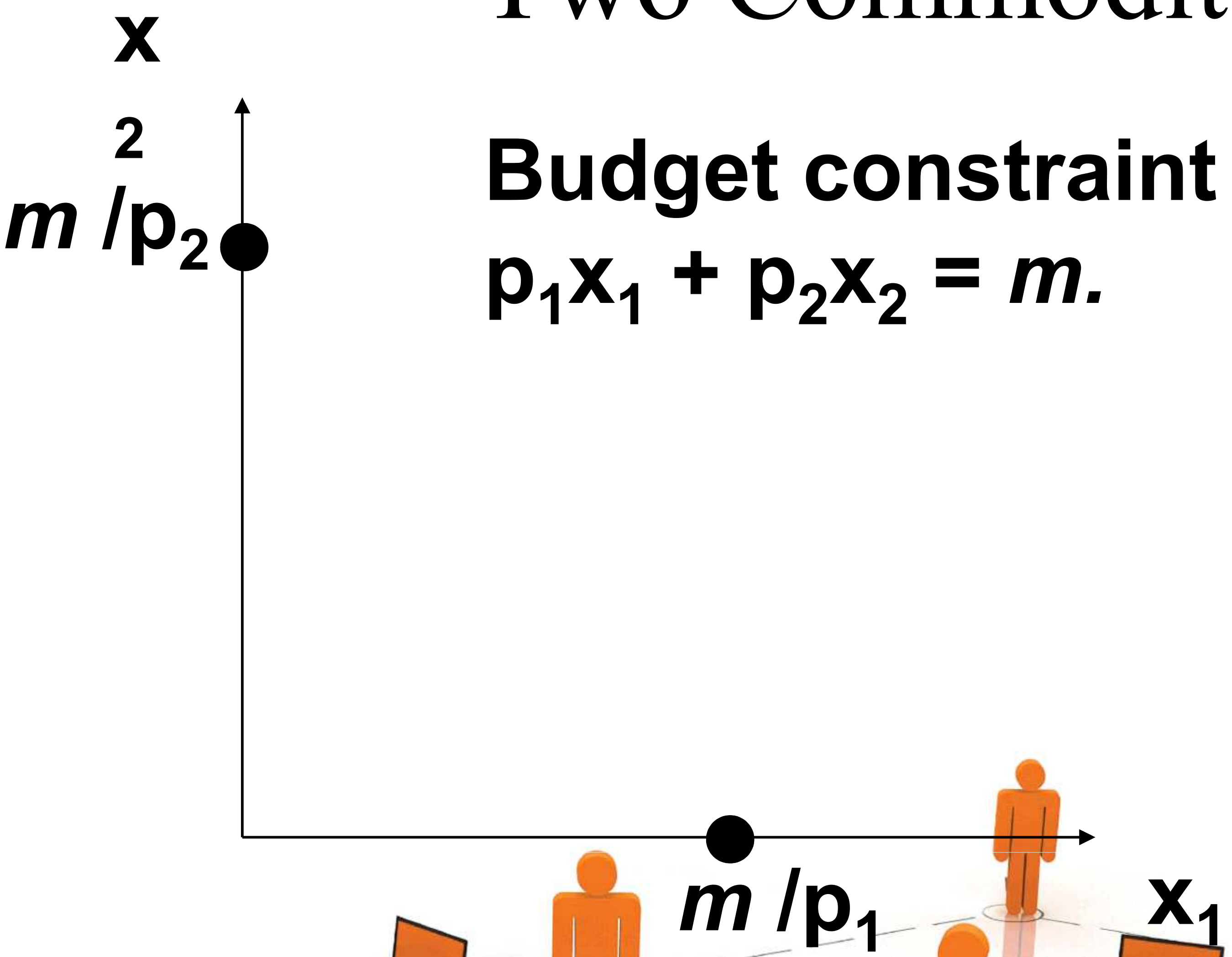
- **The bundles that are only just affordable form the consumer's budget constraint. This is the set**

$$\{ (x_1,\ldots,x_n) \mid x_1 \geq 0, \ldots, x_n \geq 0 \text{ and } p_1x_1 + \ldots + p_nx_n = m \}.$$

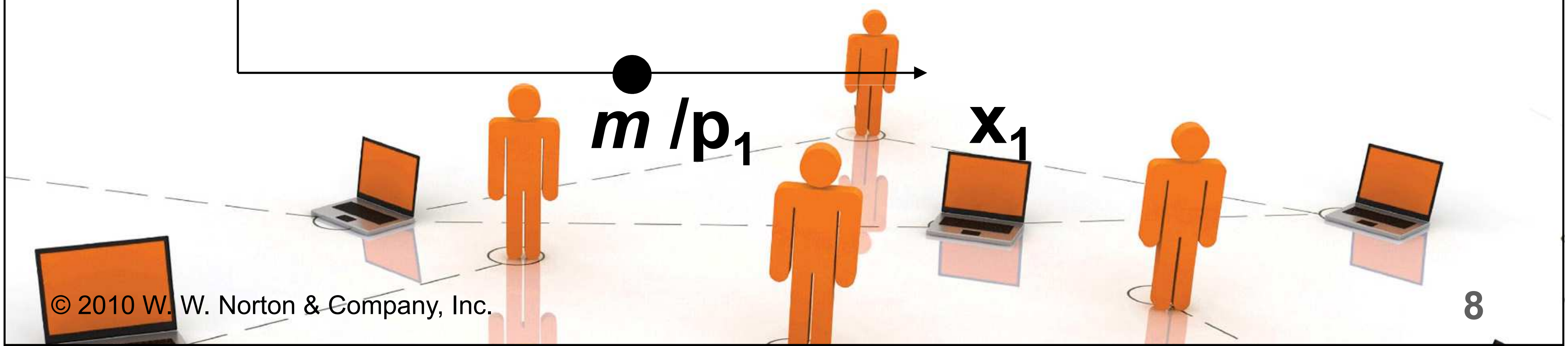
Budget Constraints

- The consumer's budget set is the set of all affordable bundles;
  $B(p_1, \ldots, p_n, m) =$
  $\{ (x_1, \ldots, x_n) \mid x_1 \geq 0, \ldots, x_n \geq 0$ and
  $p_1x_1 + \ldots + p_nx_n \leq m \}$
- The budget constraint is the upper boundary of the budget set.

Budget Set and Constraint for Two Commodities



Budget constraint is
$p_1x_1 + p_2x_2 = m$.



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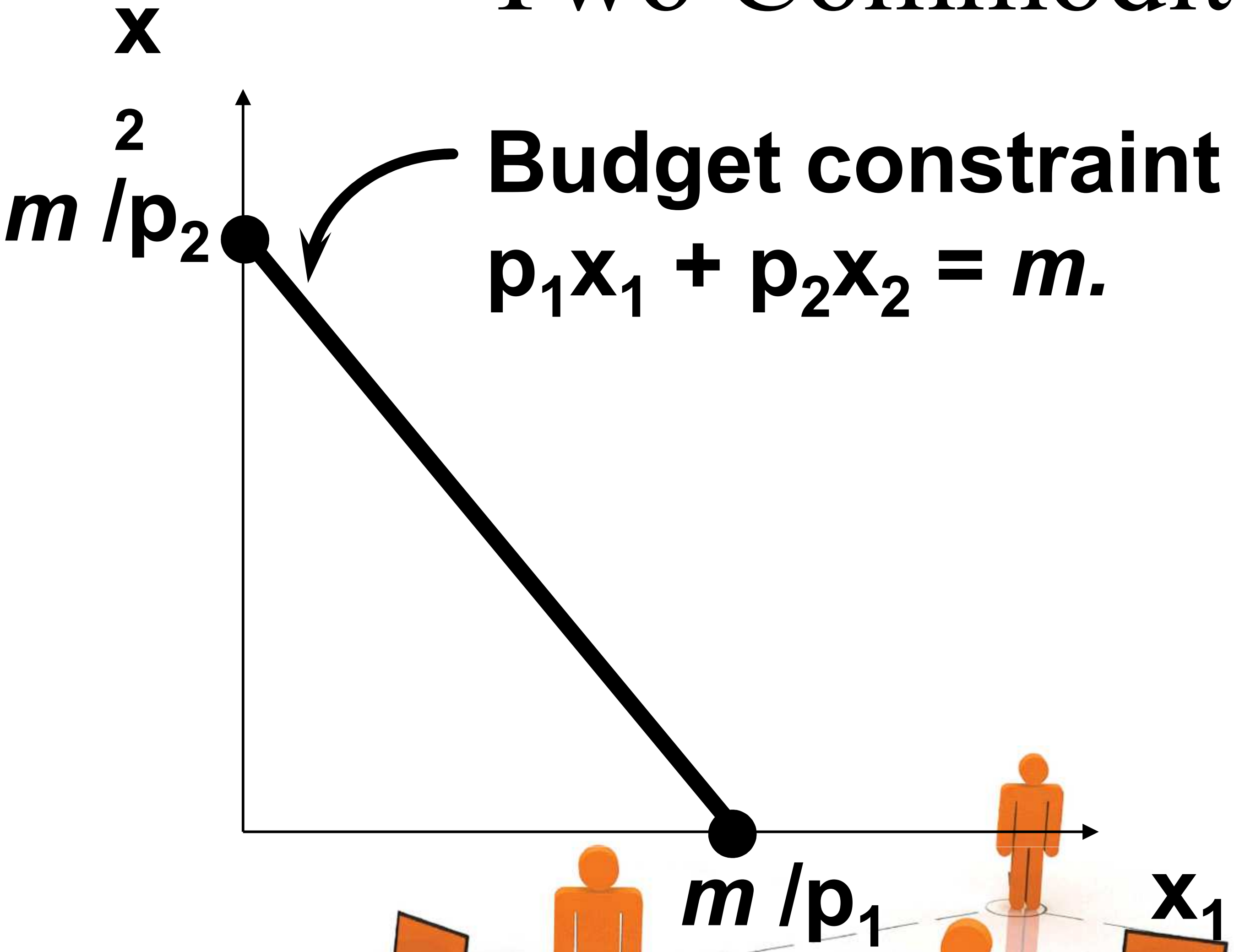
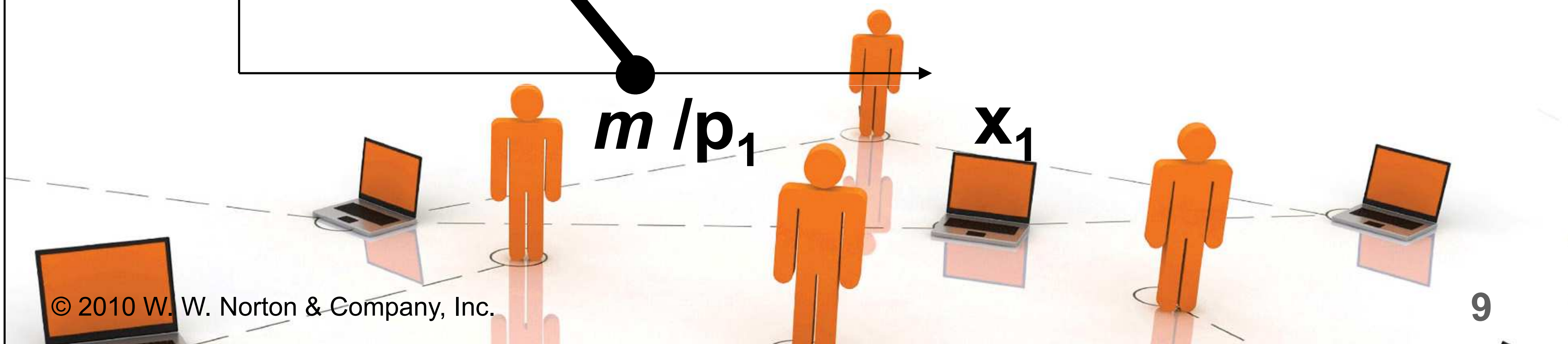
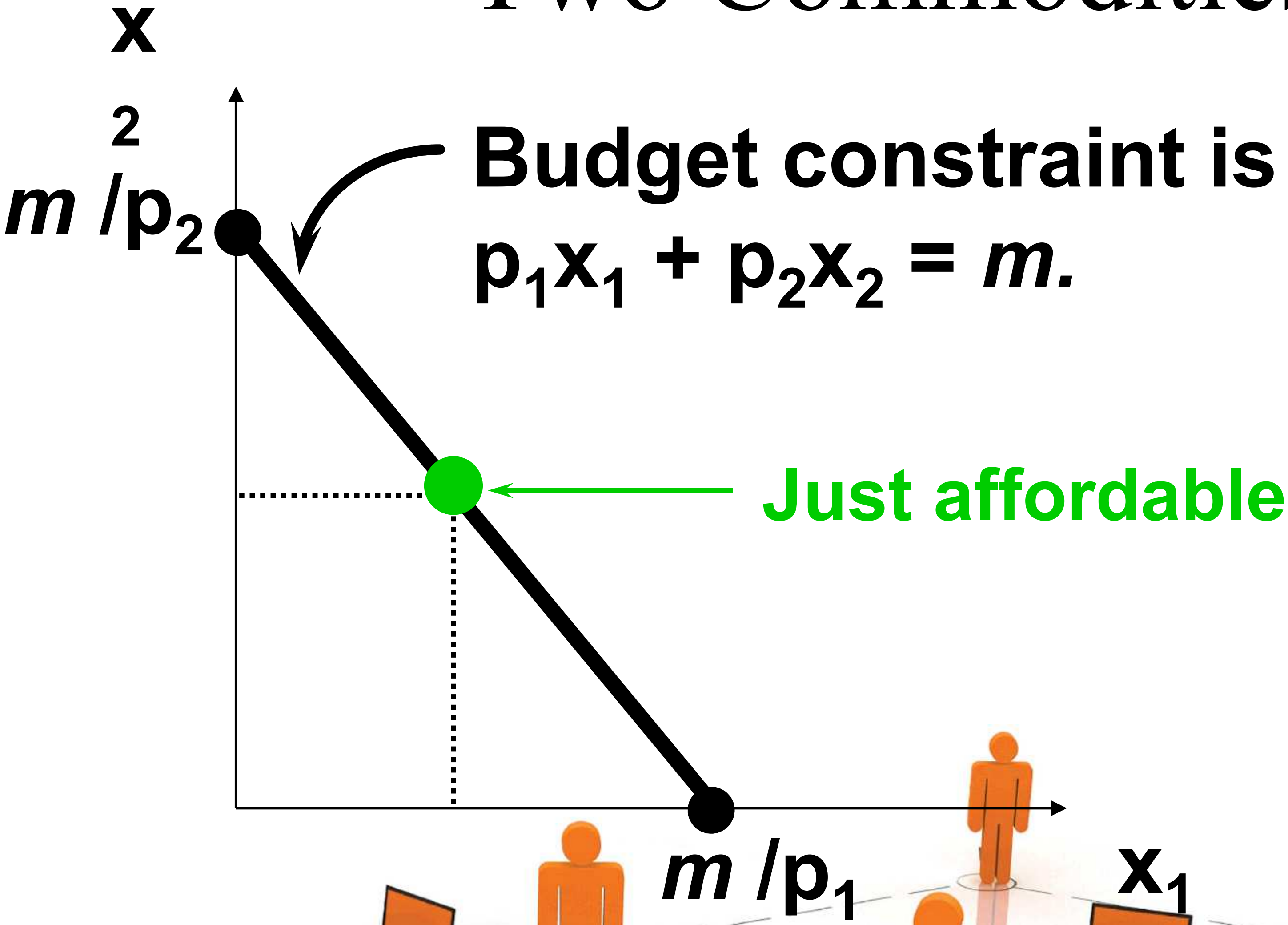
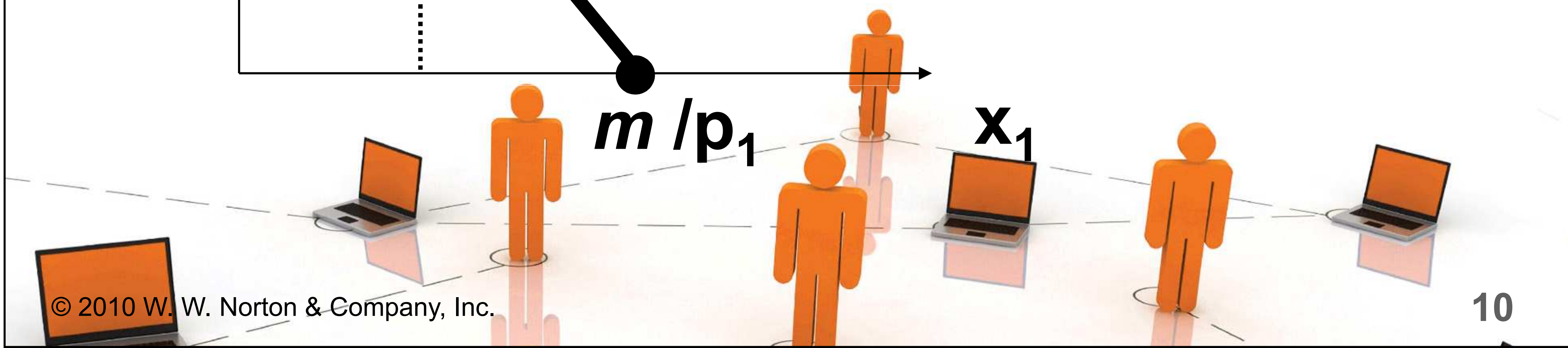


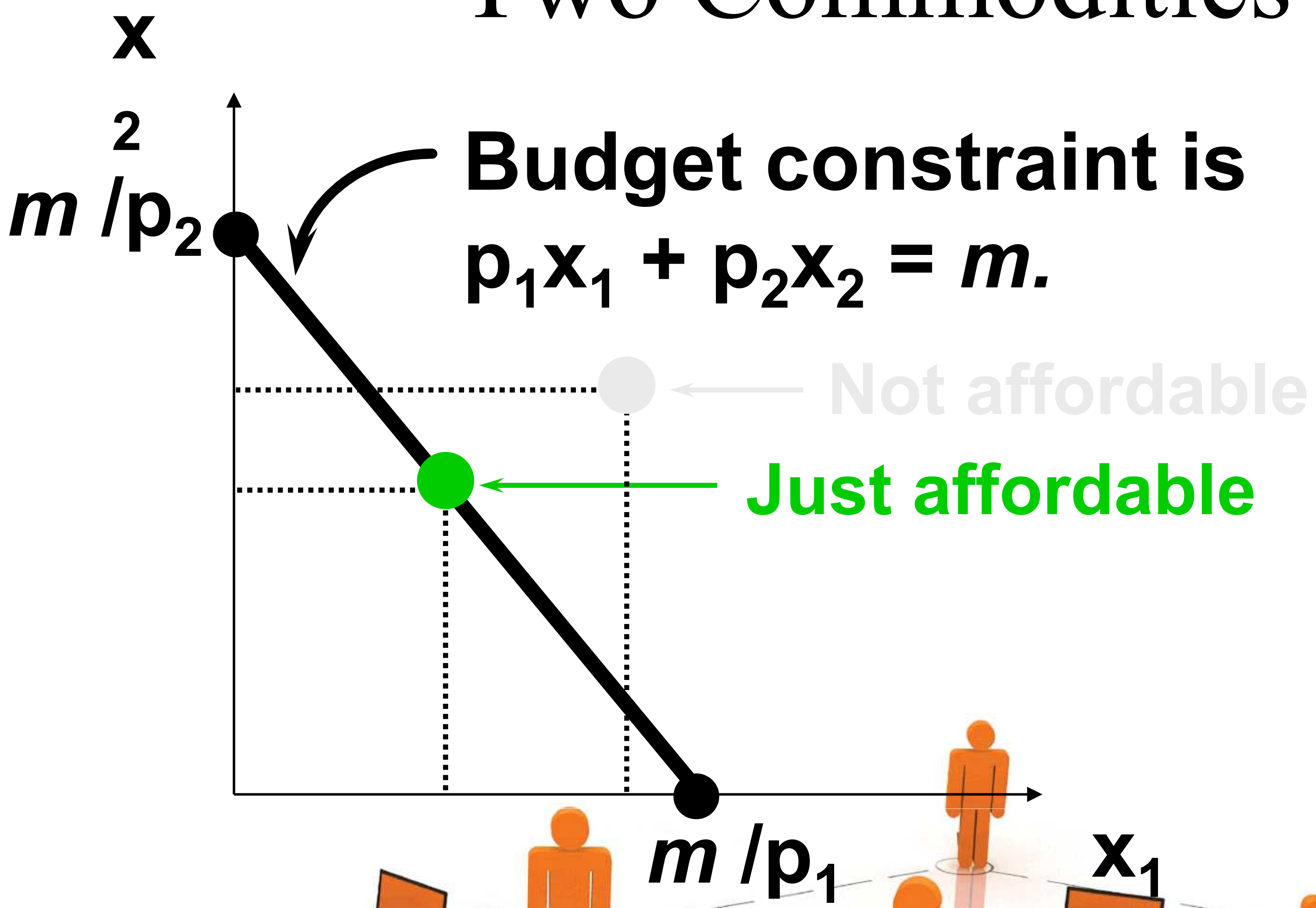


Budget Set and Constraint for Two Commodities



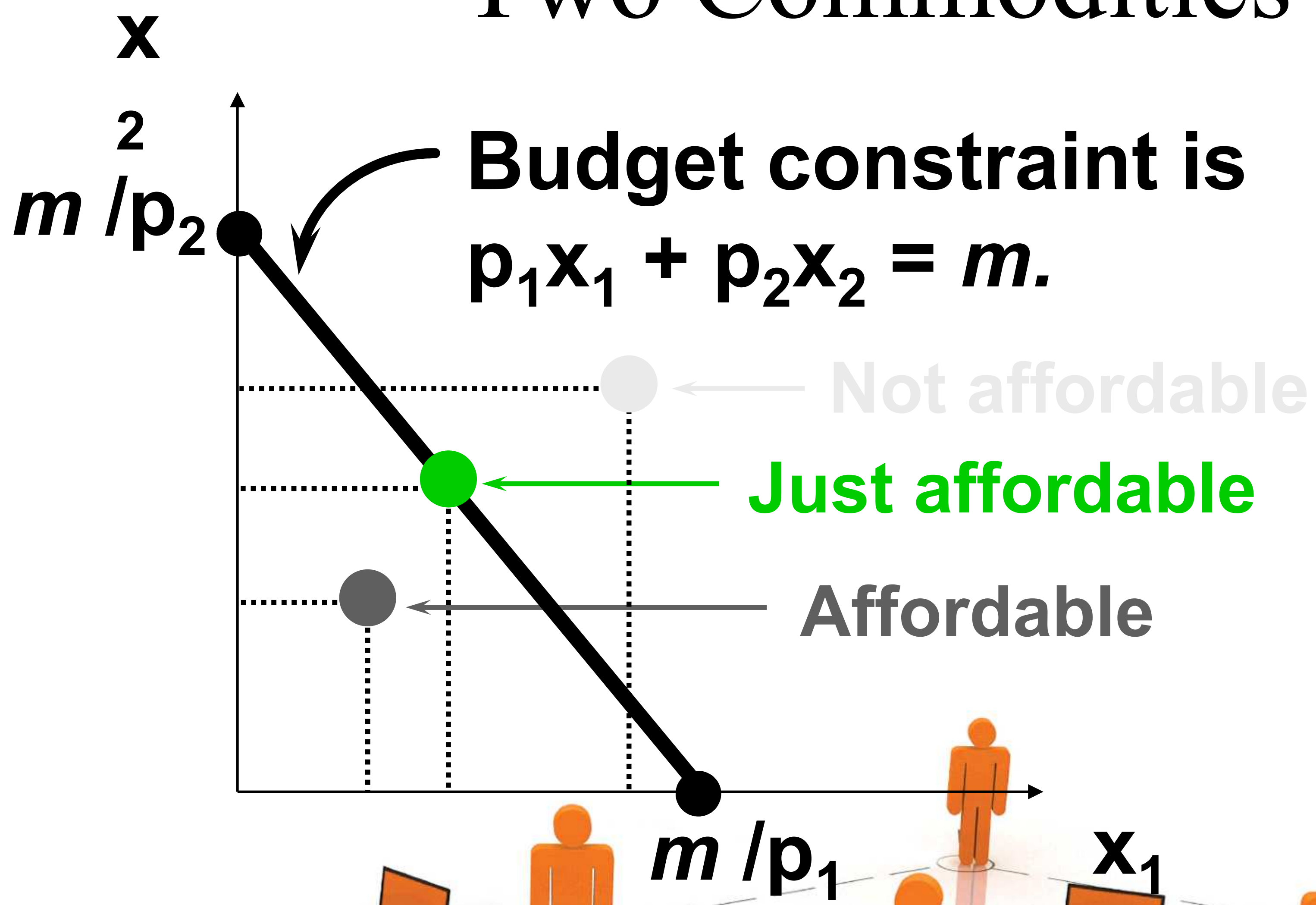


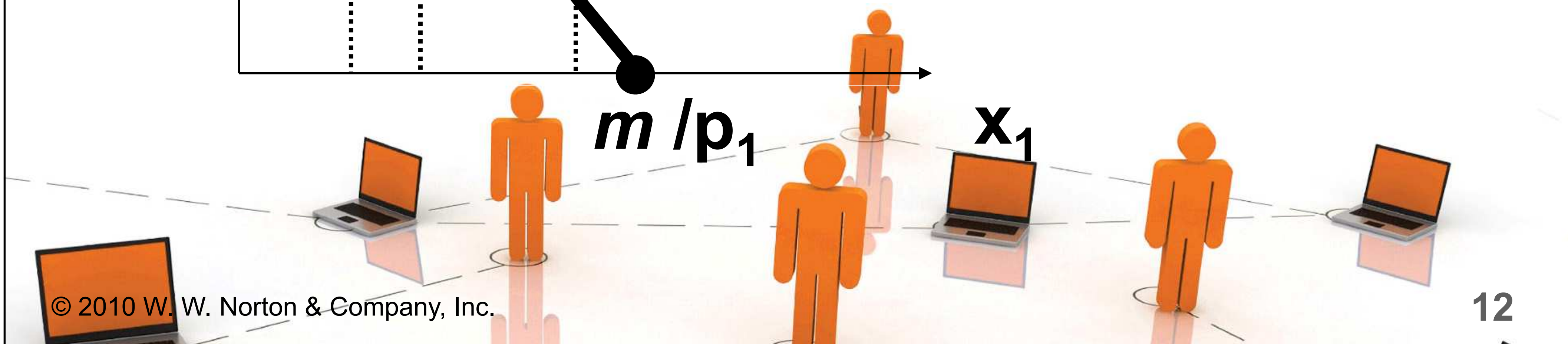
Budget Set and Constraint for Two Commodities



Budget Set and Constraint for Two Commodities

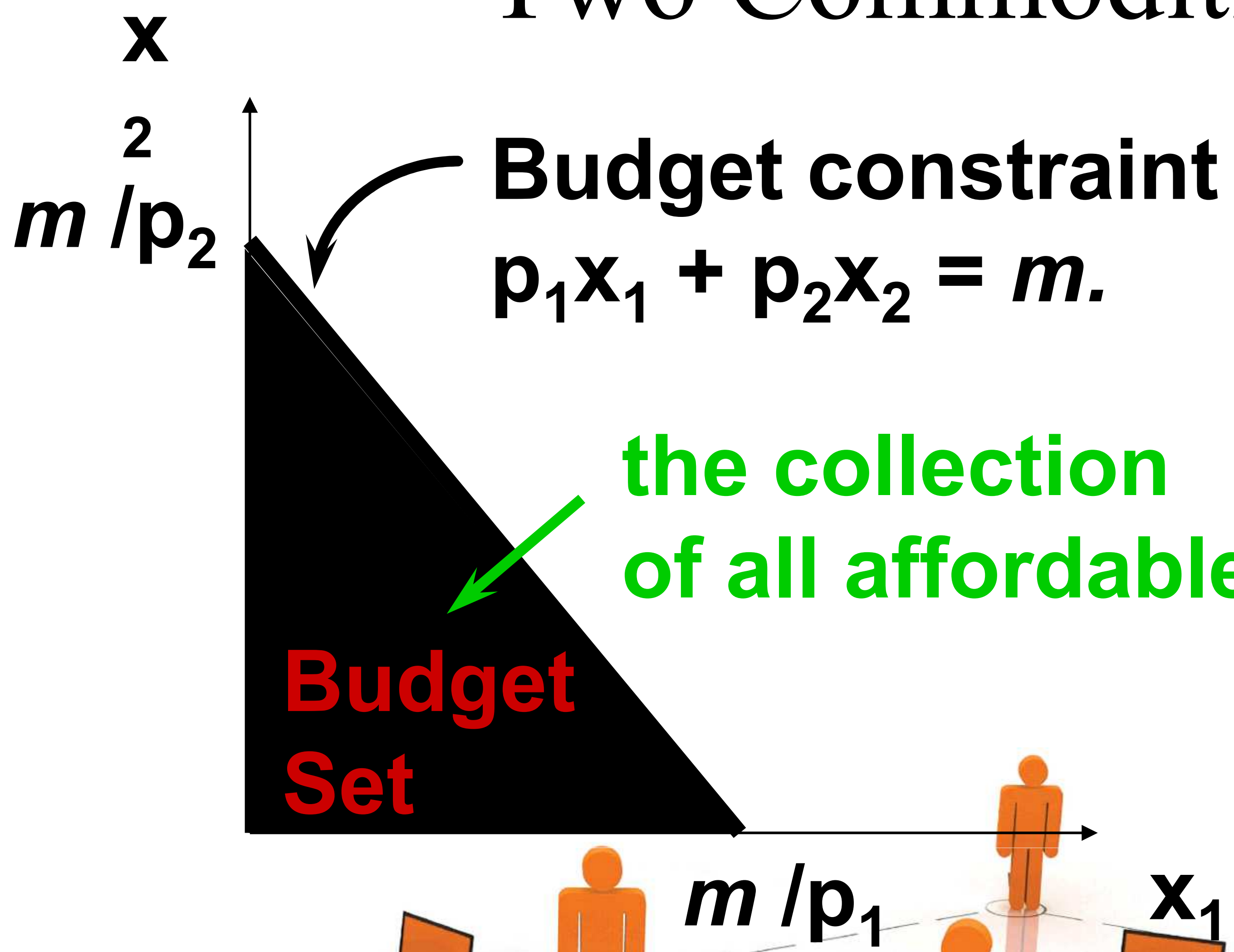
Budget constraint is $p_1x_1 + p_2x_2 = m$.



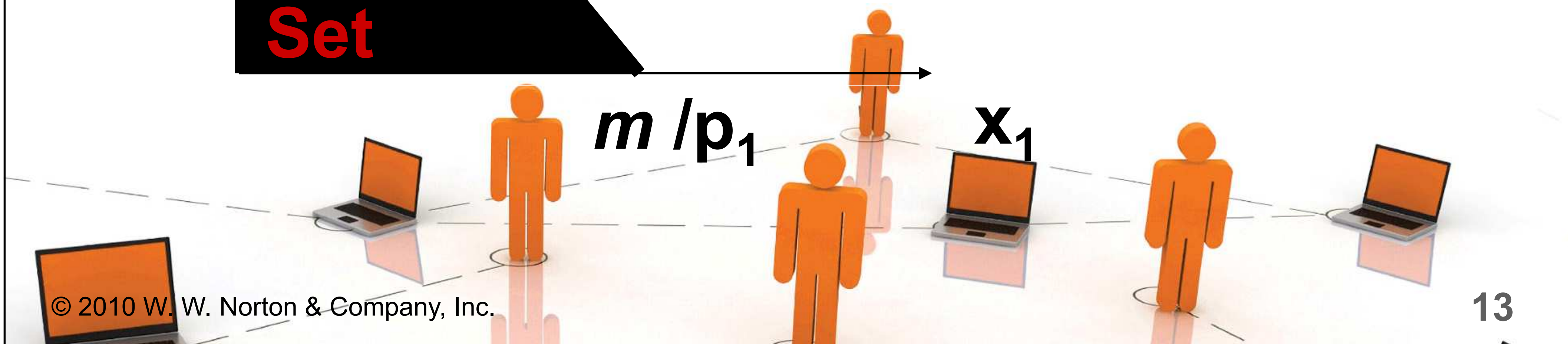


Budget Set and Constraint for Two Commodities

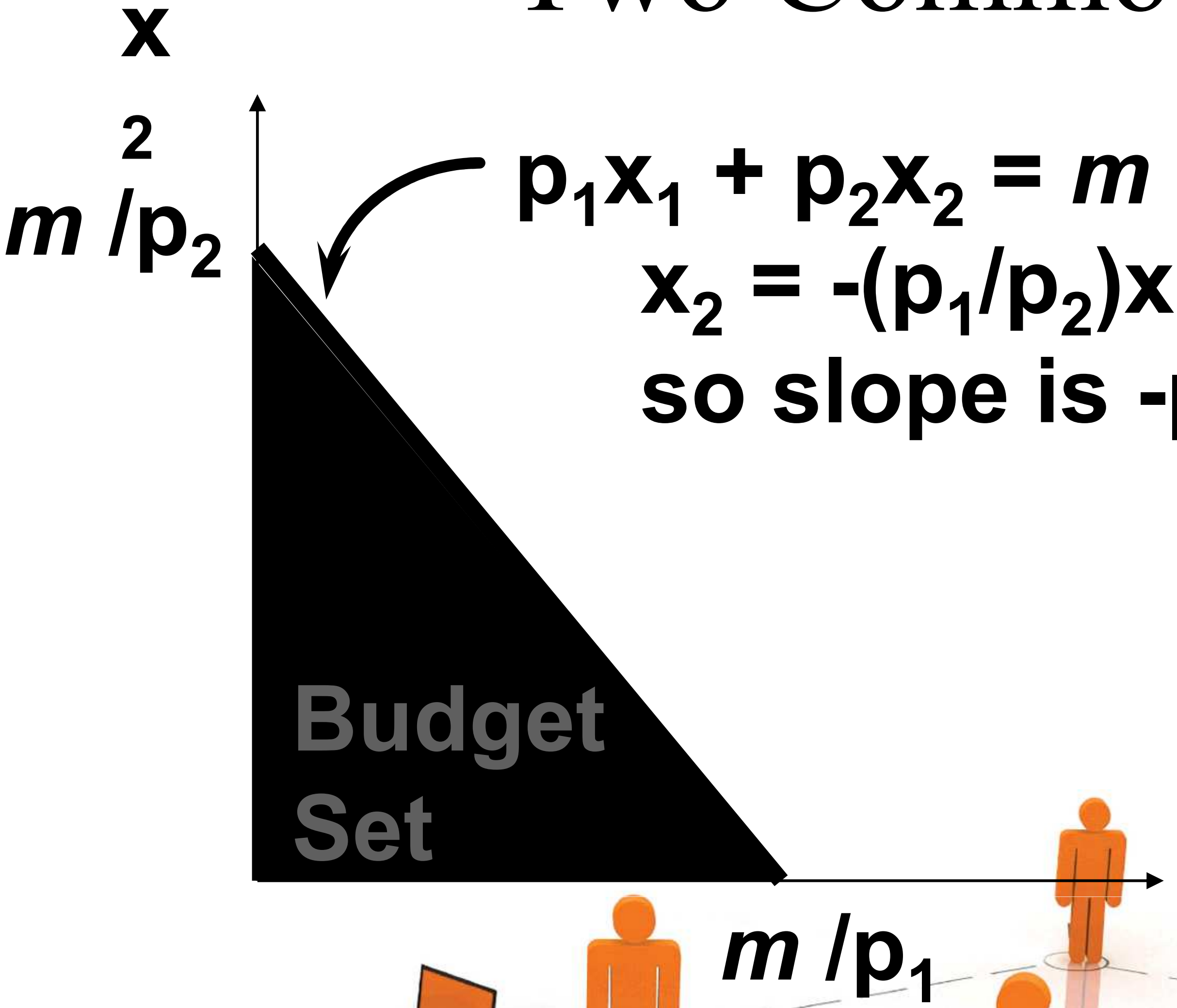
Budget constraint is $p_1x_1 + p_2x_2 = m$.



the collection of all affordable bundles.



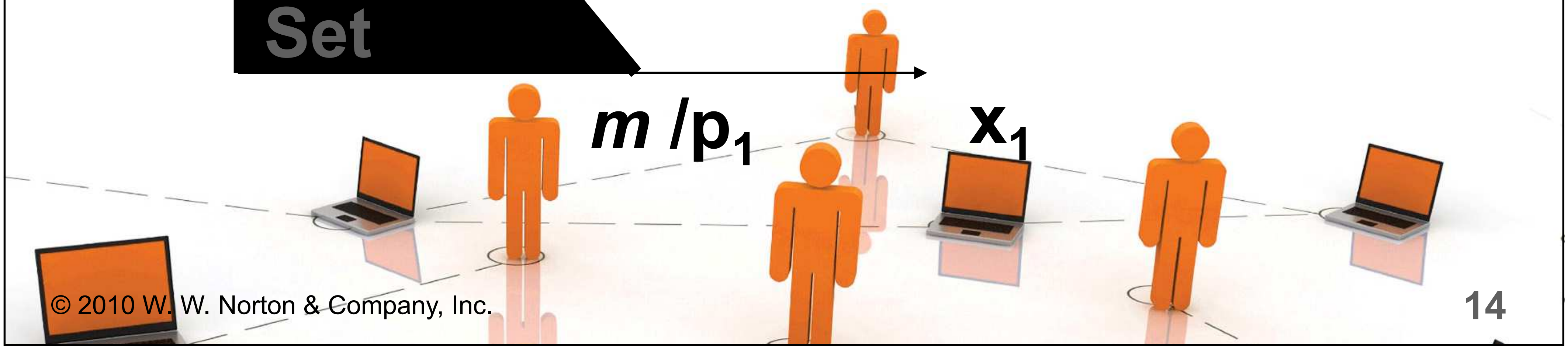
Budget Set and Constraint for Two Commodities



$p_1x_1 + p_2x_2 = m$ is

$x_2 = -(p_1/p_2)x_1 + m/p_2$

so slope is $-p_1/p_2$.

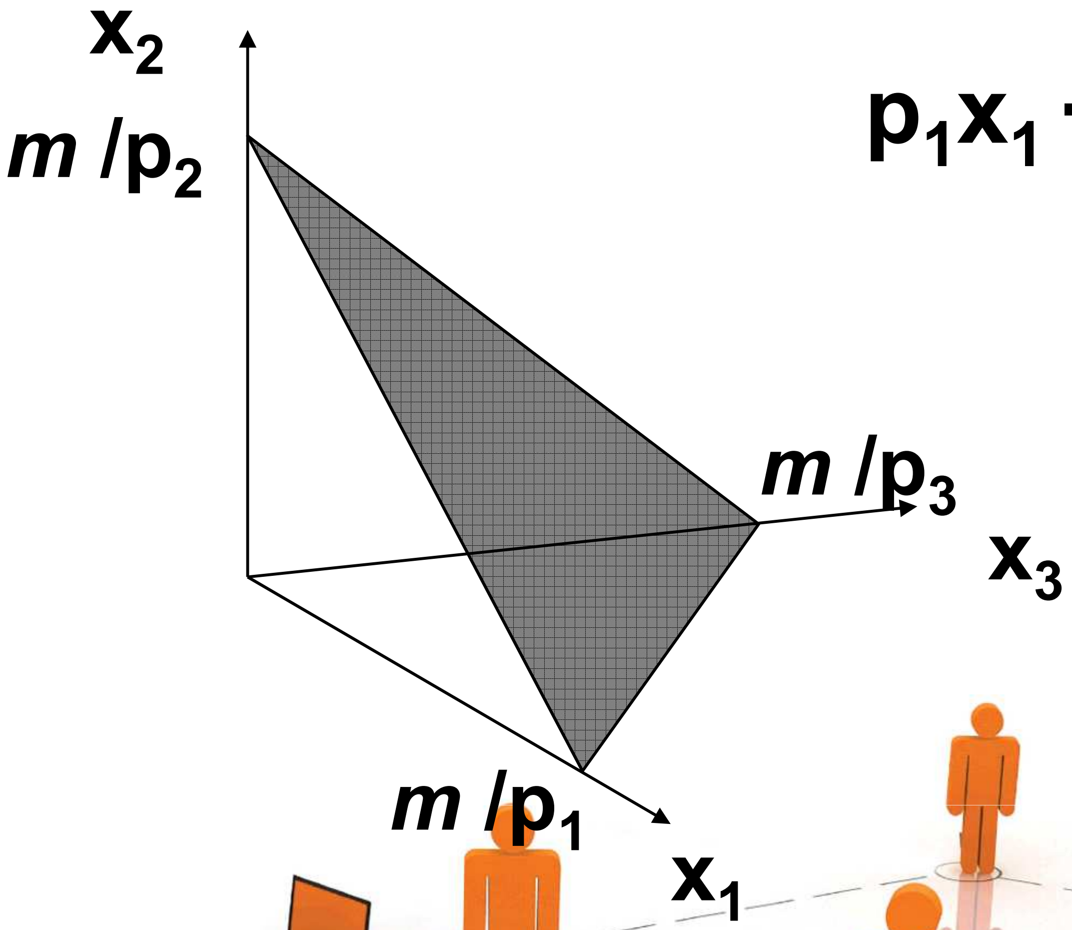


Budget Constraints

- If n = 3 what do the budget constraint and the budget set look like?

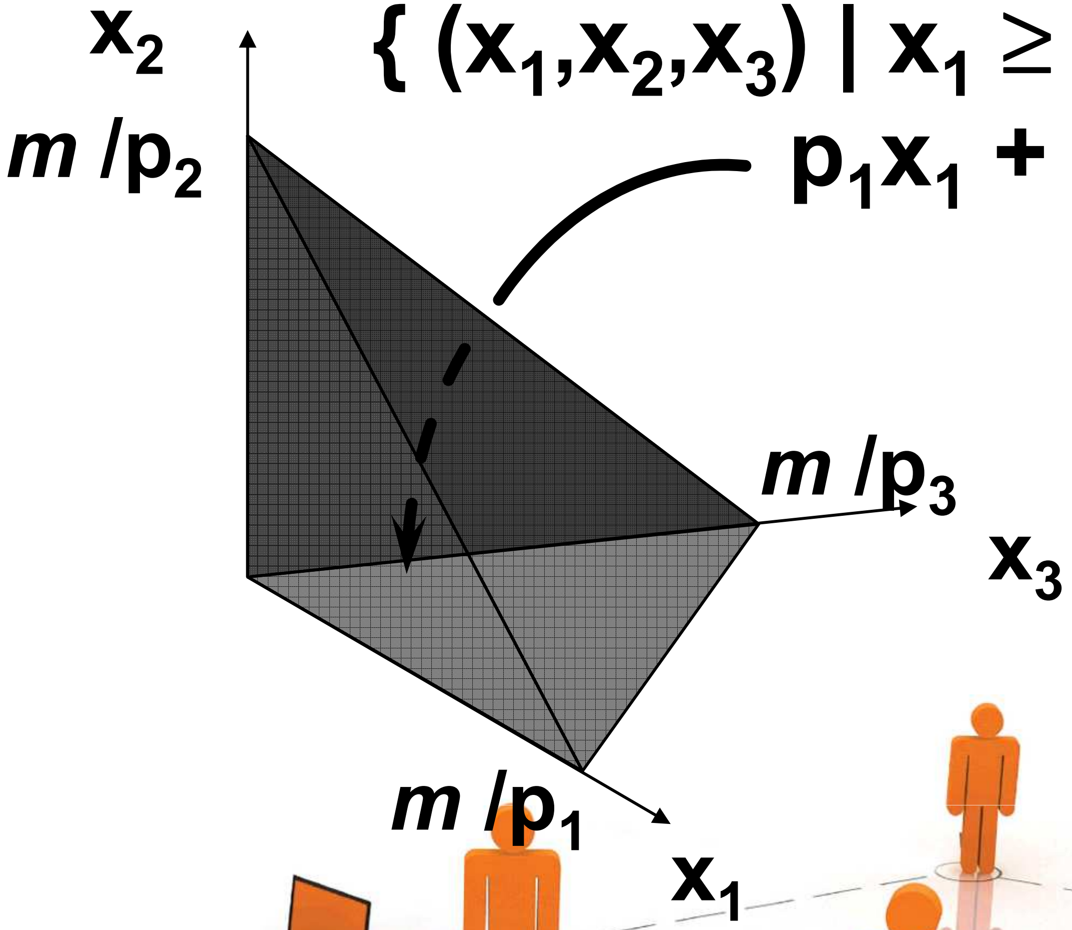
Budget Constraint for Three Commodities

$$p_1x_1 + p_2x_2 + p_3x_3 = m$$



Budget Set for Three Commodities

$$\{ (x_1,x_2,x_3) \mid x_1 \geq 0,\ x_2 \geq 0,\ x_3 \geq 0 \text{ and } p_1x_1 + p_2x_2 + p_3x_3 \leq m\}$$



Budget Constraints

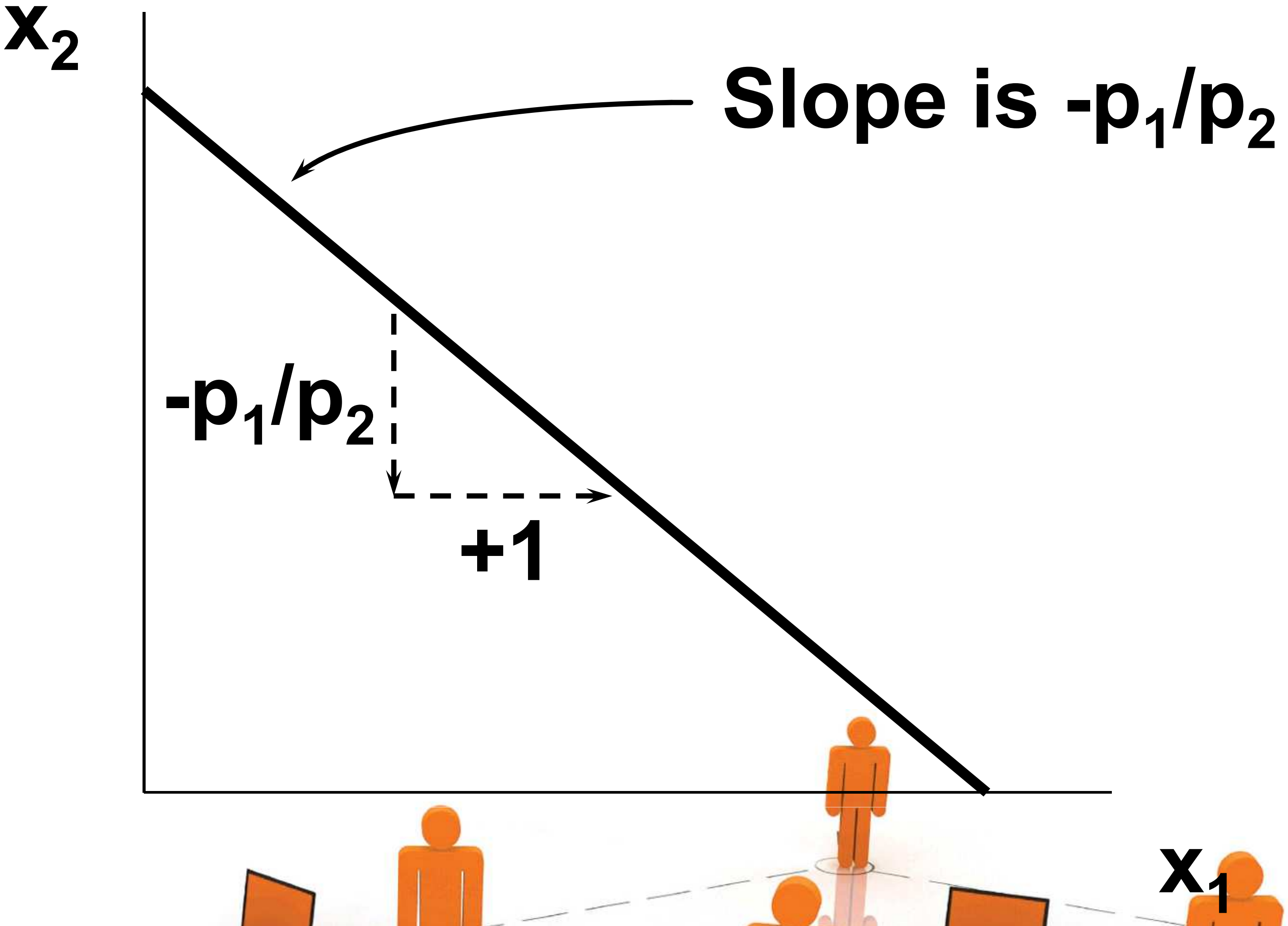
- **For n = 2 and x_1 on the horizontal axis, the constraint's slope is $-p_1/p_2$. What does it mean?**

Budget Constraints

- For n = 2 and x_1 on the horizontal axis, the constraint's slope is $-p_1/p_2$. What does it mean?

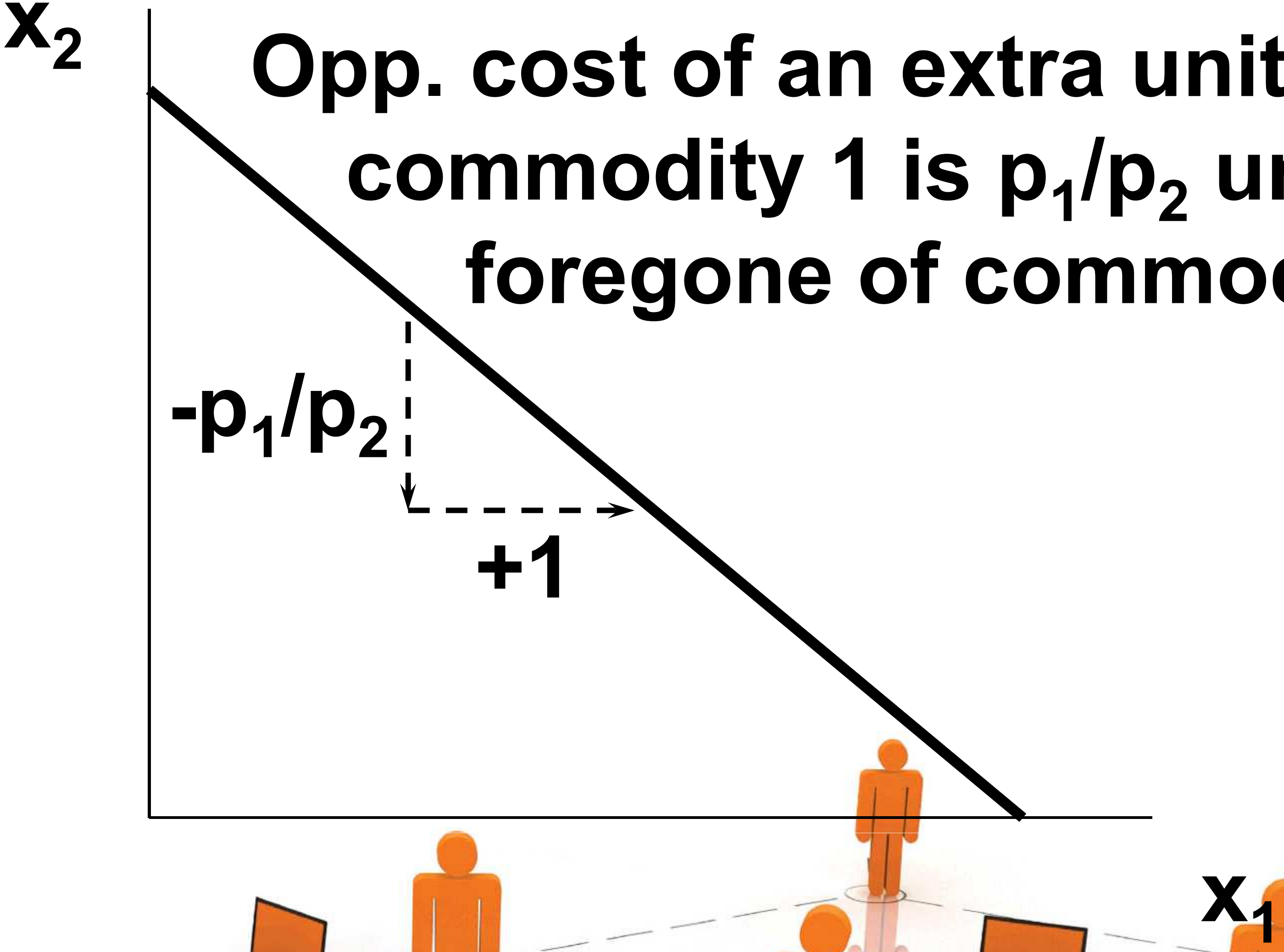
- Increasing x_1 by 1 must reduce x_2 by p_1/p_2.

Budget Constraints

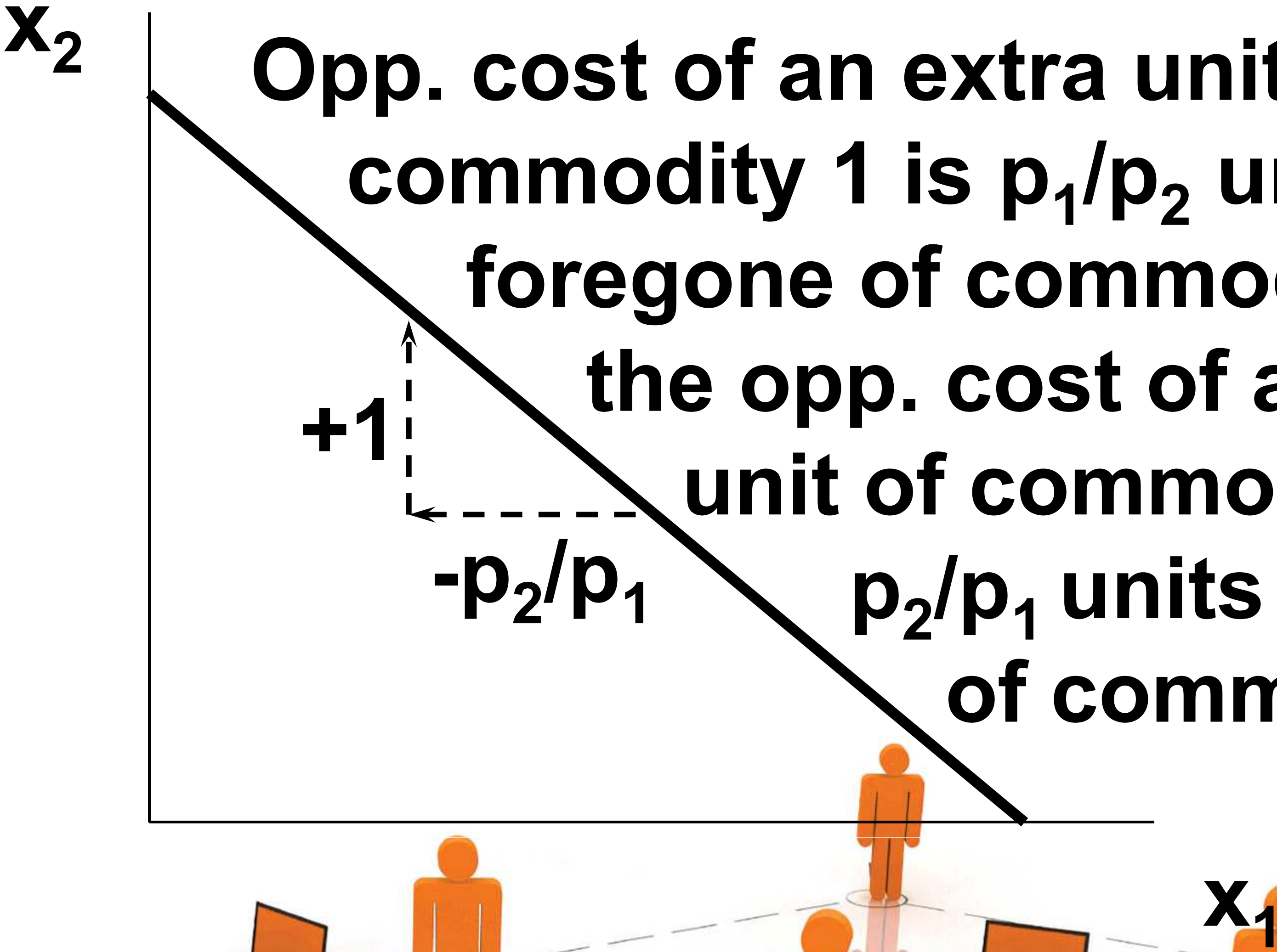


Budget Constraints

Opp. cost of an extra unit of commodity 1 is p_1/p_2 units foregone of commodity 2.



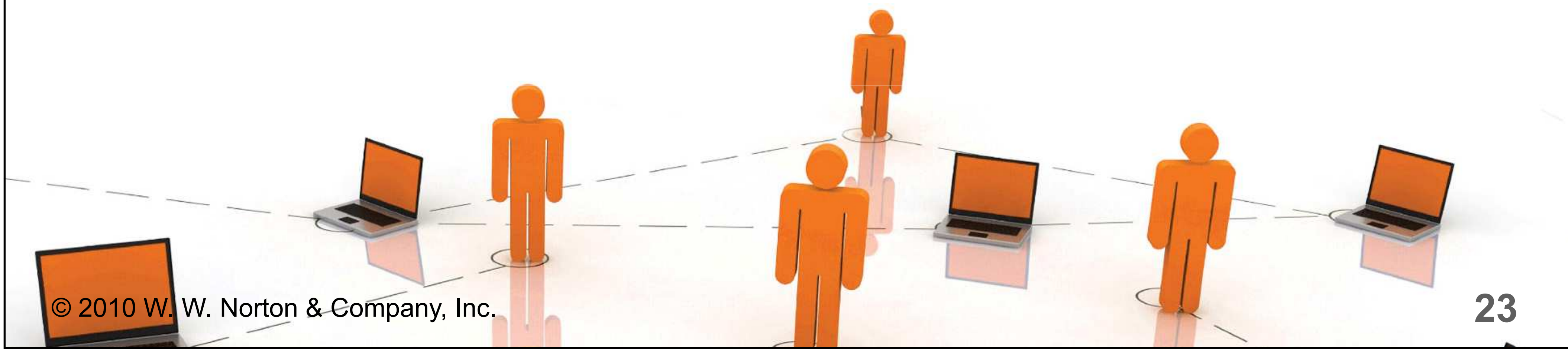
Budget Constraints



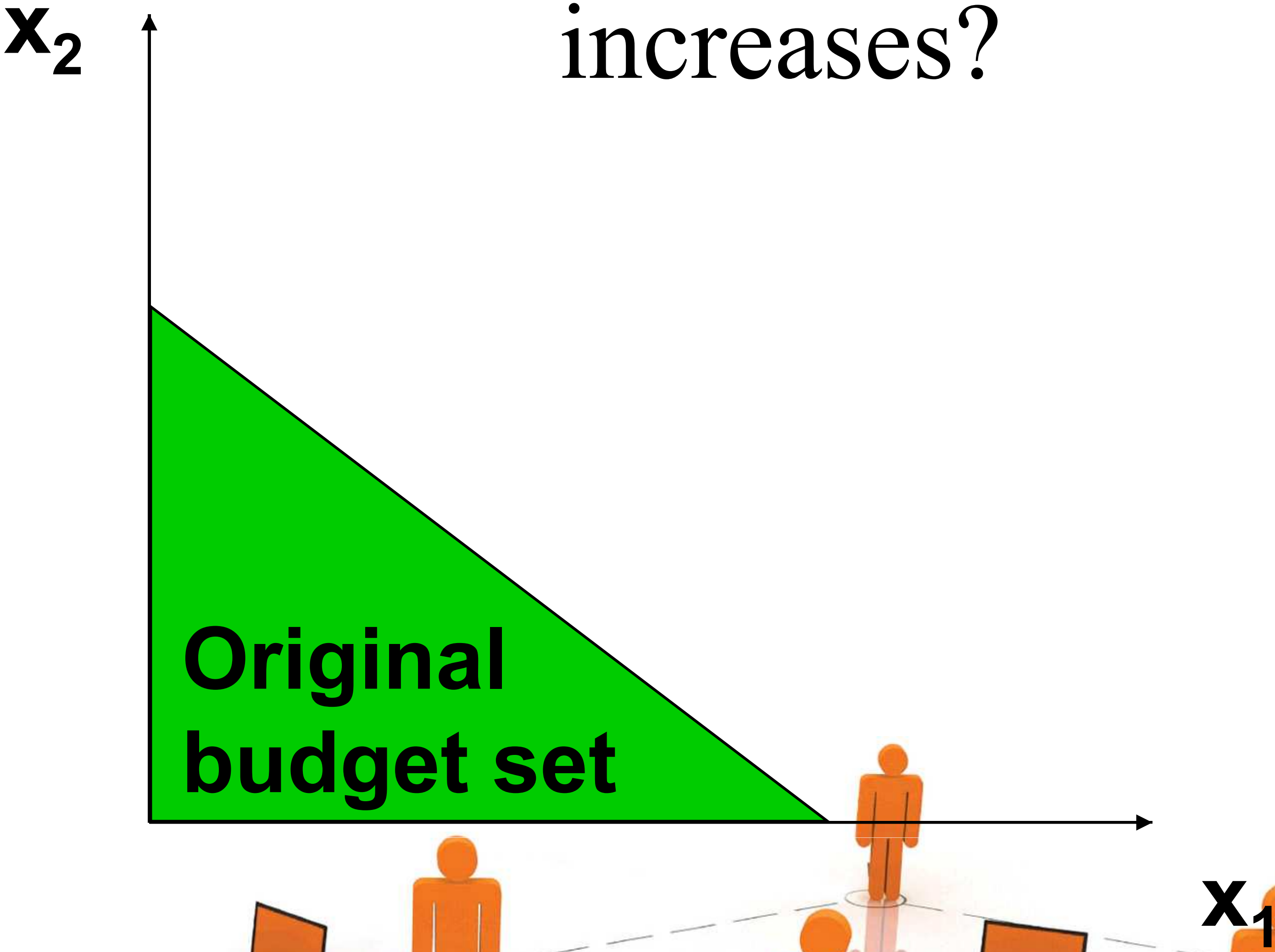
Opp. cost of an extra unit of commodity 1 is p_1/p_2 units foregone of commodity 2. And the opp. cost of an extra unit of commodity 2 is p_2/p_1 units foregone of commodity 1.

Budget Sets & Constraints; Income and Price Changes

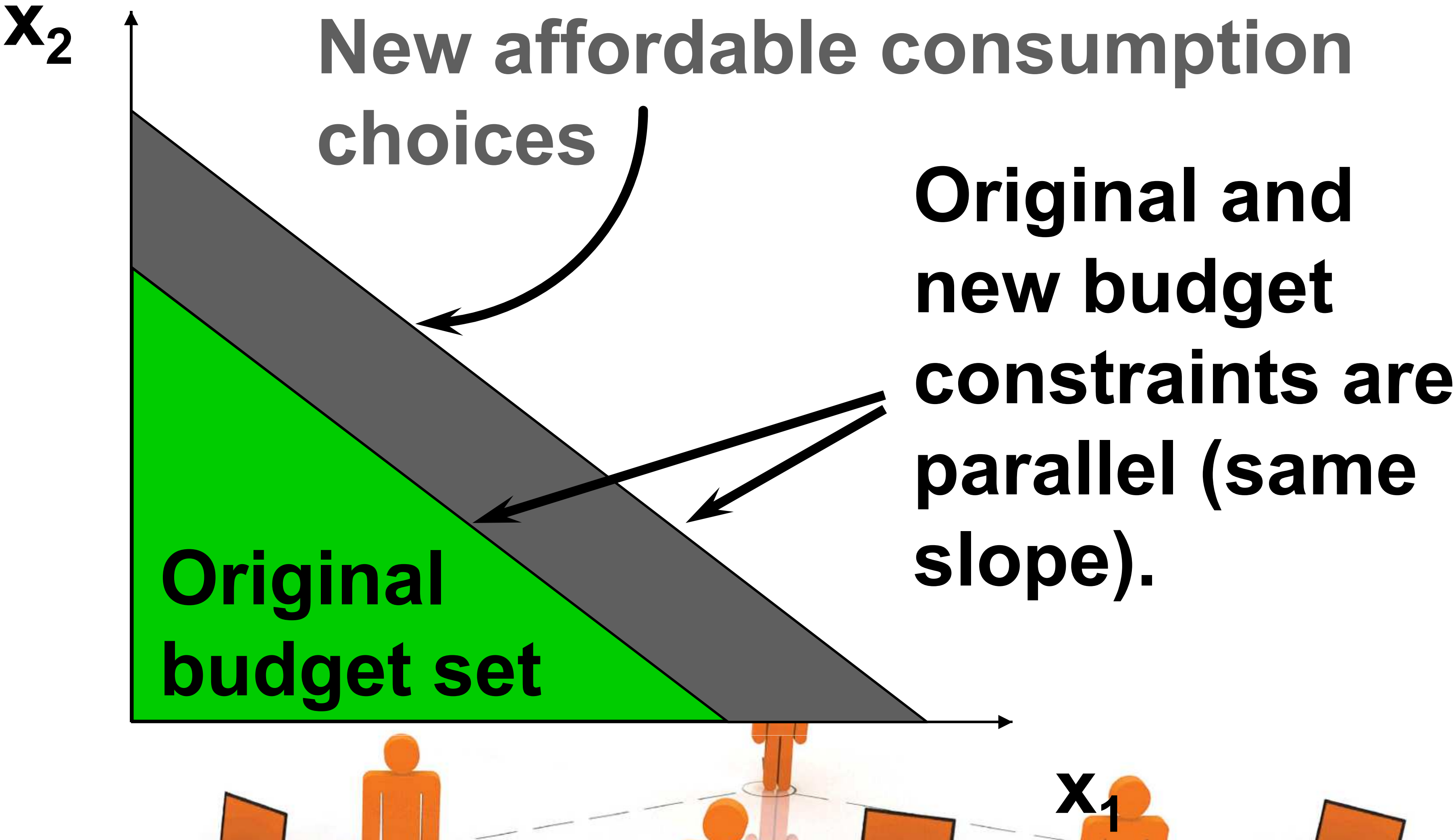
- **The budget constraint and budget set depend upon prices and income. What happens as prices or income change?**



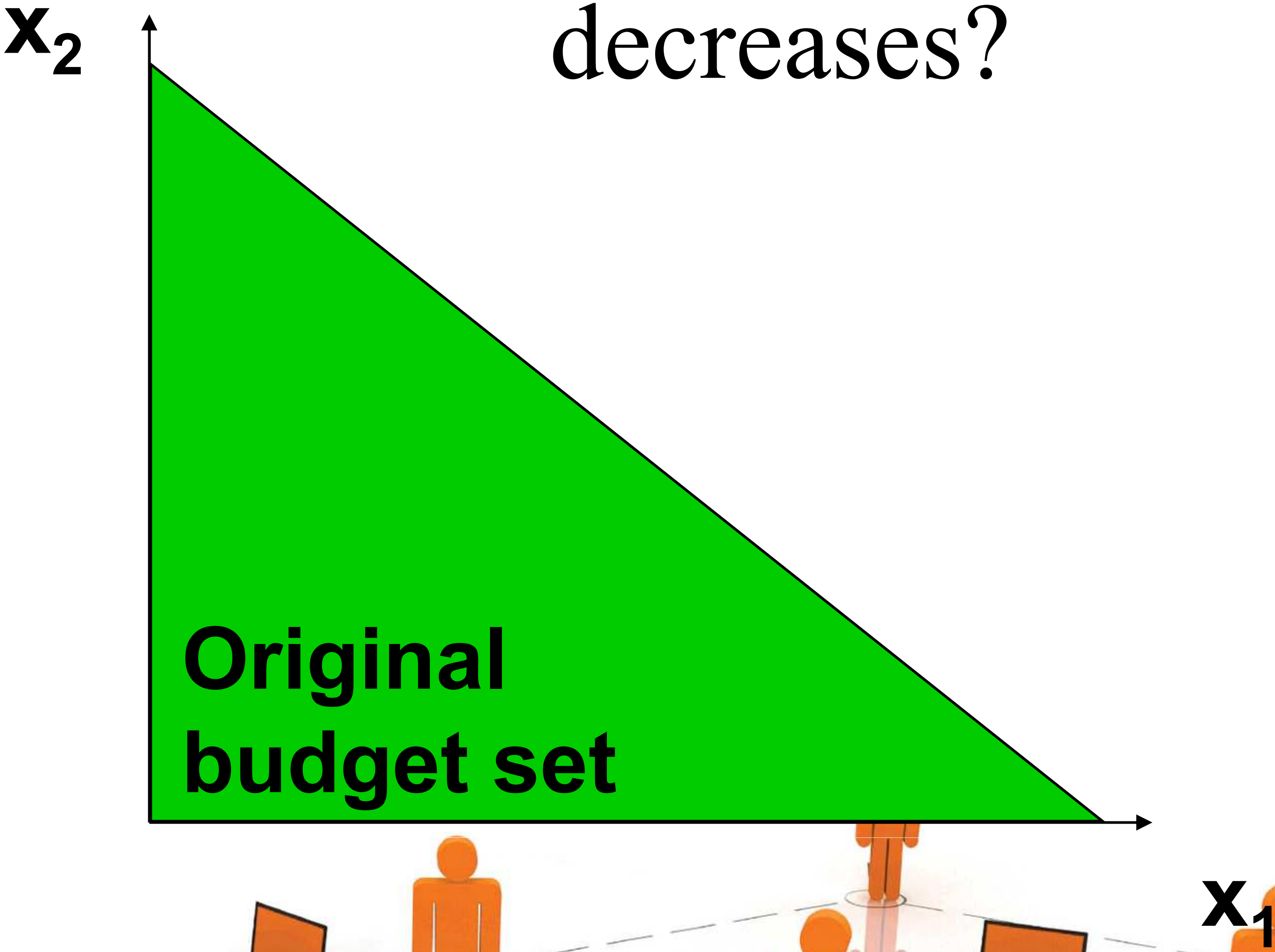
How do the budget set and budget constraint change as income *m* increases?

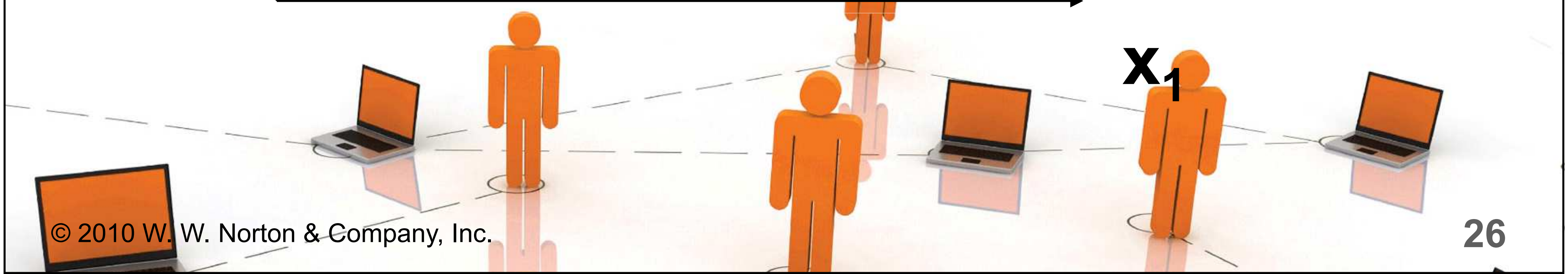


Higher income gives more choice



How do the budget set and budget constraint change as income *m* decreases?





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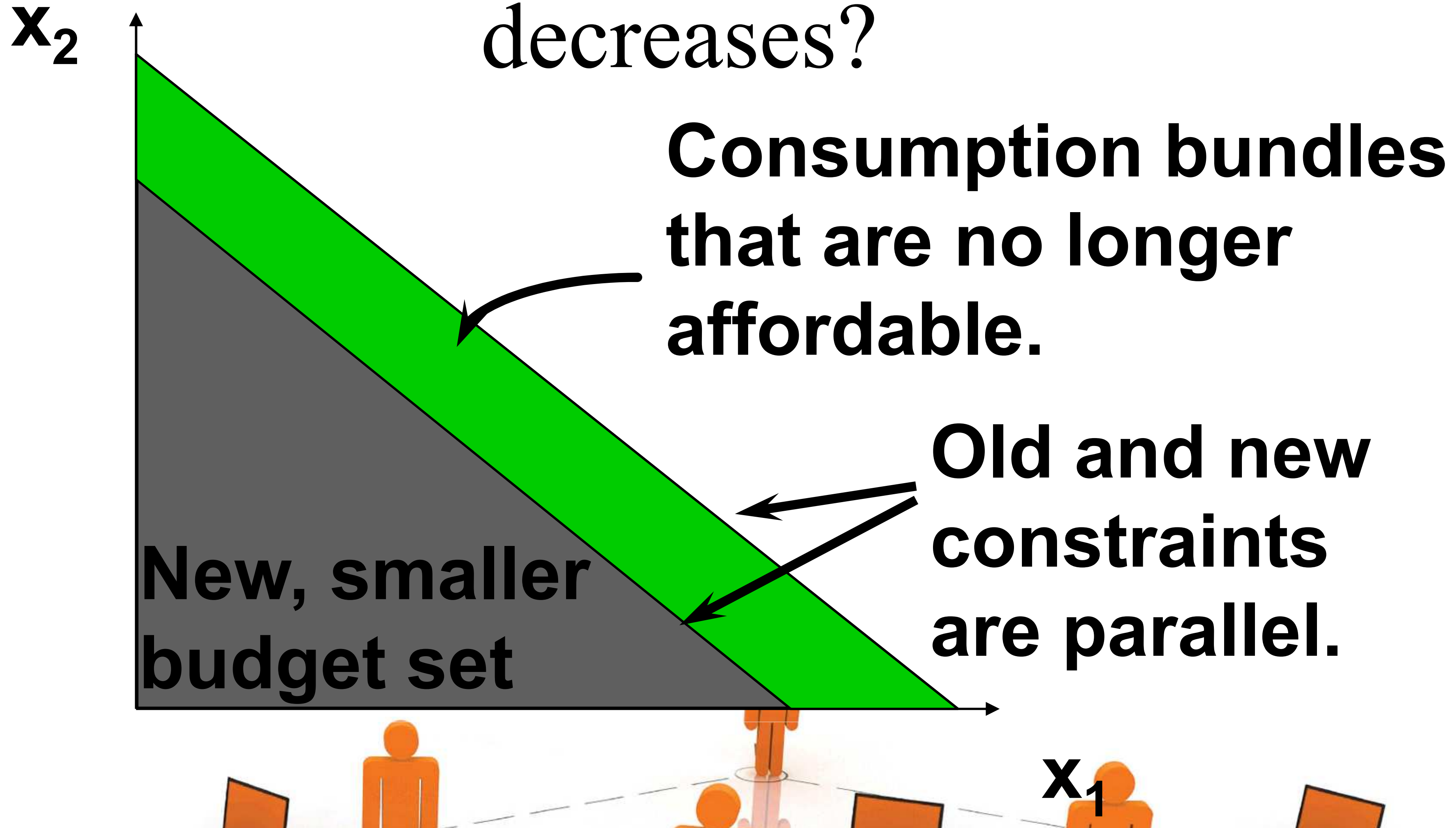


Budget Constraints - Income Changes

- **Increases in income *m* shift the constraint outward in a parallel manner, thereby enlarging the budget set and improving choice.**

Budget Constraints - Income Changes

- **Increases in income *m* shift the constraint outward in a parallel manner, thereby enlarging the budget set and improving choice.**
- **Decreases in income *m* shift the constraint inward in a parallel manner, thereby shrinking the budget set and reducing choice.**

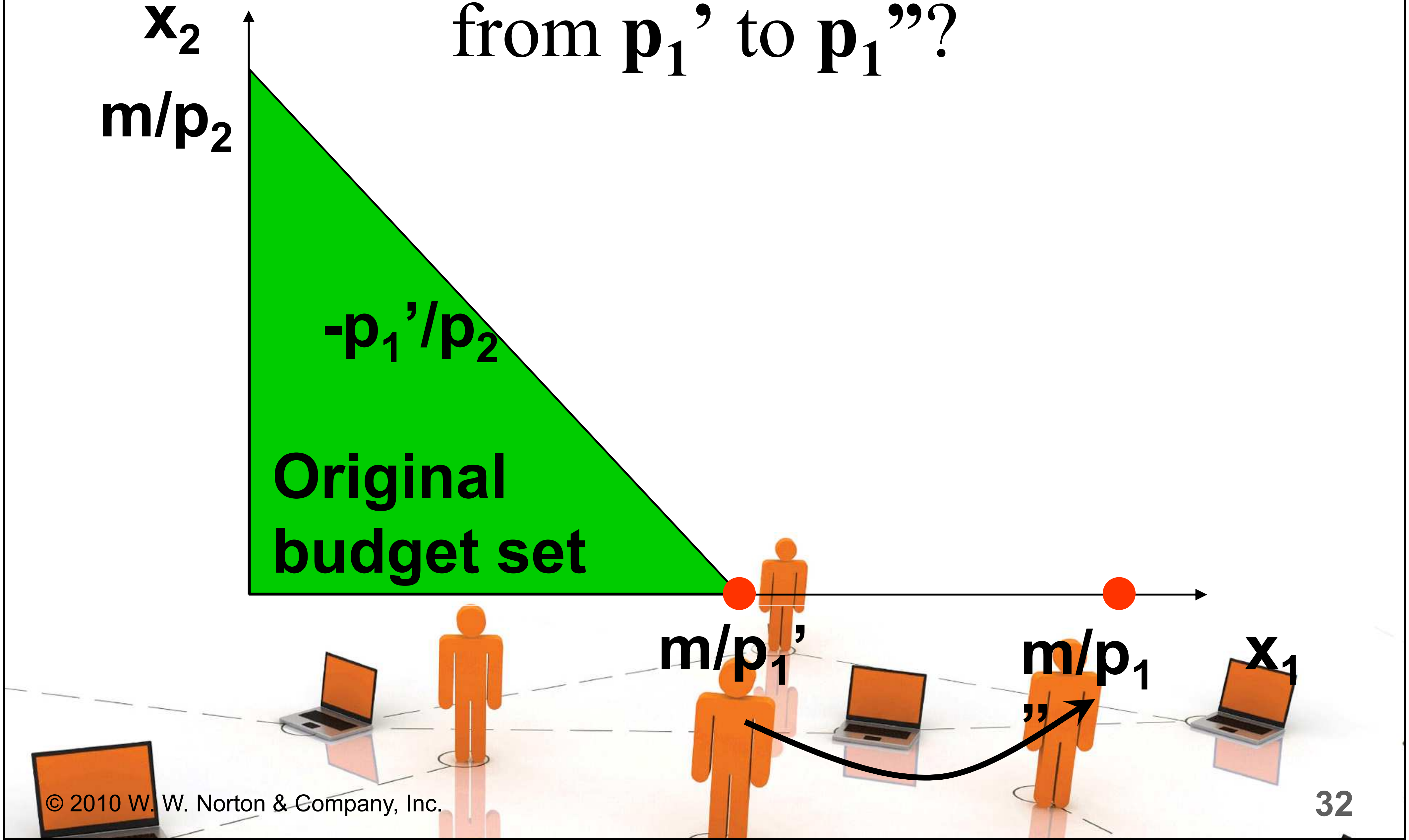
Budget Constraints - Income Changes

- **No original choice is lost and new choices are added when income increases, so higher income cannot make a consumer worse off.**
- **An income decrease may (typically will) make the consumer worse off.**

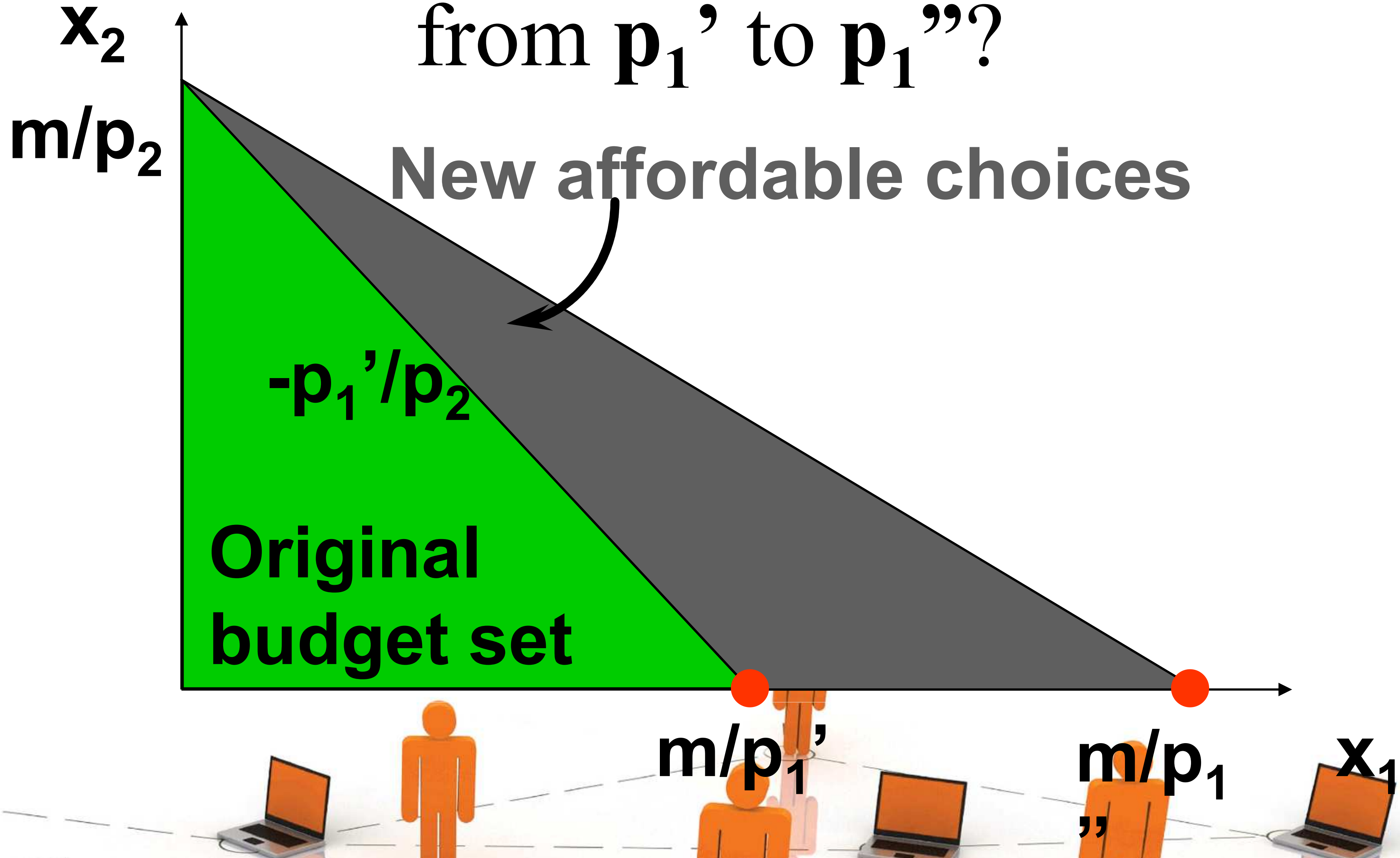
Budget Constraints - Price Changes

- **What happens if just one price decreases?**
- **Suppose p_1 decreases.**

How do the budget set and budget constraint change as p_1 decreases from p_1' to p_1''?



How do the budget set and budget constraint change as $\mathbf{p_1}$ decreases from $\mathbf{p_1}$’ to $\mathbf{p_1}$”?



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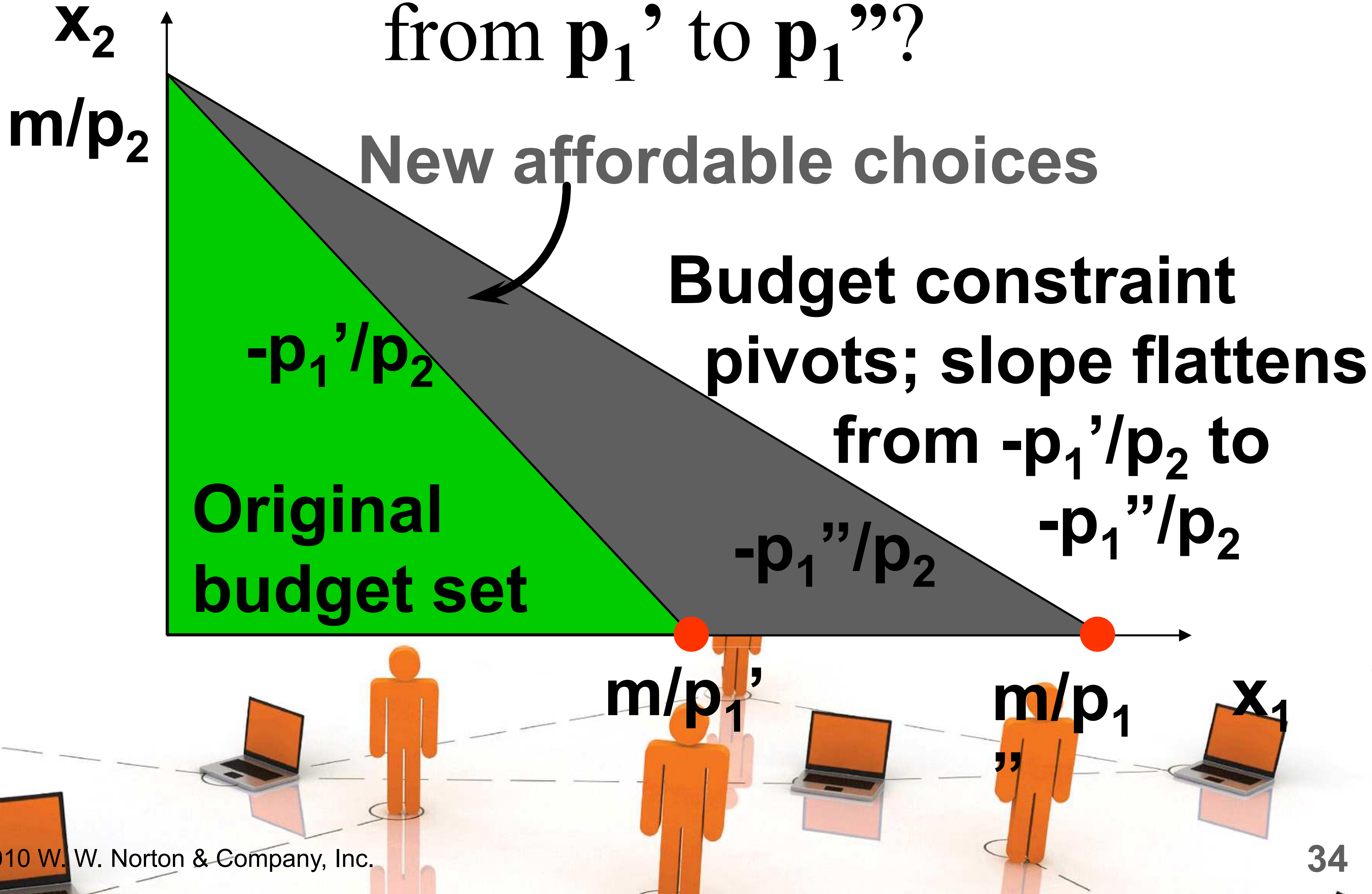
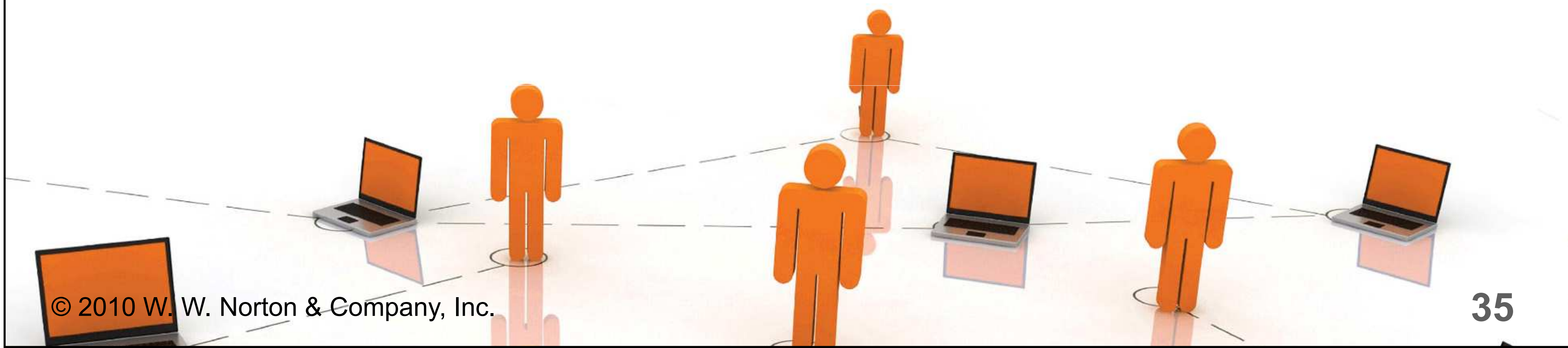


Budget Constraints - Price Changes

- **Reducing the price of one commodity pivots the constraint outward. No old choice is lost and new choices are added, so reducing one price cannot make the consumer worse off.**



Budget Constraints - Price Changes

- **Similarly, increasing one price pivots the constraint inwards, reduces choice and may (typically will) make the consumer worse off.**

Uniform *Ad Valorem* Sales Taxes

- **An *ad valorem* sales tax levied at a rate of 5% increases all prices by 5%, from p to (1+0×05)p = 1×05p.**
- **An *ad valorem* sales tax levied at a rate of *t* increases all prices by *t*p from p to (1+*t*)p.**
- **A uniform sales tax is applied uniformly to all commodities.**

Uniform *Ad Valorem* Sales Taxes

- **A uniform sales tax levied at rate t changes the constraint from**

$$p_1x_1 + p_2x_2 = m$$

to

$$(1+t)p_1x_1 + (1+t)p_2x_2 = m$$

Uniform *Ad Valorem* Sales Taxes

- **A uniform sales tax levied at rate *t* changes the constraint from**

$$p_1x_1 + p_2x_2 = m$$

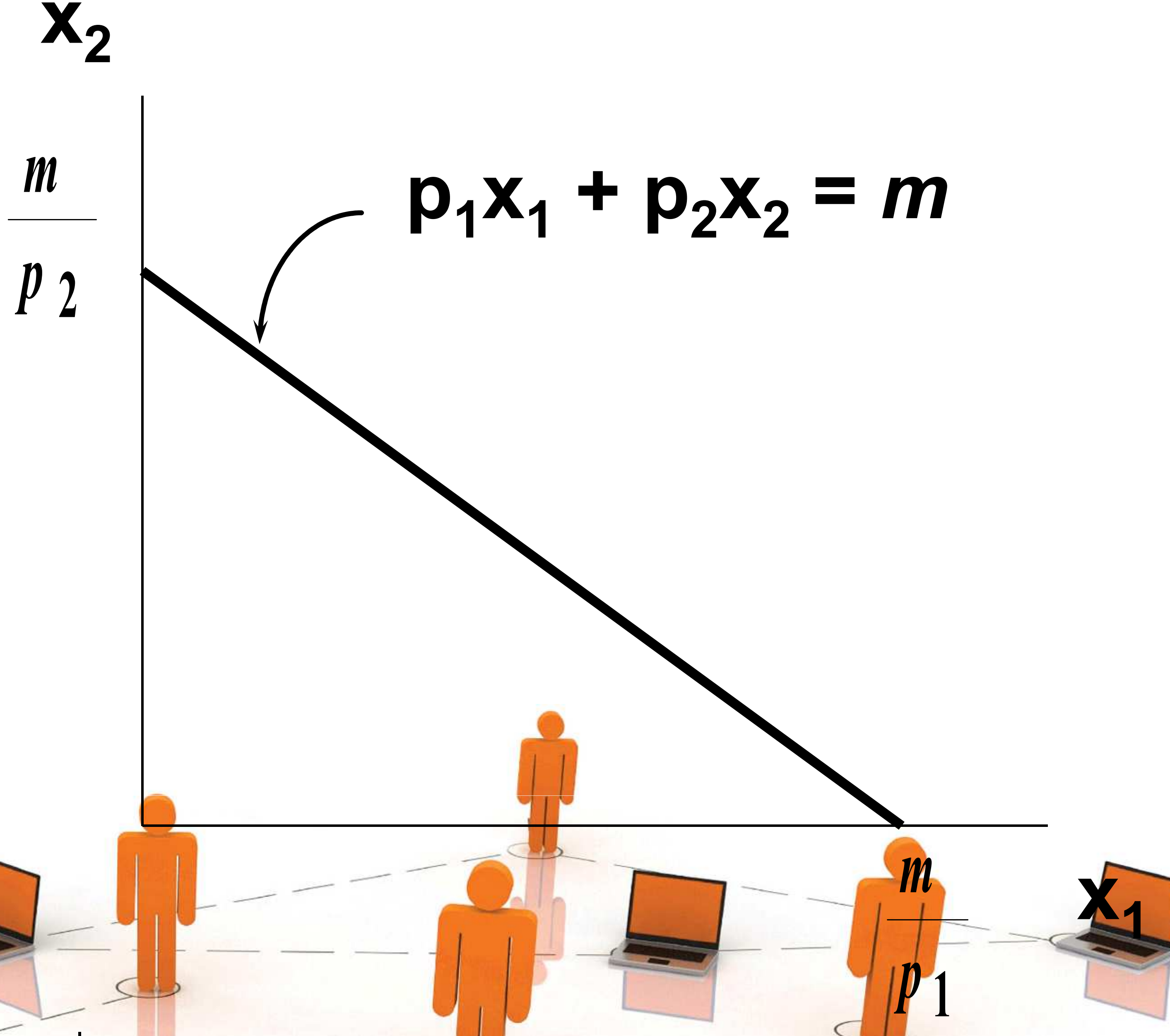
to

$$(1+t)p_1x_1 + (1+t)p_2x_2 = m$$

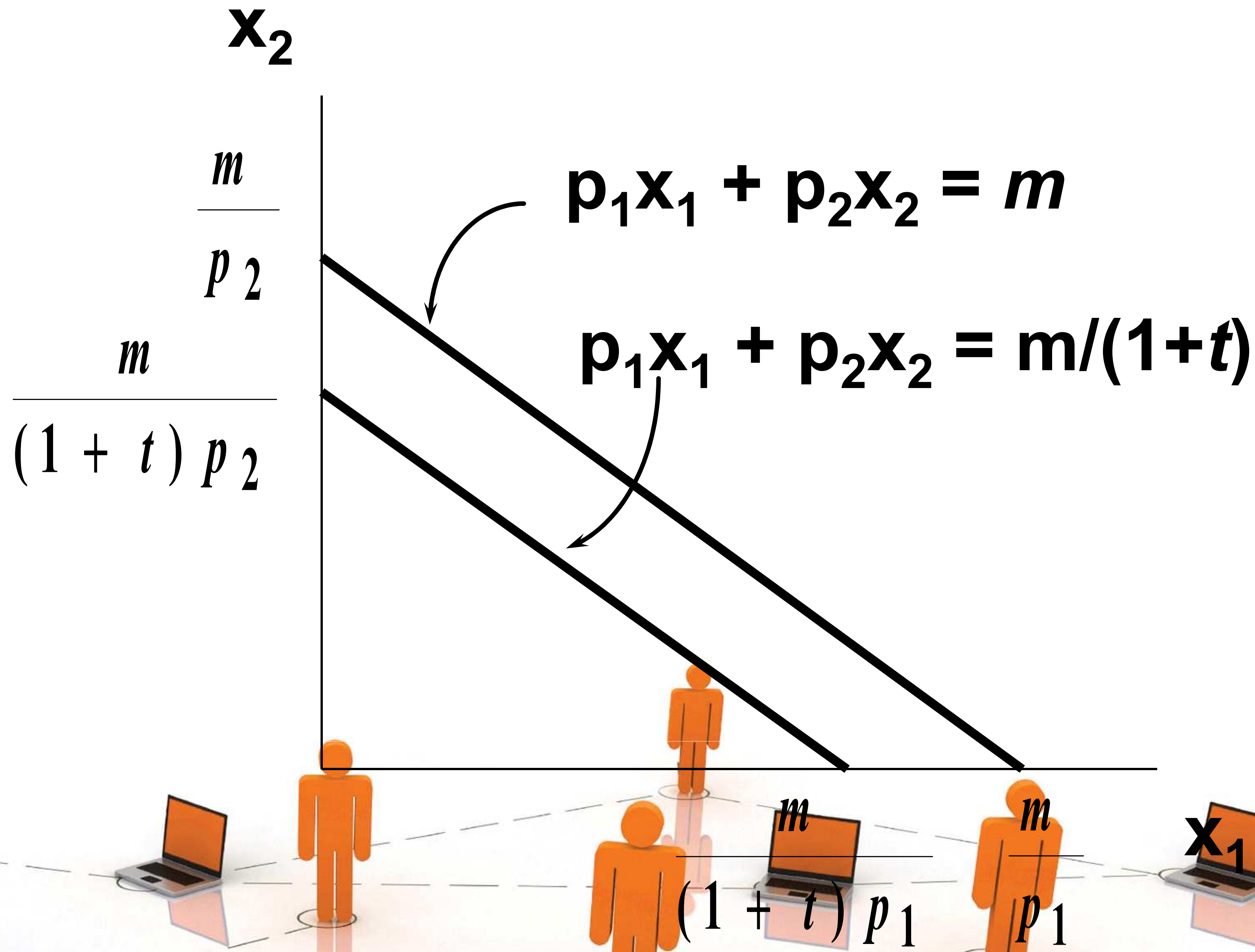
i.e.

$$p_1x_1 + p_2x_2 = m/(1+t).$$

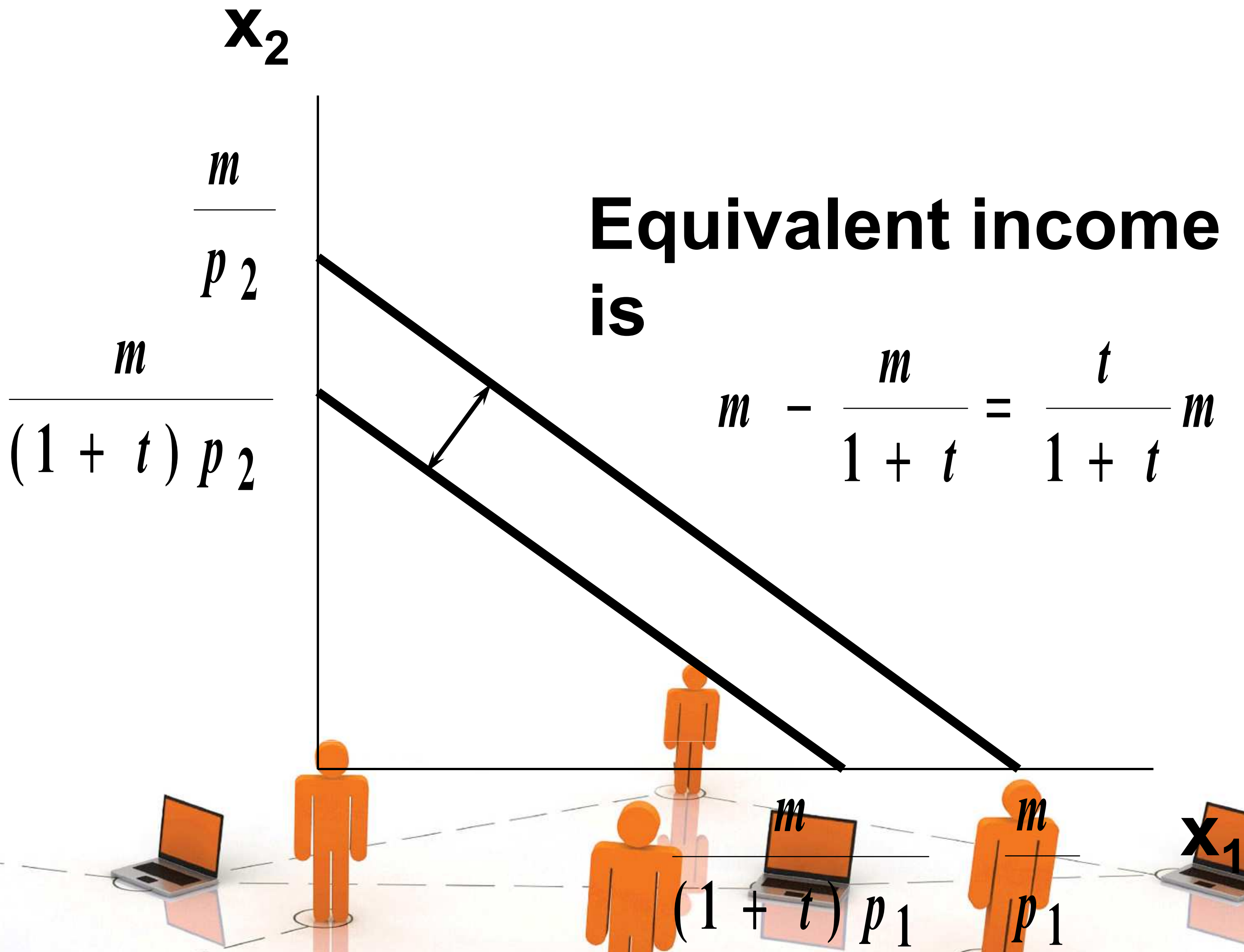
Uniform *Ad Valorem* Sales Taxes



Uniform *Ad Valorem* Sales Taxes



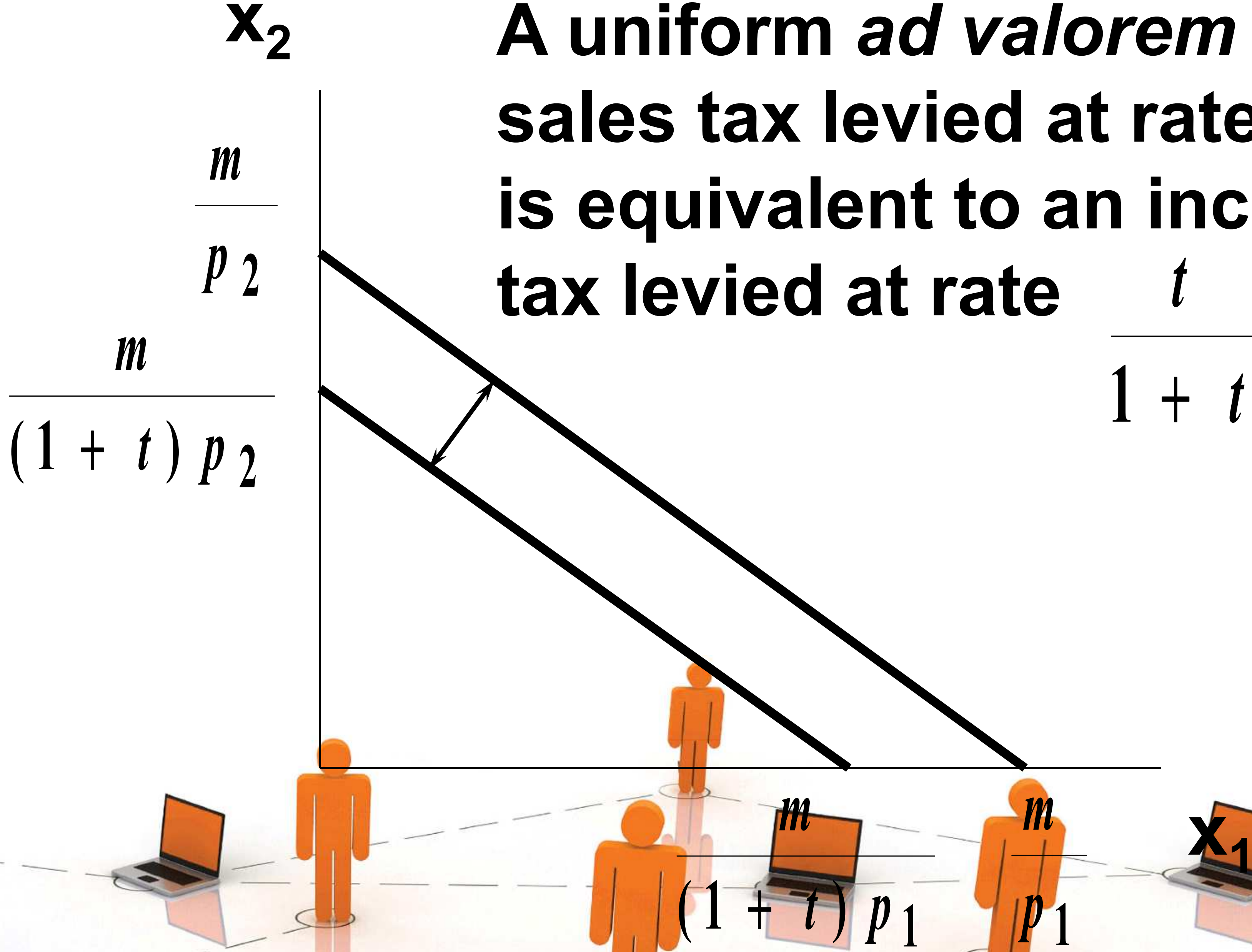
Uniform *Ad Valorem* Sales Taxes



Equivalent income loss is

$$m - \frac{m}{1+t} = \frac{t}{1+t}m$$

Uniform *Ad Valorem* Sales Taxes



A uniform *ad valorem* sales tax levied at rate *t* is equivalent to an income tax levied at rate $\frac{t}{1+t}$.

The Food Stamp Program

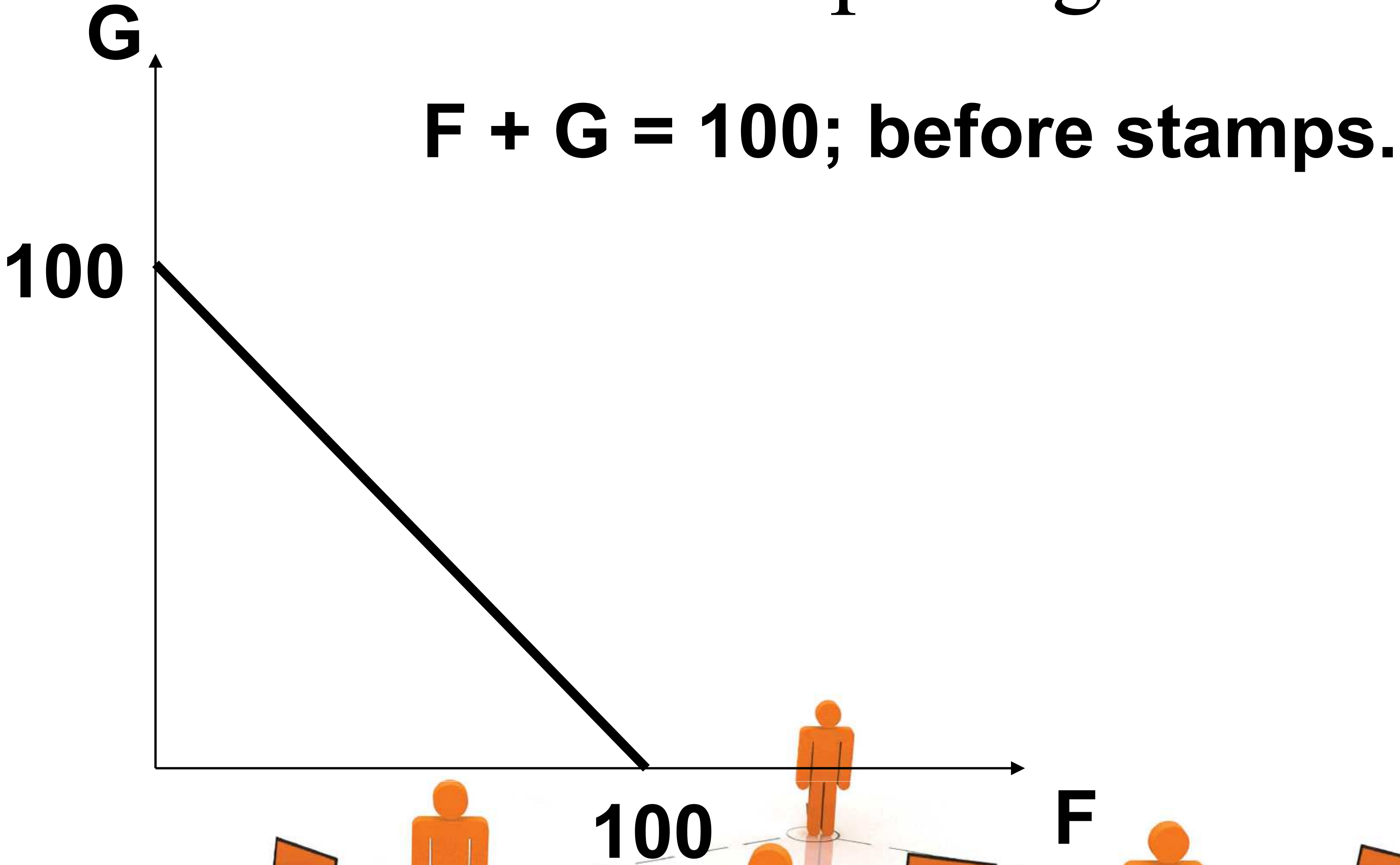
- Food stamps are coupons that can be legally exchanged only for food.
- How does a commodity-specific gift such as a food stamp alter a family’s budget constraint?

The Food Stamp Program

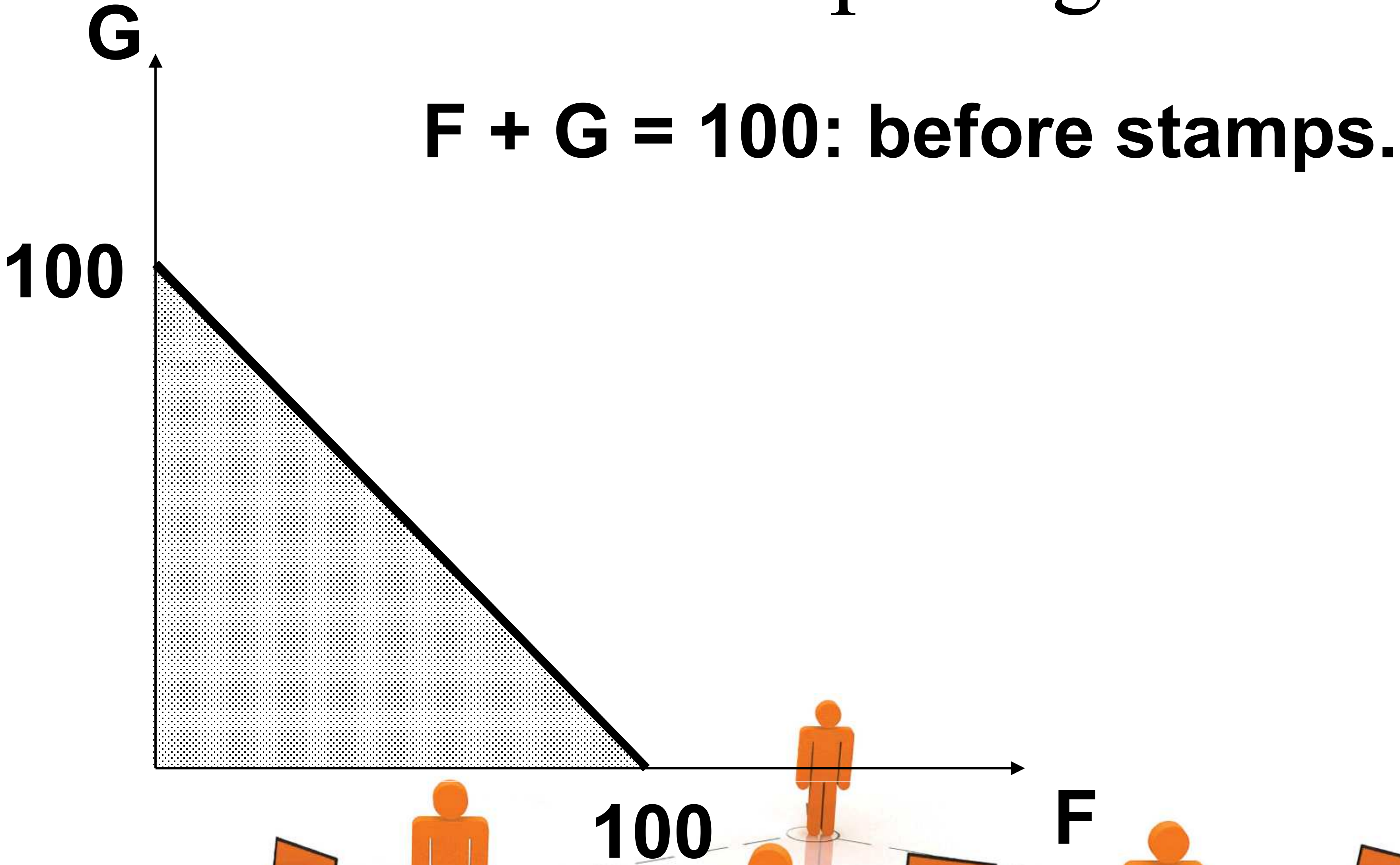
- Suppose m = \$100, p_F = \$1 and the price of “other goods” is p_G = \$1.
- The budget constraint is then

$$F + G = 100.$$

The Food Stamp Program



The Food Stamp Program



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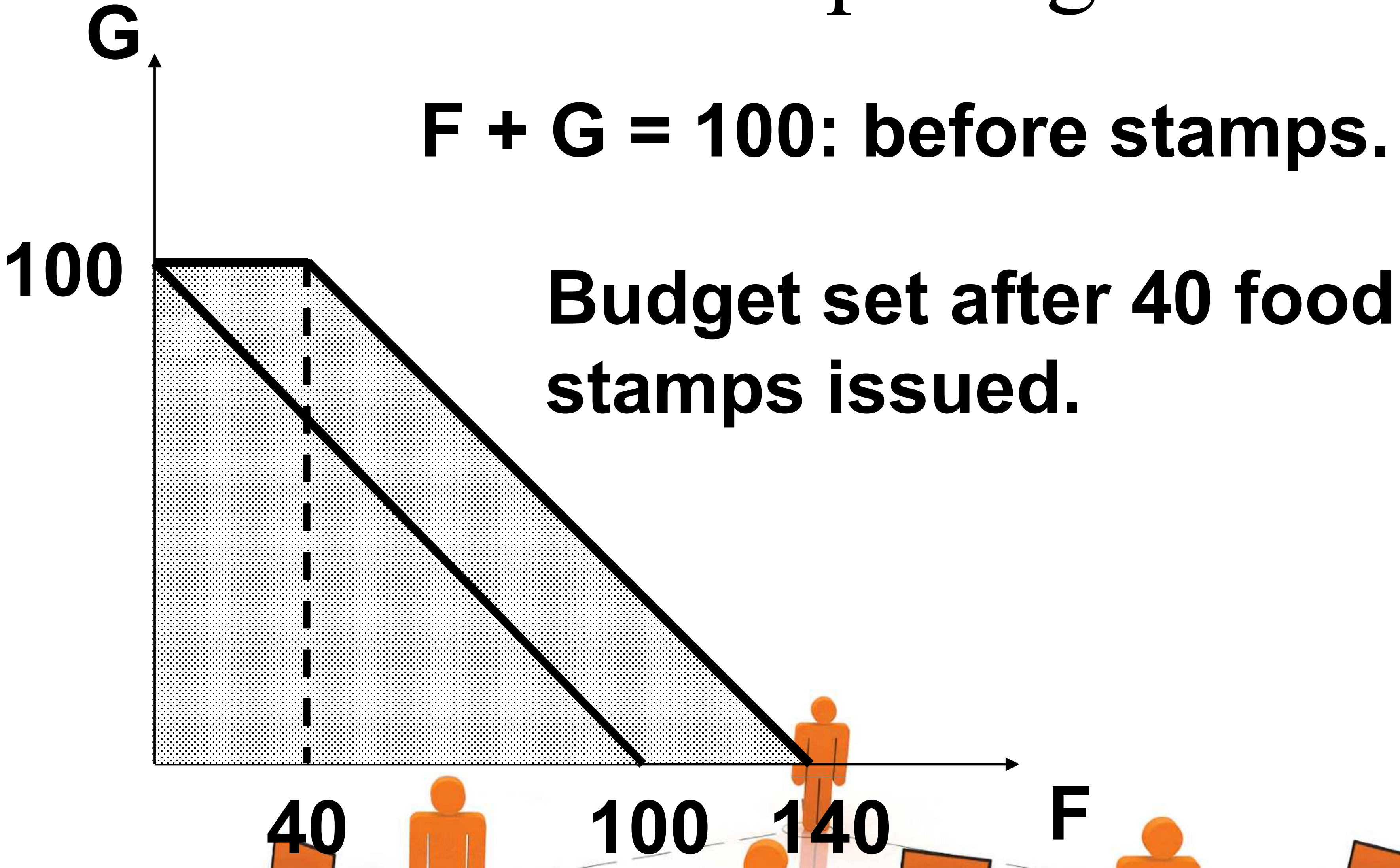
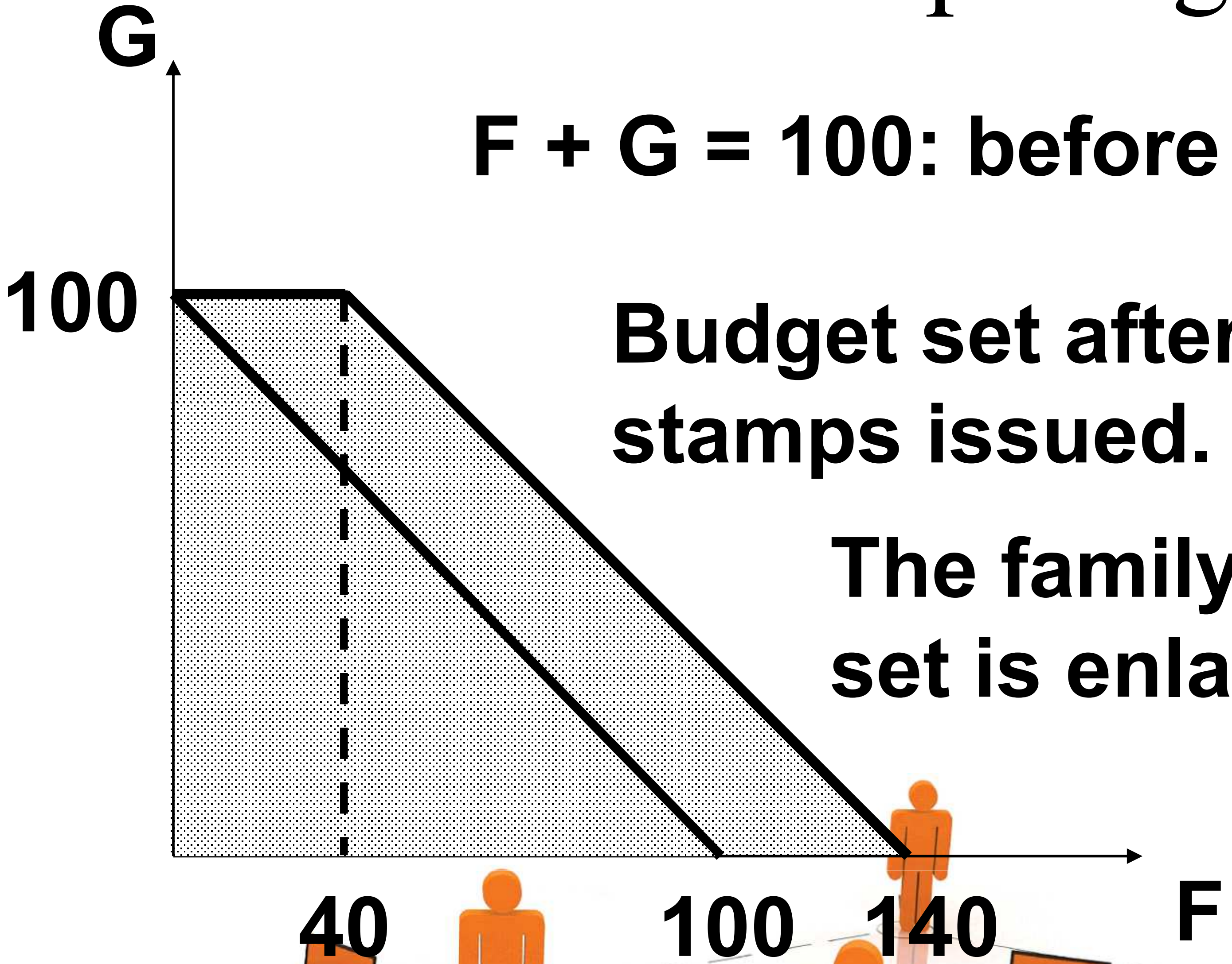


The Food Stamp Program



F + G = 100: before stamps.

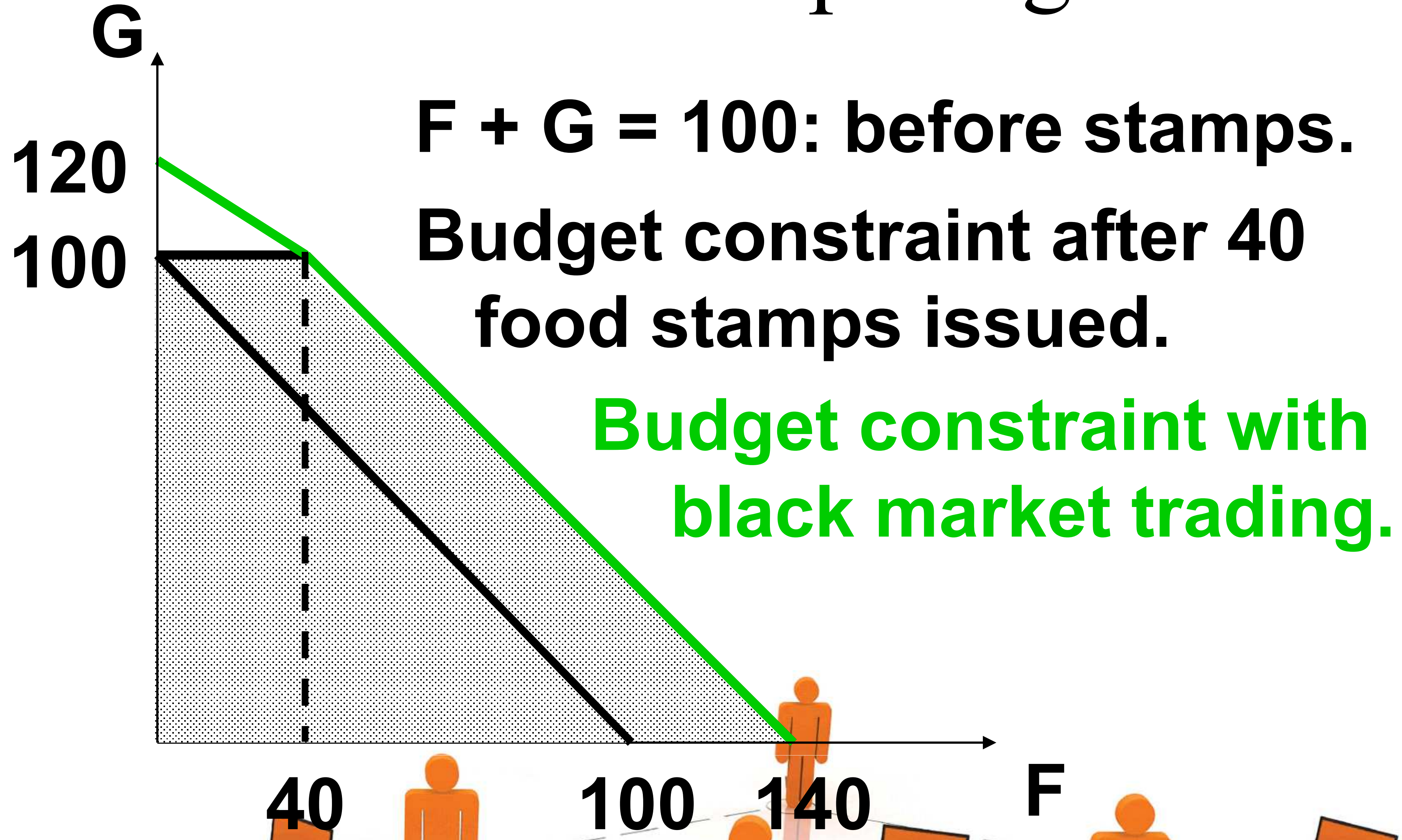
Budget set after 40 food stamps issued.

The family's budget set is enlarged.

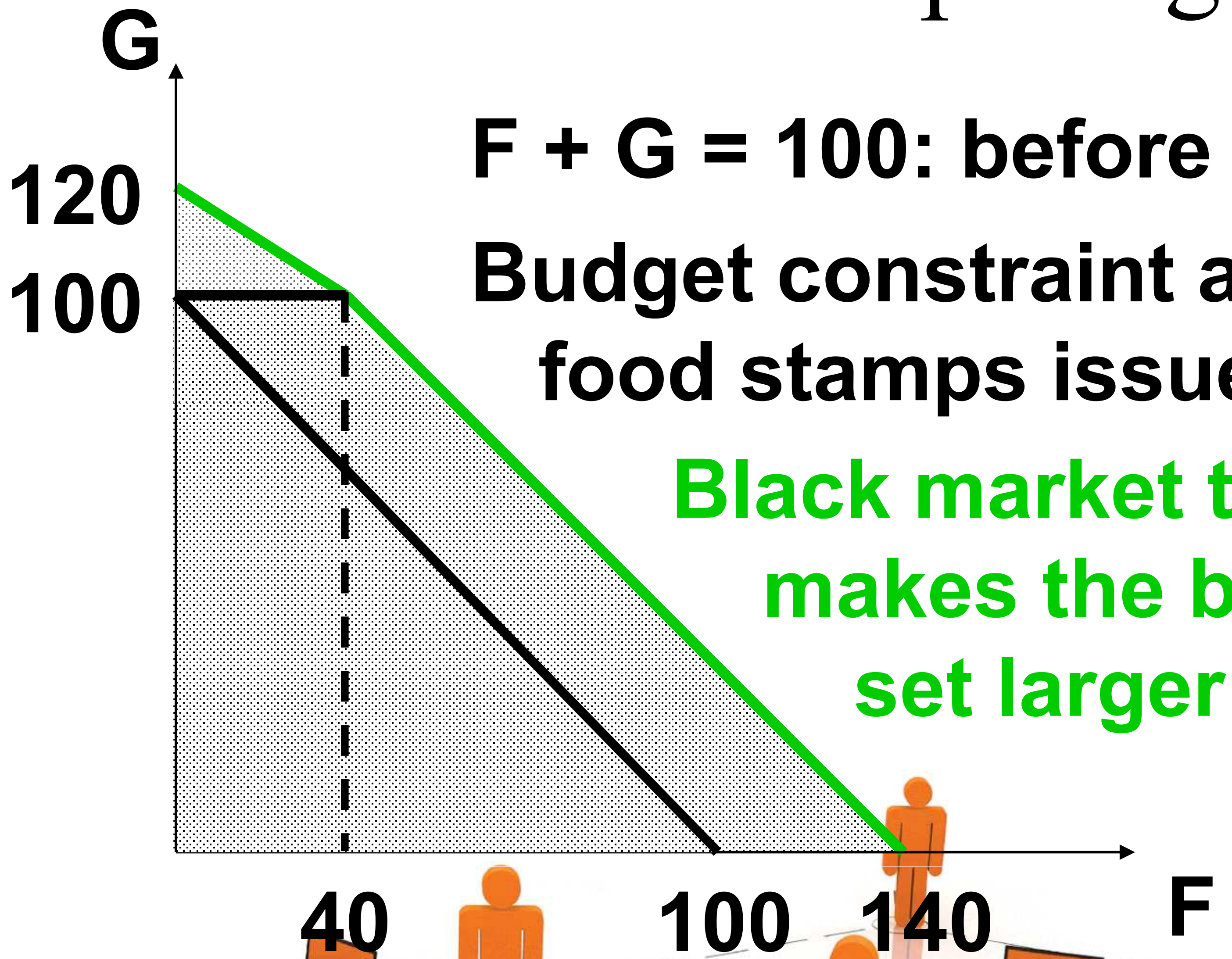
The Food Stamp Program

- **What if food stamps can be traded on a black market for $0.50 each?**

The Food Stamp Program



The Food Stamp Program



F + G = 100: before stamps.

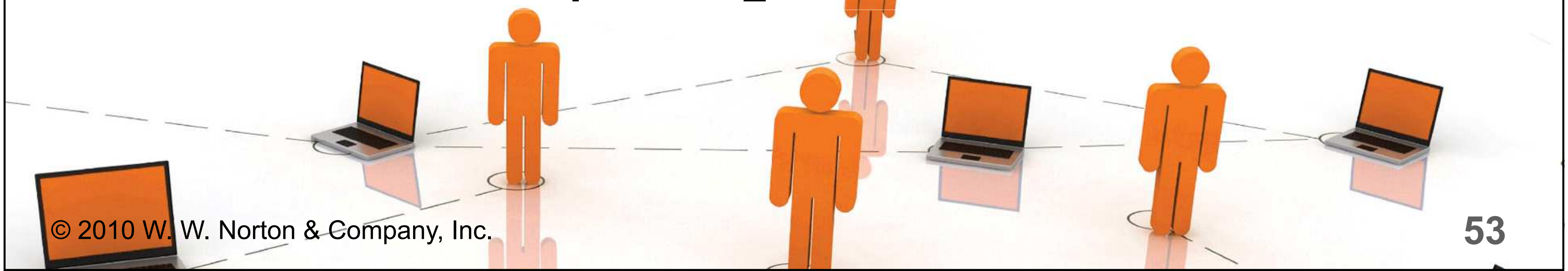
Budget constraint after 40 food stamps issued.

Black market trading makes the budget set larger again.

Budget Constraints - Relative Prices

- **"Numeraire" means "unit of account".**
- **Suppose prices and income are measured in dollars. Say p_1=\$2, p_2=\$3, *m* = \$12. Then the constraint is**

$$2x_1 + 3x_2 = 12.$$



Budget Constraints - Relative Prices

- If prices and income are measured in cents, then p_1=200, p_2=300, *m*=1200 and the constraint is

$$200x_1 + 300x_2 = 1200,$$

the same as

$$2x_1 + 3x_2 = 12.$$

- Changing the numeraire changes neither the budget constraint nor the budget set.

Budget Constraints - Relative Prices

- **The constraint for $p_1=2$, $p_2=3$, $m=12$**

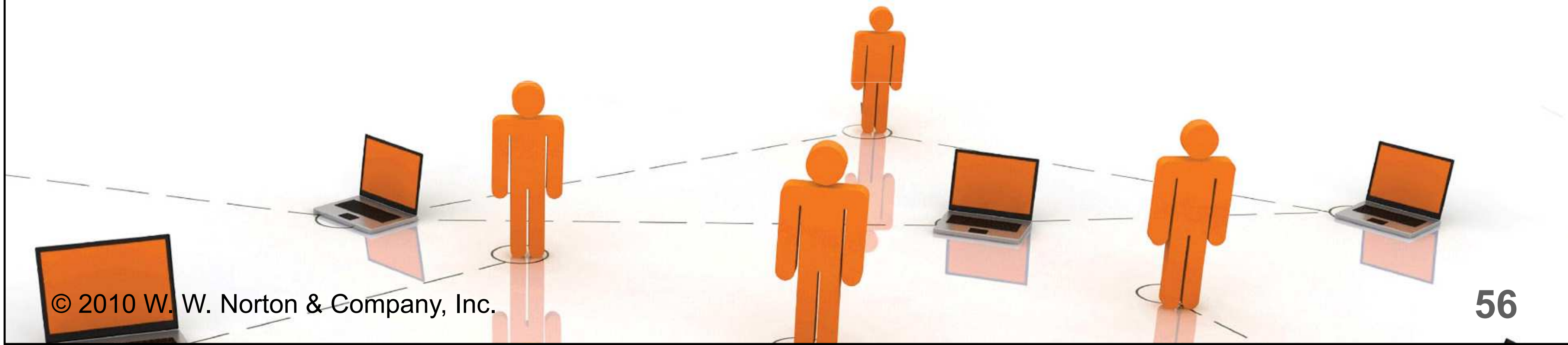
$$2x_1 + 3x_2 = 12$$

is also $$1.x_1 + (3/2)x_2 = 6,$$

the constraint for $p_1=1$, $p_2=3/2$, $m=6$. Setting $p_1=1$ makes commodity 1 the numeraire and defines all prices relative to p_1; *e.g.* 3/2 is the price of commodity 2 relative to the price of commodity 1.

Budget Constraints - Relative Prices

- **Any commodity can be chosen as the numeraire without changing the budget set or the budget constraint.**



Budget Constraints - Relative Prices

- p_1=2, p_2=3 and p_3=6 $\Rightarrow$
- price of commodity 2 relative to commodity 1 is 3/2,
- price of commodity 3 relative to commodity 1 is 3.
- Relative prices are the rates of exchange of commodities 2 and 3 for units of commodity 1.

Shapes of Budget Constraints

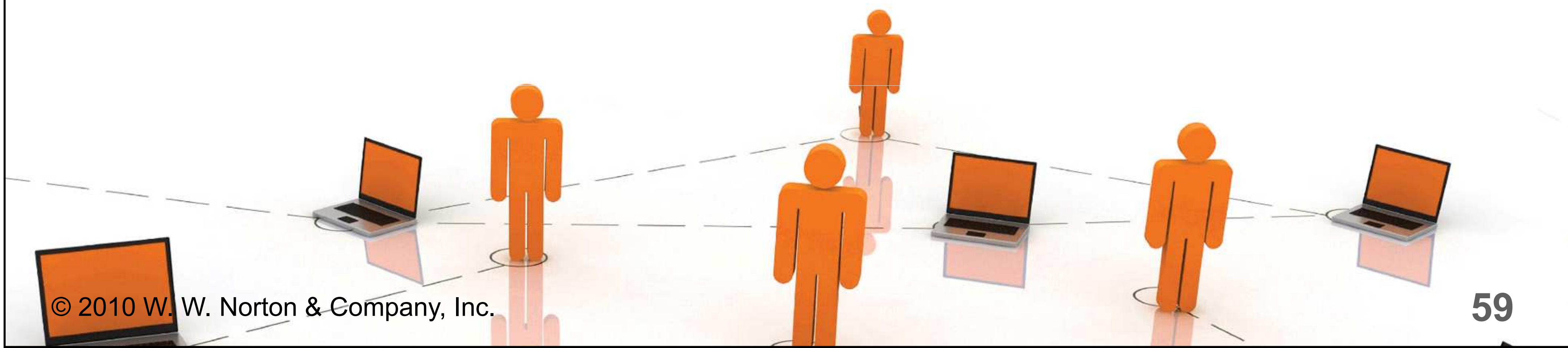
- **Q: What makes a budget constraint a straight line?**
- **A: A straight line has a constant slope and the constraint is**

$$p_1x_1 + \ldots + p_nx_n = m$$

so if prices are constants then a constraint is a straight line.

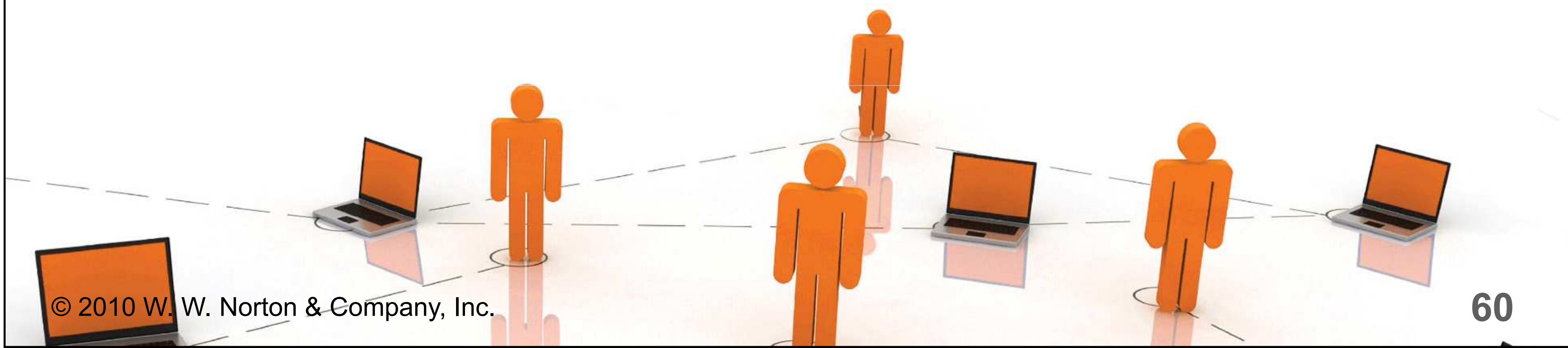
Shapes of Budget Constraints

- But what if prices are not constants?
- *E.g.* bulk buying discounts, or price penalties for buying "too much".
- Then constraints will be curved.



Shapes of Budget Constraints - Quantity Discounts

- **Suppose p_2 is constant at \$1 but that p_1=\$2 for $0 \leq x_1 \leq 20$ and p_1=\$1 for x_1>20.**



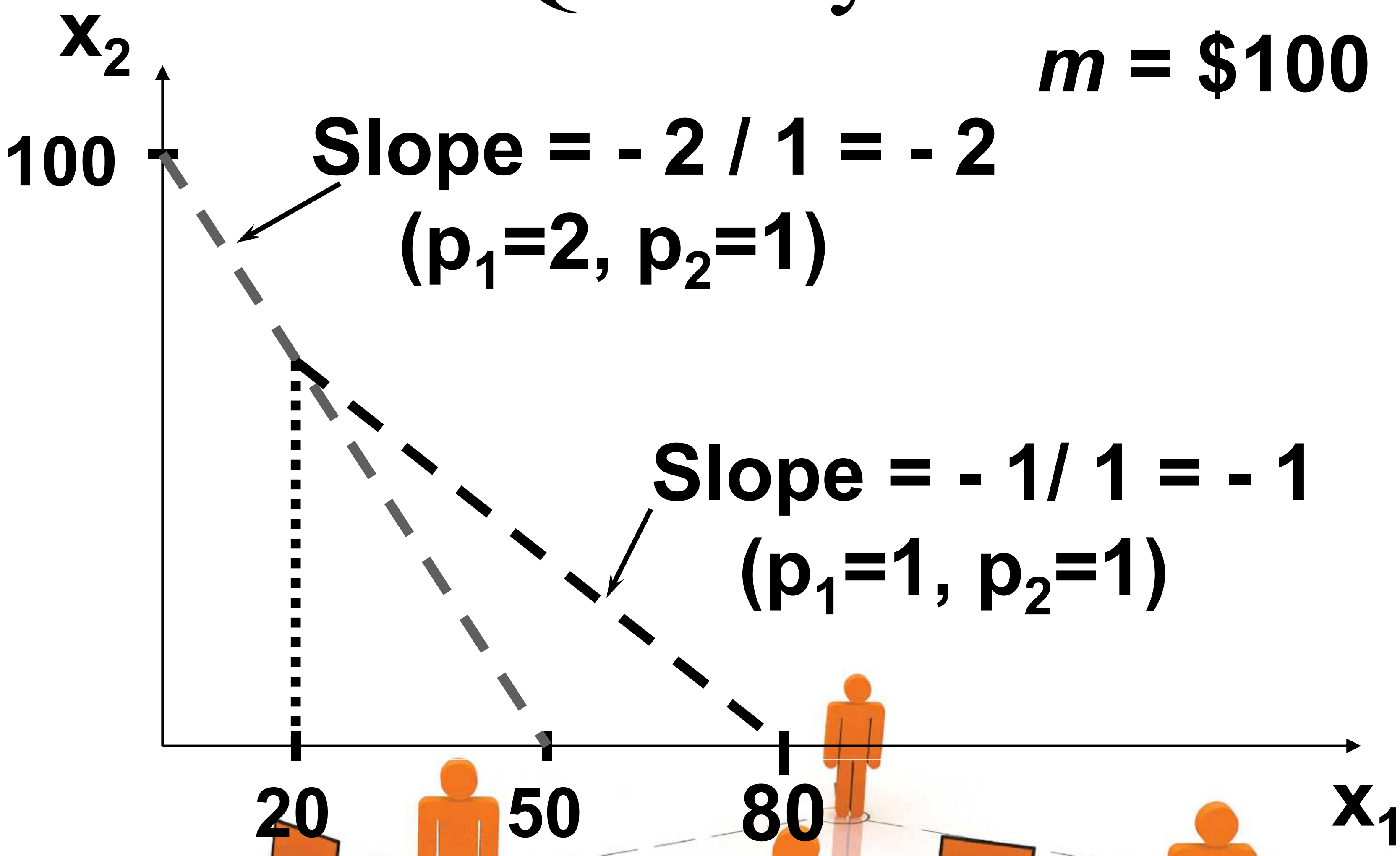
Shapes of Budget Constraints - Quantity Discounts

- **Suppose p_2 is constant at \$1 but that p_1=\$2 for $0 \le x_1 \le 20$ and p_1=\$1 for x_1>20. Then the constraint's slope is**

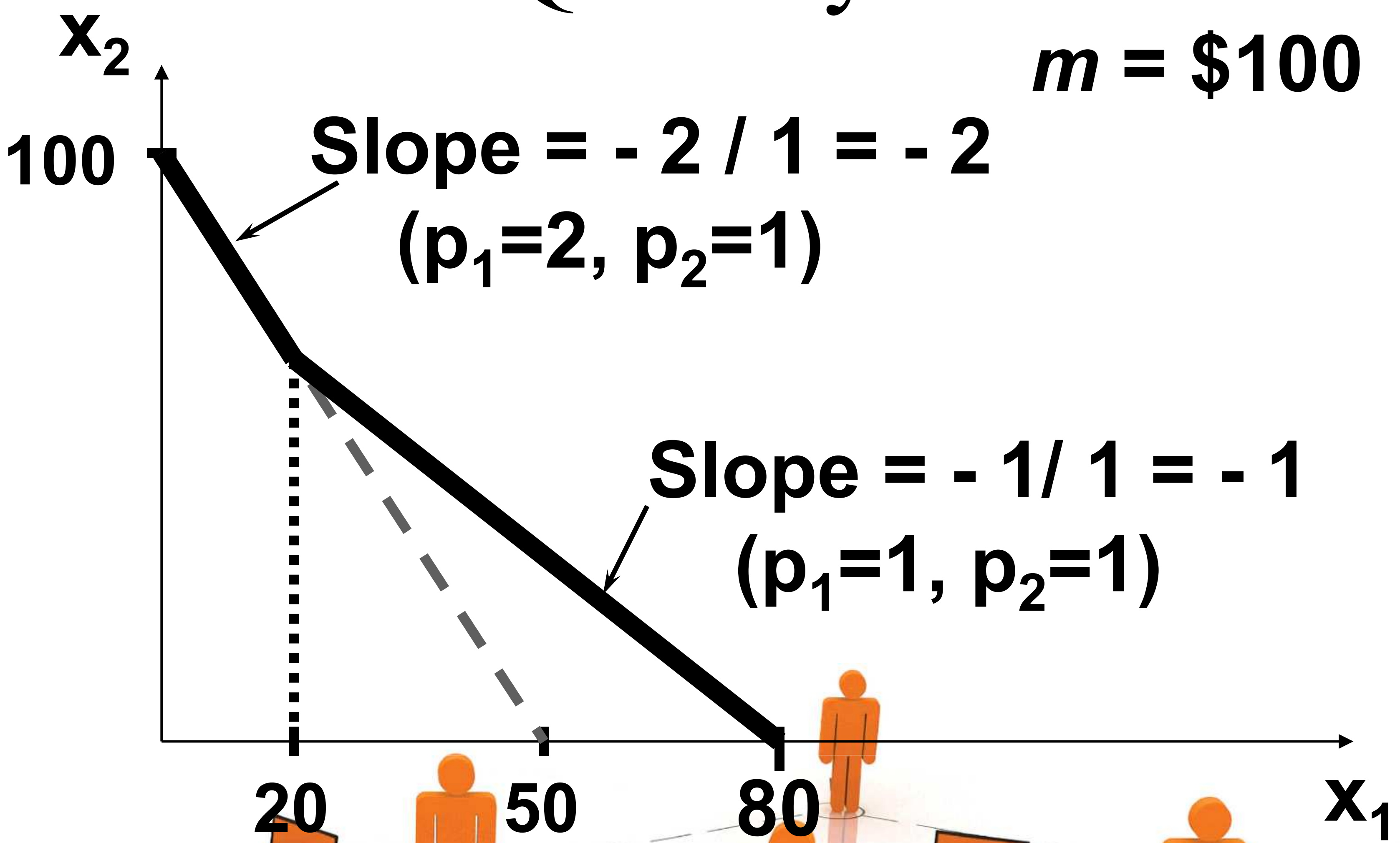
$$-p_1/p_2 = \begin{cases} -2, & \text{for } 0 \le x_1 \le 20 \\ -1, & \text{for } x_1 > 20 \end{cases}$$

and the constraint is

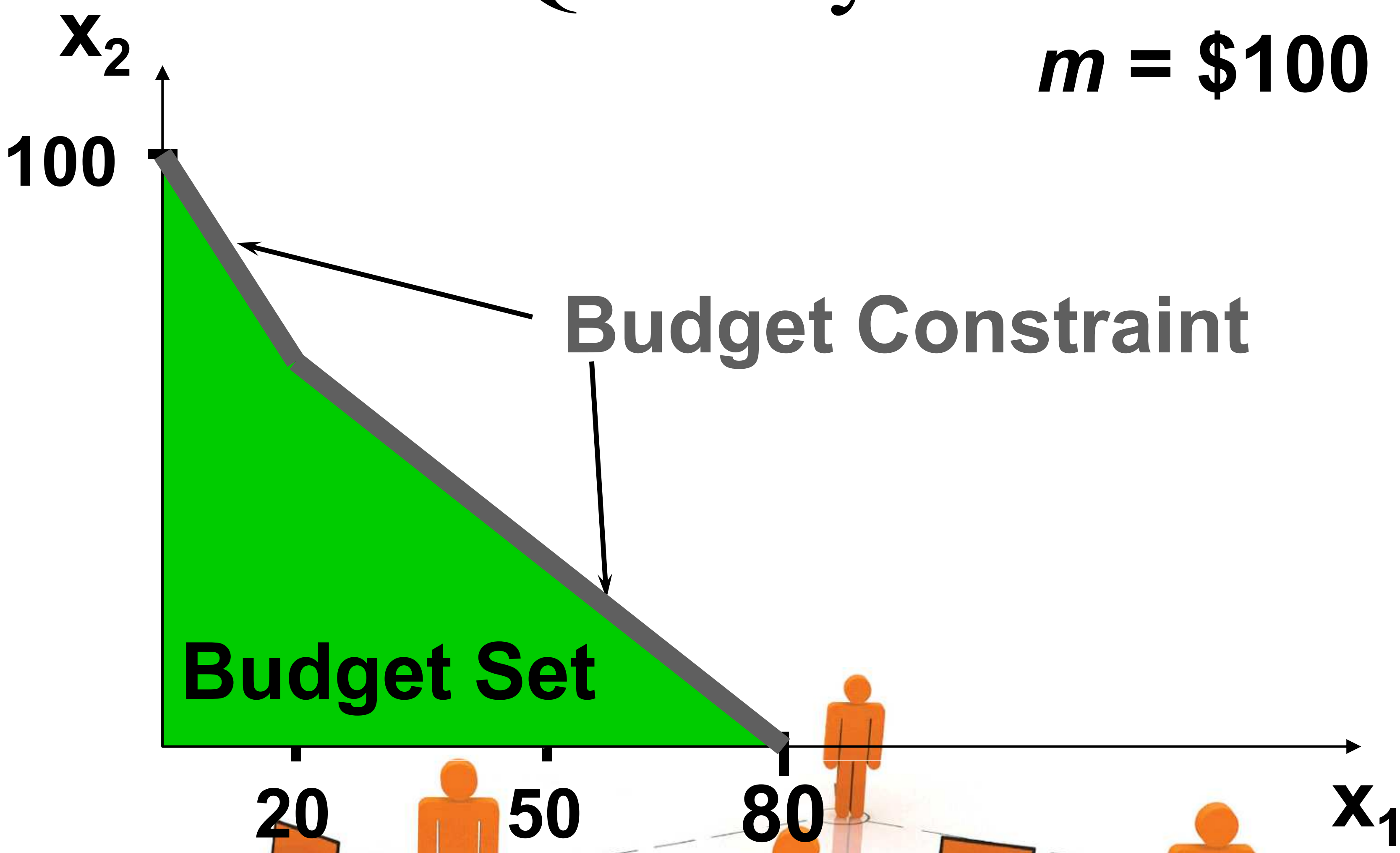
Shapes of Budget Constraints with a Quantity Discount



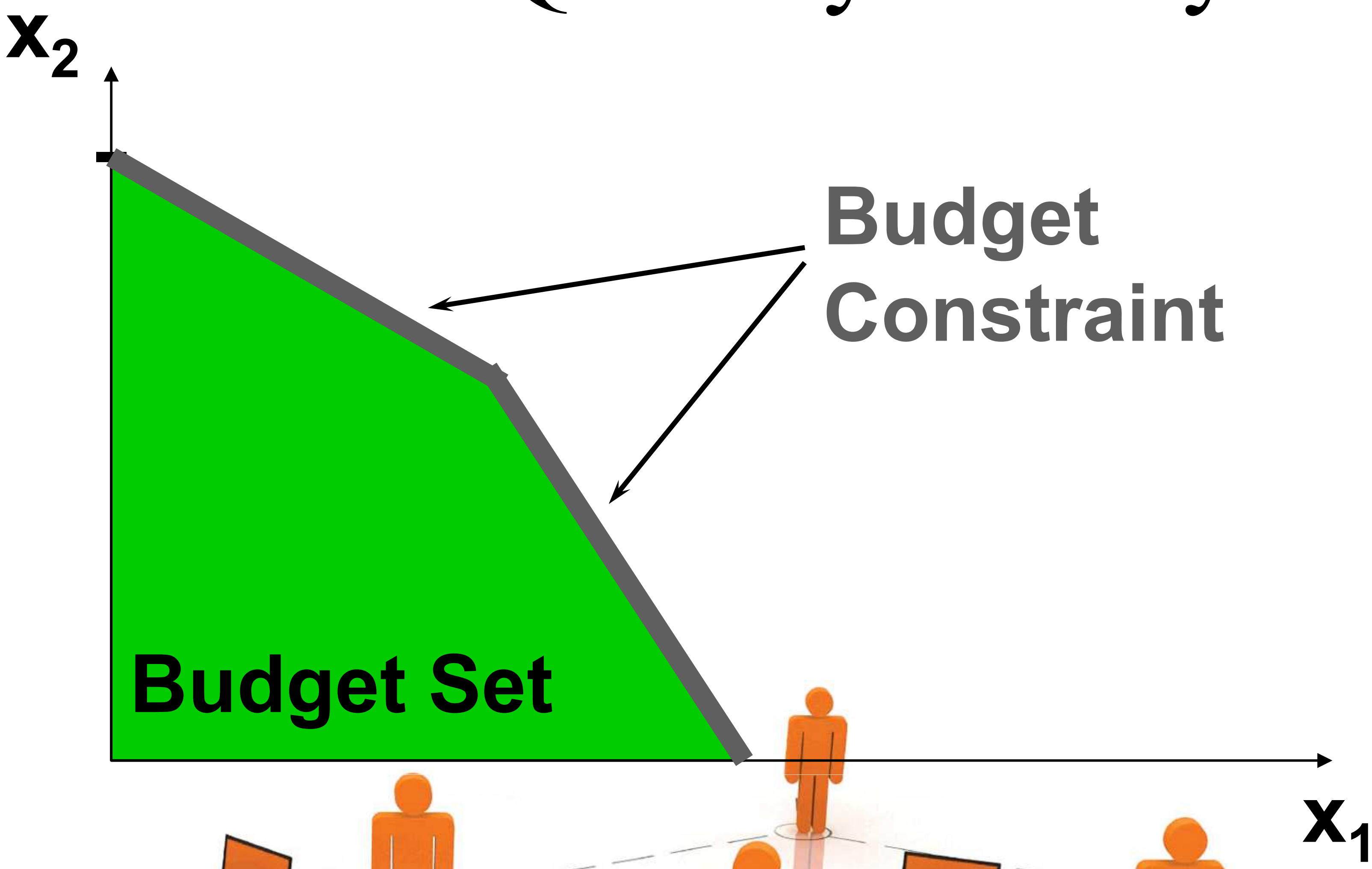
Shapes of Budget Constraints with a Quantity Discount



Shapes of Budget Constraints with a Quantity Discount



Shapes of Budget Constraints with a Quantity Penalty

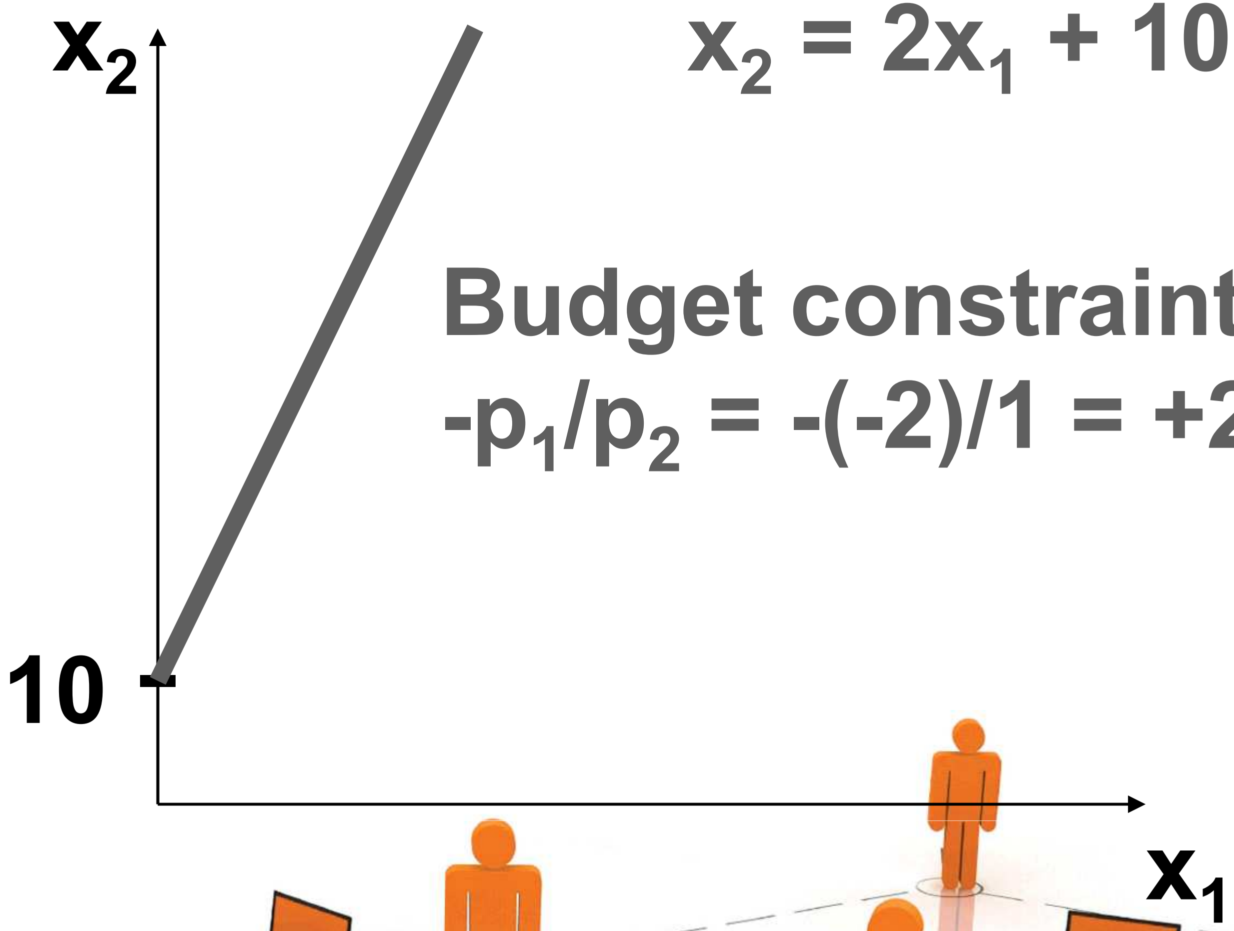


Shapes of Budget Constraints - One Price Negative

- **Commodity 1 is stinky garbage. You are paid \$2 per unit to accept it; *i.e.* p_1 = - \$2. p_2 = \$1. Income, other than from accepting commodity 1, is *m* = \$10.**
- **Then the constraint is**

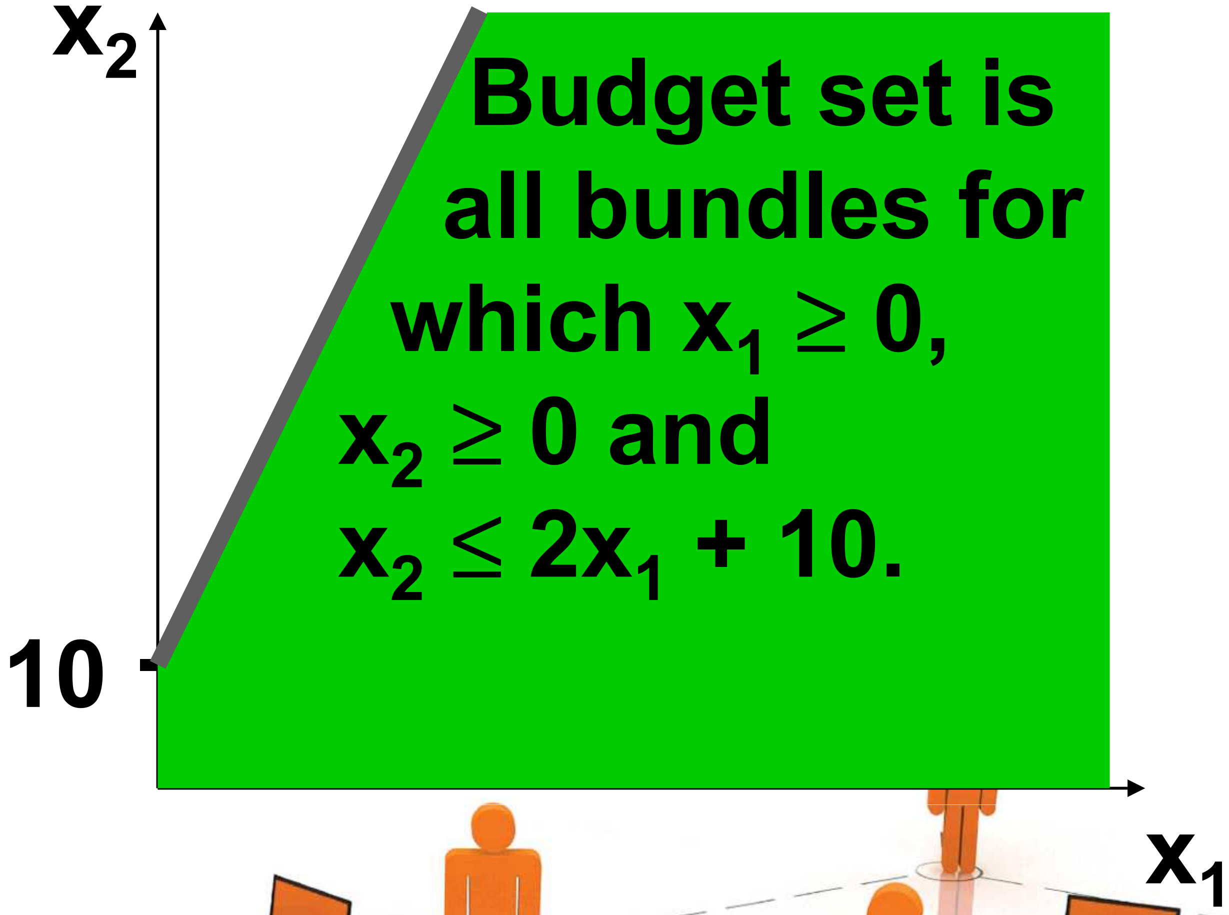
$$-2x_1 + x_2 = 10 \quad \text{or} \quad x_2 = 2x_1 + 10.$$

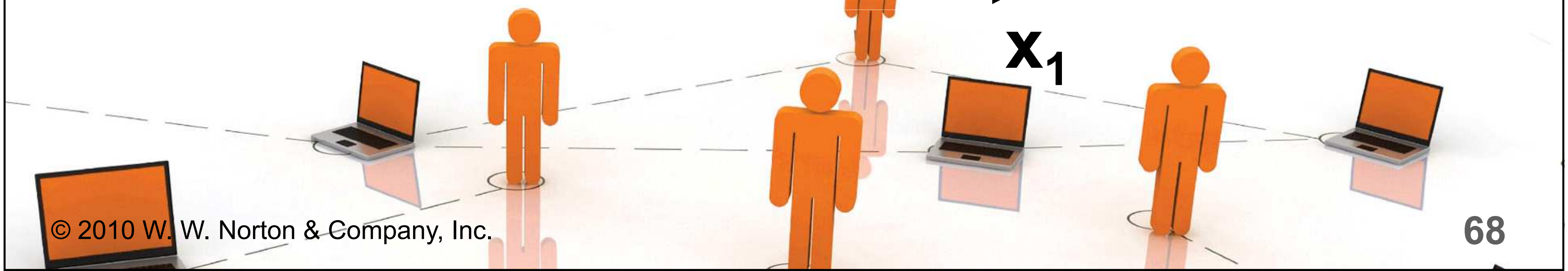
Shapes of Budget Constraints - One Price Negative



Budget constraint's slope is $-p_1/p_2 = -(-2)/1 = +2$

Shapes of Budget Constraints - One Price Negative



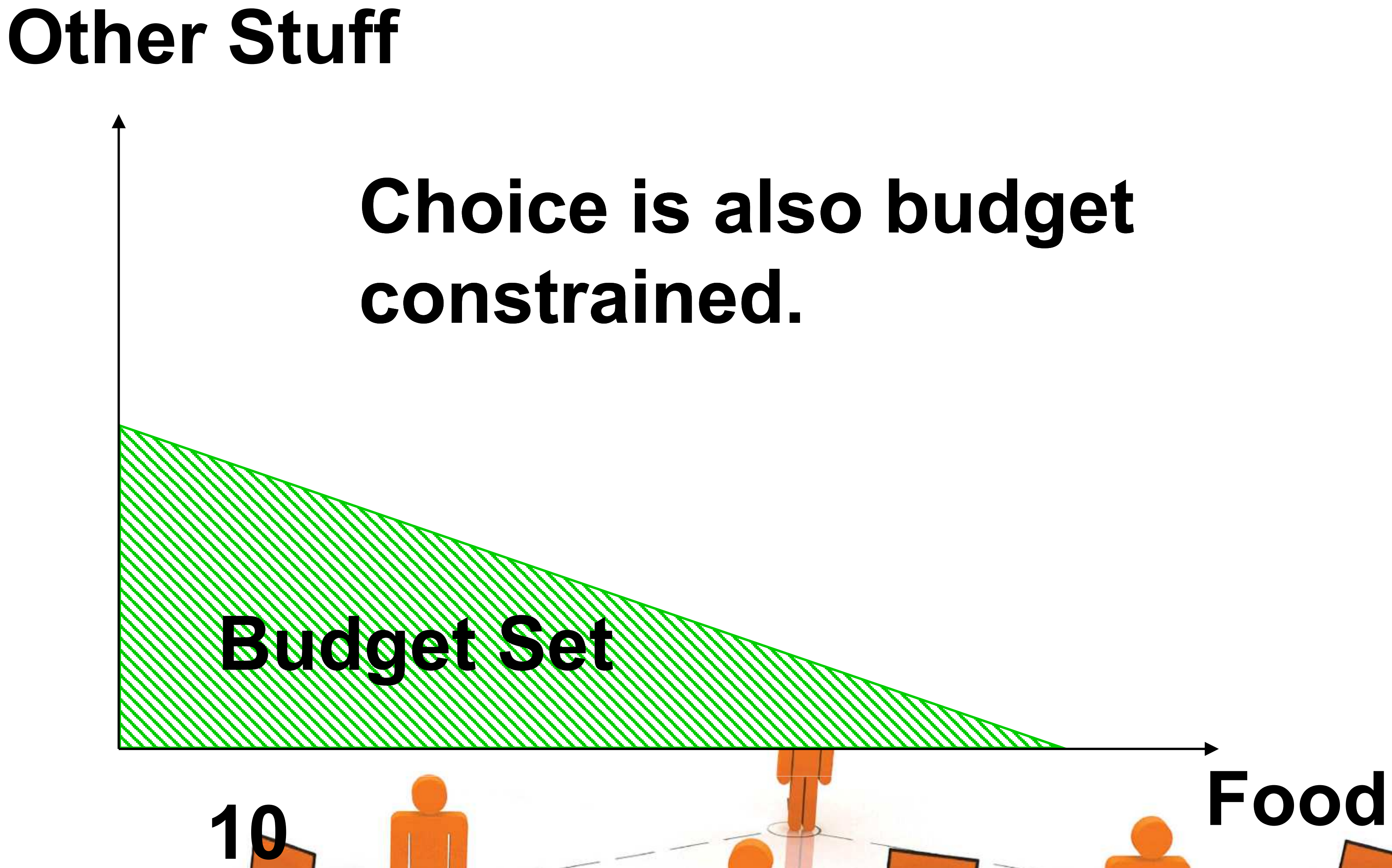


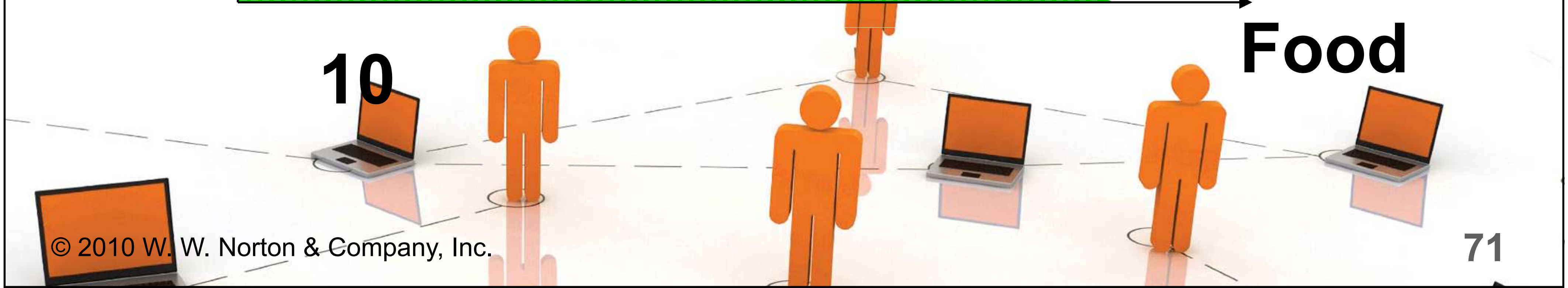
More General Choice Sets

- Choices are usually constrained by more than a budget; e.g. time constraints and other resources constraints.
- A bundle is available only if it meets every constraint.

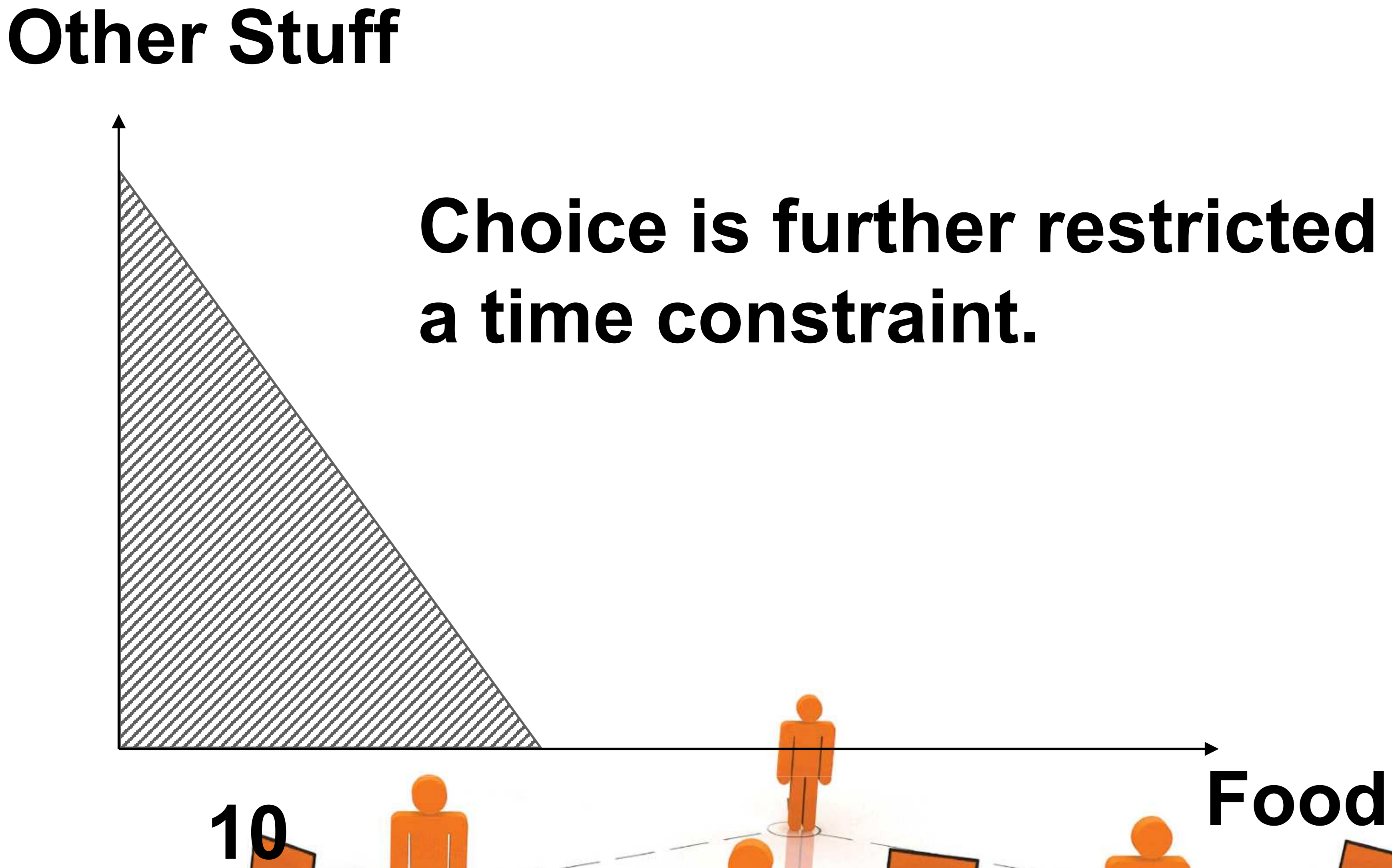
More General Choice Sets

More General Choice Sets





More General Choice Sets

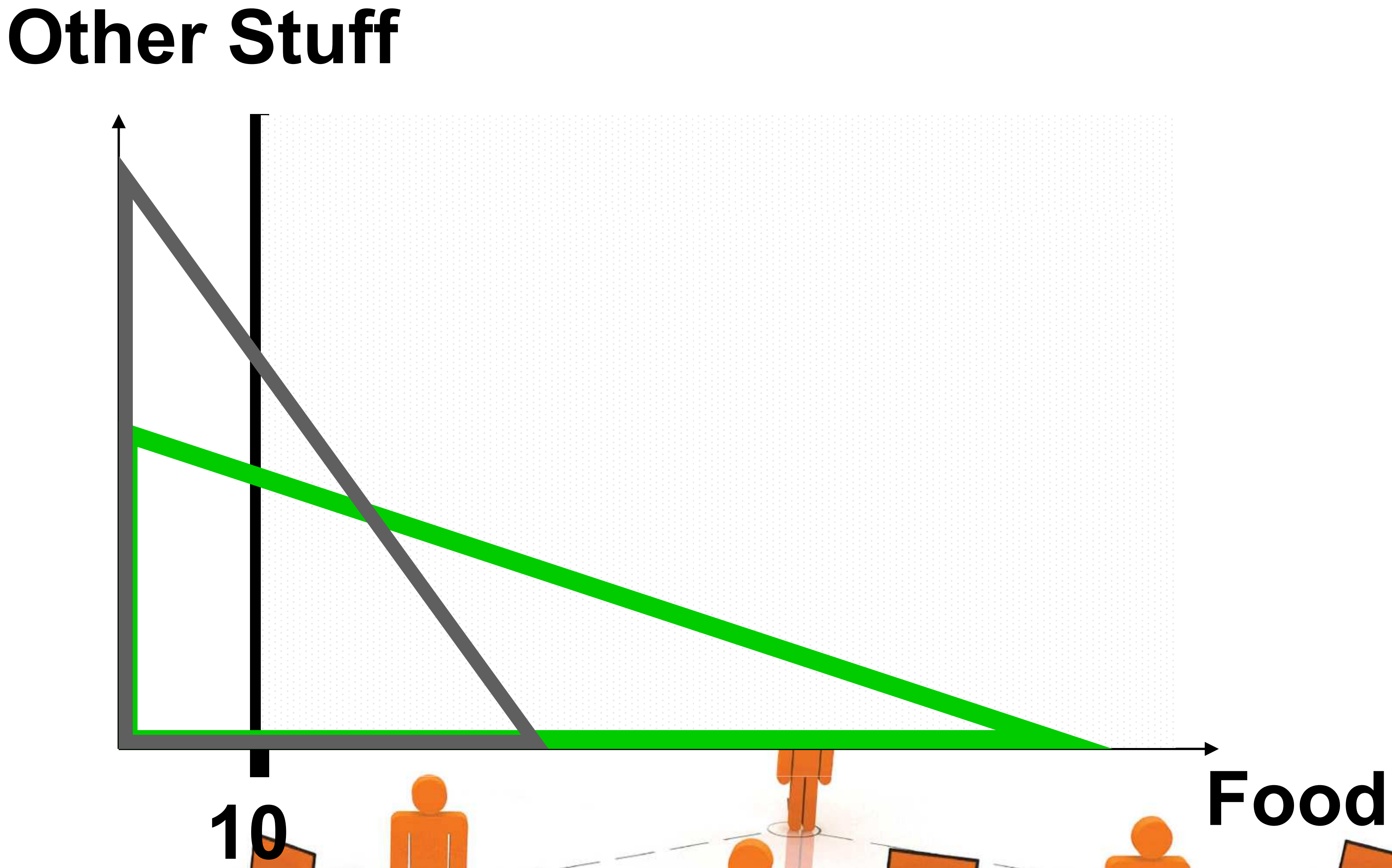


Choice is further restricted by a time constraint.

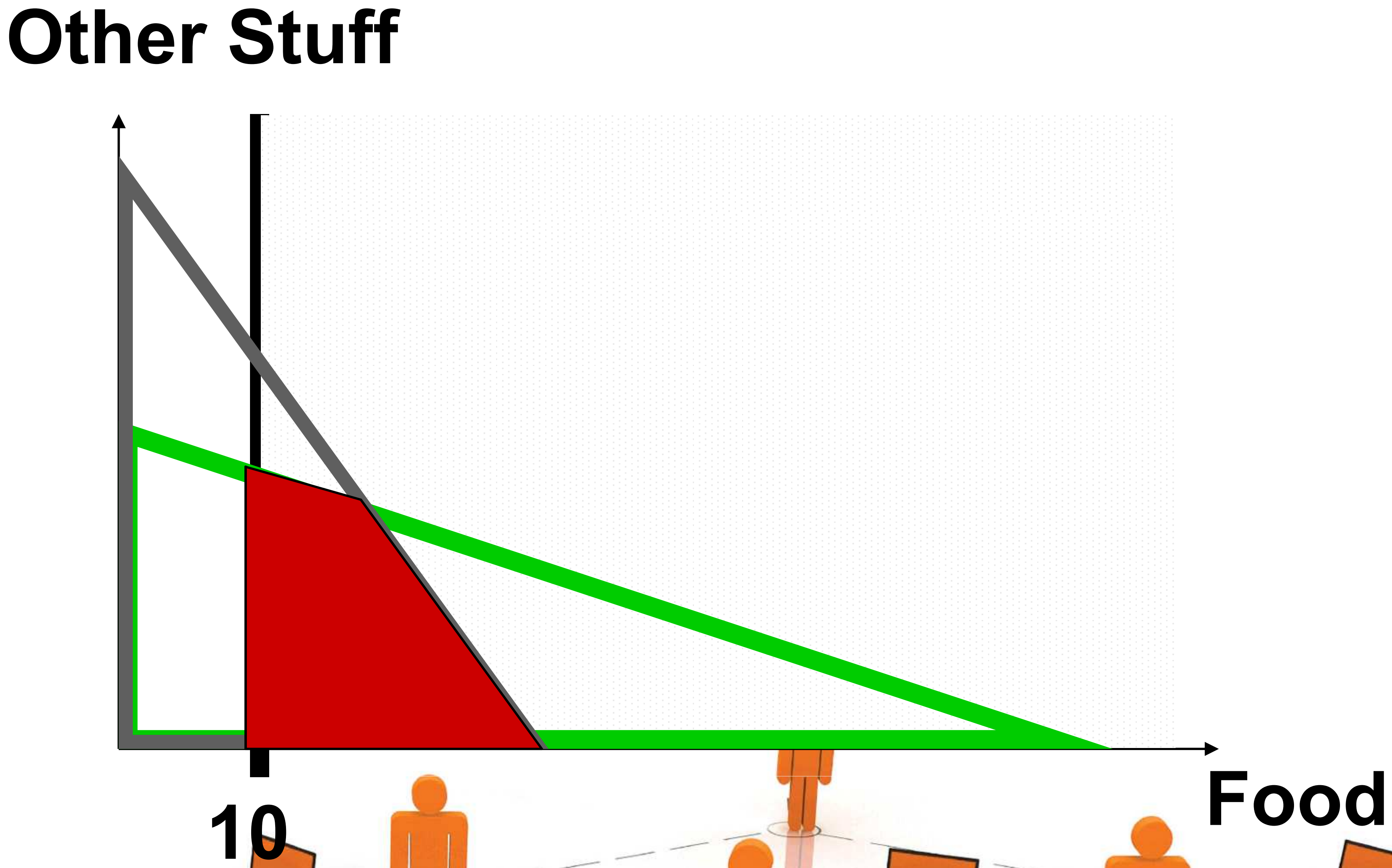
More General Choice Sets

So what is the choice set?

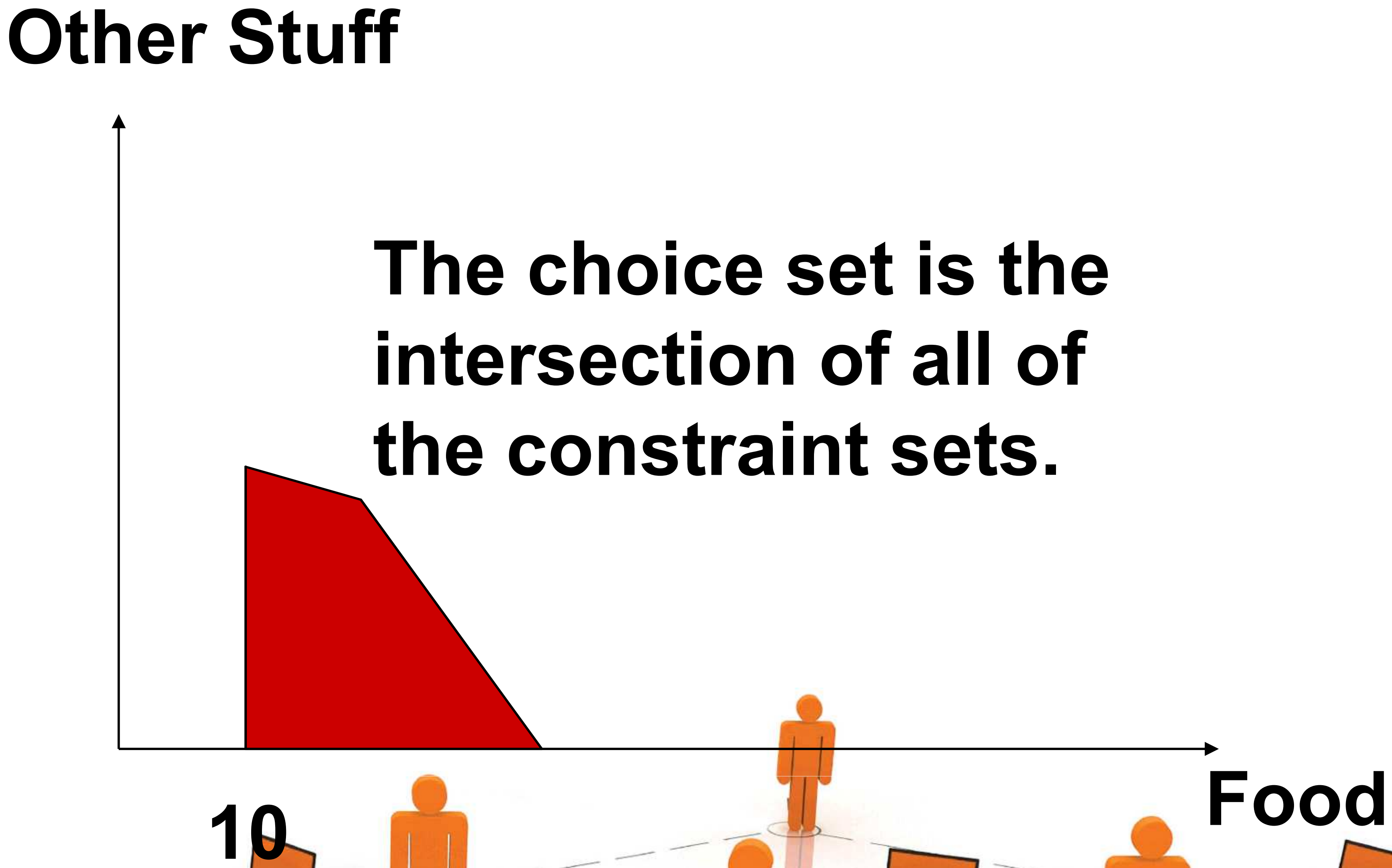
More General Choice Sets



More General Choice Sets



More General Choice Sets



The choice set is the intersection of all of the constraint sets.