Consumption and Leisure Model and Producer Profit Maximization

ECO 305: Intermediate Macroeconomics

Develop a *microfounded* model to describe the following behaviors:

1. Consumption demand
2. Labor supply
3. Labor demand
4. Production Decisions

- Williamson, Chapter 4, pp. 98-117

- Williamson, Chapter 4, pp. 122-135

- **Canvas Quiz due Wednesday 11:59 PM**.
  Multiple-choice, 10 questions, unlimited attempts allowed,
  only best score counts

- **Homework/In-class Exercise due Friday 11:59 PM**. We
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Representative Consumer
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Microfounded Macroeconomics Modeling 3/ 27

Microeconomic Behavior

- Individual optimizing behavior
- Utility maximizing consumers
- Profit maximizing producers (next module)

Representative Consumer

- Model one consumer's behavior to represent all consumers
- Useful: Explains macroeconomic consequences to changing conditions or incentives
- Not useful: Cannot explain income inequality or even unemployment
- Heterogenous agent models: Possible to extend the model with multiple consumers (beyond the scope of this class)

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Utility

Utility

Utility is a "quantity" of satisfaction gained from consuming goods, services, or leisure.

- **Consumption:** A general single "good" representing all final goods and services that consumers purchase
- **Leisure:** Any time spent not working for compensation.
- **Marginal utility (MU):** additional utility derived from one additional unit of a good, service, or leisure.

Assumptions

- Marginal utility is always positive
- **Diminishing marginal utility:** as consumption of something increases, the marginal utility decreases.

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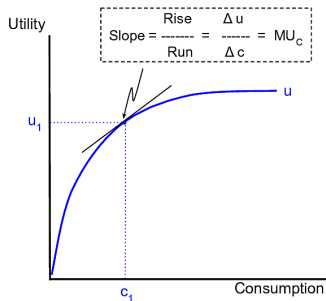
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Utility

Attributes

- Utility function slope = Marginal utility

- Upward sloping → always positive marginal utility
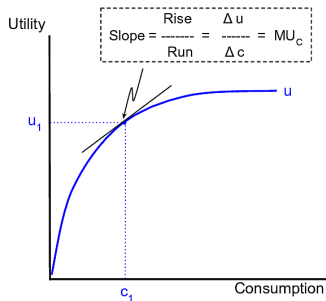
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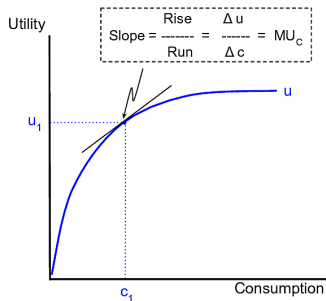
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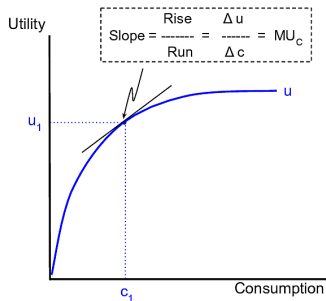
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Utility

$$\text{Slope} = \frac{\text{Rise}}{\text{Run}} = \frac{\Delta u}{\Delta c} = MU_c$$

u_1

u

c_1

Consumption

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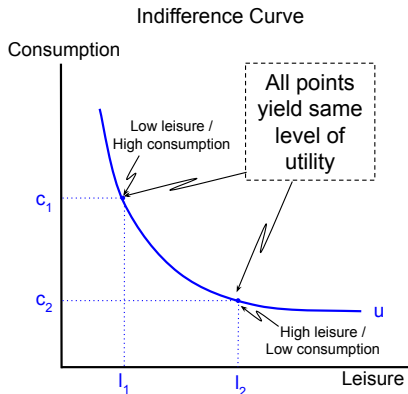Budget Constraint
Utility Maximization

Indifference Curves

Indifference Curves

- Alternative combinations of quantities of two types of goods that yield the same level of utility.

- Indifference curves are downward sloping → To keep same level of utility, give up one good when gaining another

Indifference Curve

Consumer Optimization
Producer Profit Maximization

Representative Consumer
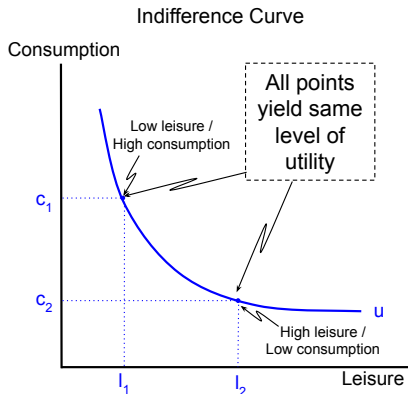Utility and Indifference Curves
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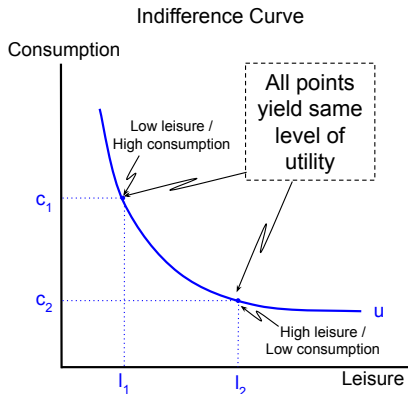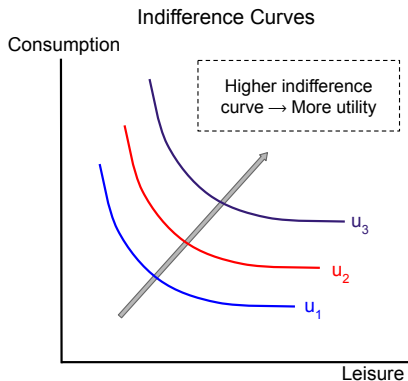
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Indifference Curves with Increasing Utility   7/ 27

Indifference Curves

- Higher indifference curves have larger quantities of goods → yield higher utility
- Indifference curves never cross
- Utility-maximizing consumers: Choose consumption and leisure to get on highest indifference curve possible

Indifference Curves

Consumption

Higher indifference curve → More utility

u_3

u_2

u_1

Leisure

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Indifference Curves with Increasing Utility 7/ 27

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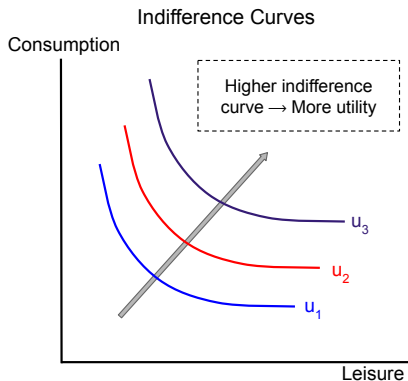
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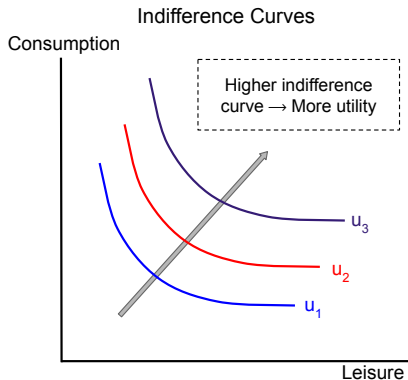- Utility-maximizing consumers: Choose consumption and leisure to get on highest indifference curve possible

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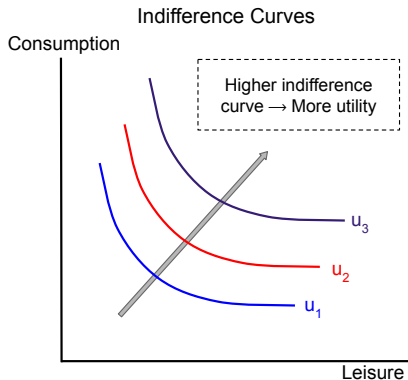- Utility-maximizing consumers: Choose consumption and leisure to get on highest indifference curve possible

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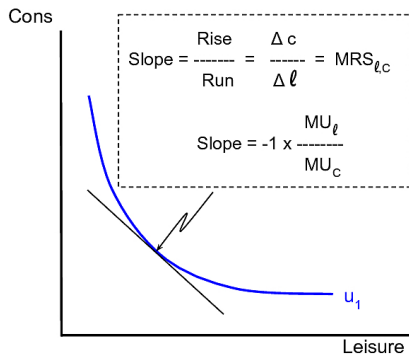
Marginal Rate of Substitution

Marginal Rate of Substitution

The quantity of good Y that a consumer is willing to give up to gain one more unit of good X.

Slope of the indifference curve $= -MRS_{X,Y}$:

$$MRS_{X,Y} = -\frac{MU_X}{MU_Y}$$

Indifference Curve Slope

Cons

$$\text{Slope} = \frac{\text{Rise}}{\text{Run}} = \frac{\Delta c}{\Delta \ell} = MRS_{\ell,c}$$

$$\text{Slope} = -1 \times \frac{MU_\ell}{MU_c}$$

u_1

Leisure

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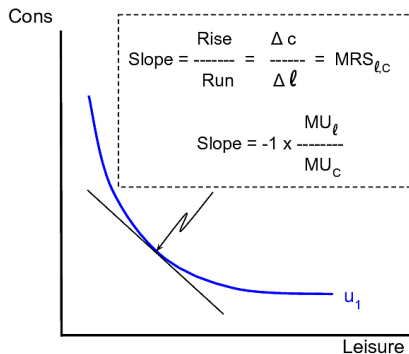
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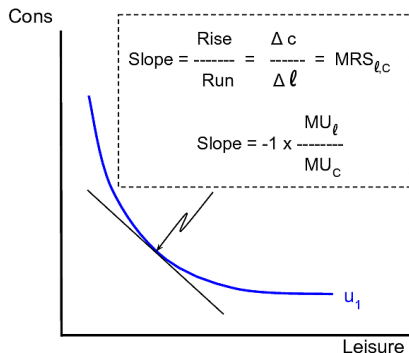
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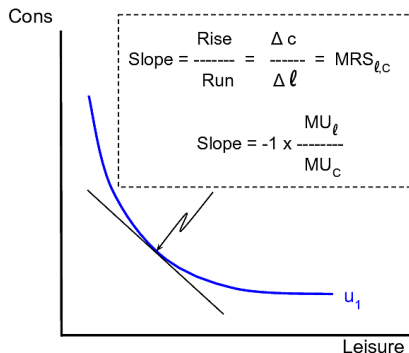
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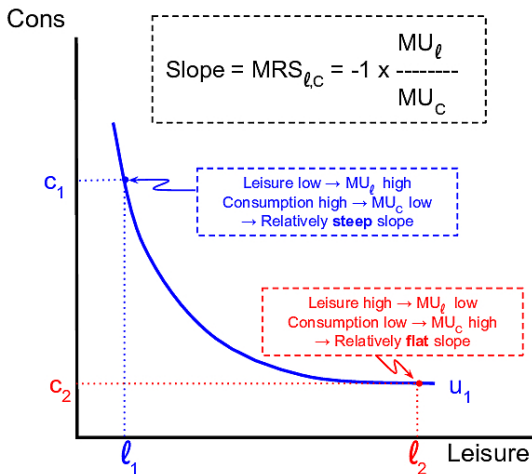The quantity of good Y that a consumer is willing to give up to gain one more unit of good X.

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Slope of Indifference Curves

Cons

$$\text{Slope} = \text{MRS}_{\ell,C} = -1 \times \frac{\text{MU}_\ell}{\text{MU}_C}$$

c_1

Leisure low → MU_ℓ high
Consumption high → MU_C low
→ Relatively **steep** slope

Leisure high → MU_ℓ low
Consumption low → MU_C high
→ Relatively **flat** slope

c_2 u_1

ℓ_1 ℓ_2 Leisure

Diminishing marginal utility gives indifference curves the convex shape

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Budget constraint

$$Pc = W(h - l) + \Pi - T \qquad (1)$$

- P: Price of consumption good (aggregate price level, eg: GDP Deflator)
- c: Real quantity of consumption (Real consumption in aggregate expenditure equation)
- W: Nominal wage rate
- h: total time available for work and leisure
- $h - l$: time spent working (total employment / labor supply)
- Π: non-wage income = dividends earned from owning stock in firms.
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Real Budget Constraint

Divide everything by P to get the budget constraint, in *real terms*:

$$c = w(h - l) + \pi - t \qquad (2)$$

(lowercase letters are real variables)

Re-arranging:

$$c + wl = wh + \pi - t \qquad (3)$$

- Goods c and l appear on left-side as "goods" to buy

- Income appears on right-side

- That is, this looks *just like*:

  $Price_X \ (Qty \ X) + Price_Y \ (Qty \ Y) = Income$

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- Income appears on right-side
- That is, this looks *just like*:
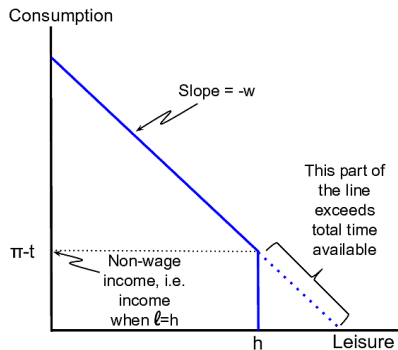
  $Price_X (Qty\ X) + Price_Y (Qty\ Y) = Income$

Consumer Optimization
Producer Profit Maximization

Representative Consumer
Utility and Indifference Curves
Budget Constraint
Utility Maximization

Real Budget Constraint

Divide everything by P to get the budget constraint, in *real terms*:

$$c = w(h - l) + \pi - t \qquad (2)$$

(lowercase letters are real variables)

Re-arranging:

$$c + wl = wh + \pi - t \qquad (3)$$

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Real Budget Constraint 11/ 27

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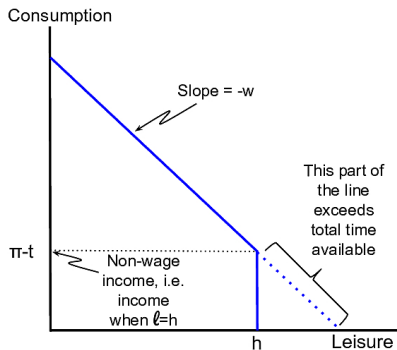**Budget Constraint**
Utility Maximization

Budget Constraint

Budget Constraint

Equation: $c + wl = wh + \pi - t$

- Points on the line: largest quantities of consumption and leisure the consumer can afford
- Slope of the line = -w
- Vertical height changes with amount of non-wage income

Consumption / Leisure Model

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Budget Constraint

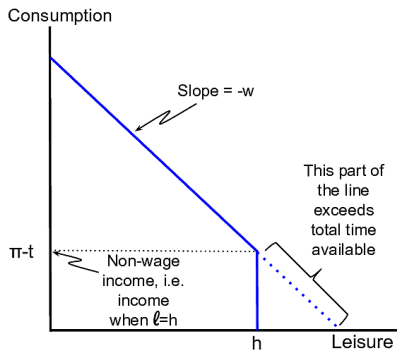### Budget Constraint

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Consumption / Leisure Model

Consumption

Slope = -w

This part of the line exceeds total time available

π-t

Non-wage income, i.e. income when ℓ=h

h

Leisure

Consumer Optimization
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Utility and Indifference Curves
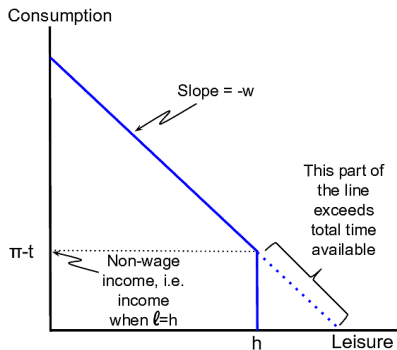**Budget Constraint**
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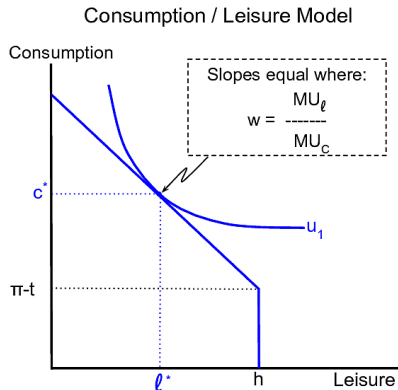
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h   Leisure

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Utility Maximization

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Utility Maximizing Choice

- Maximize utility subject to budget constraint
- Get on the highest indifference curve that is affordable
- Highest indifference curve *is tangent* to the budget line
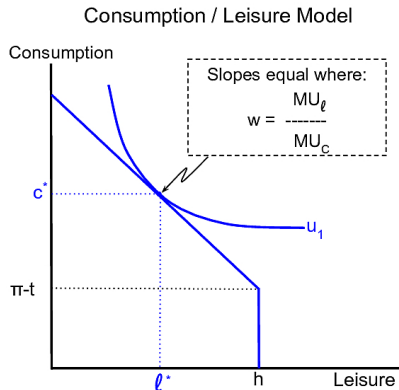- Optimal choice is where *slopes are equal*:
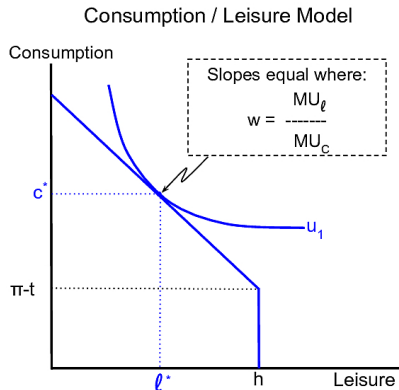
$$\frac{MU_l}{MU_c} = w$$

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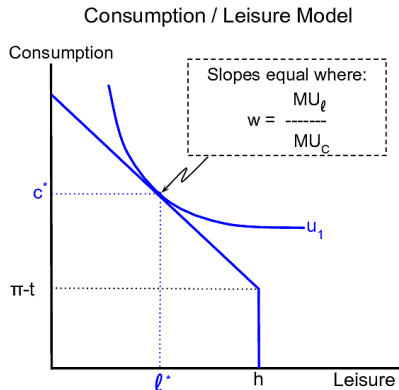
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Consumption / Leisure Model

Consumption

Slopes equal where:

$$w = \frac{MU_\ell}{MU_c}$$

c^*

u_1

π-t

ℓ^* h   Leisure

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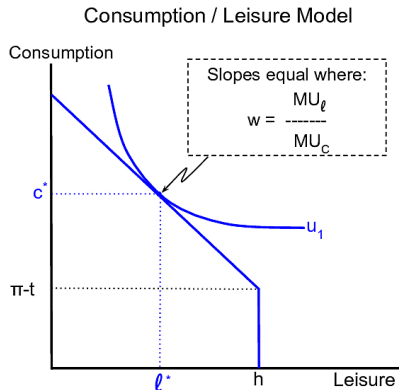
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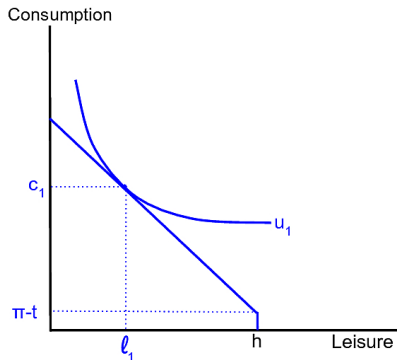
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Increase in Non-Wage Income

Utility Maximizing Choice

- Examples: Property tax cut, lump sum tax rebate, increase in asset (stock market) values
- Budget constraint makes a parallel shift outward/upward
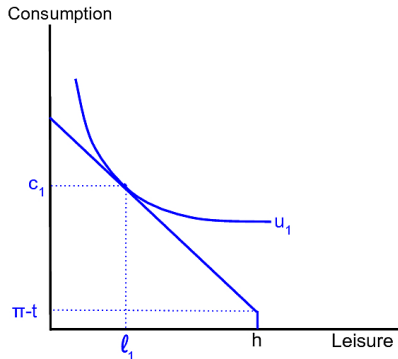- Optimal choices for consumption and leisure increase
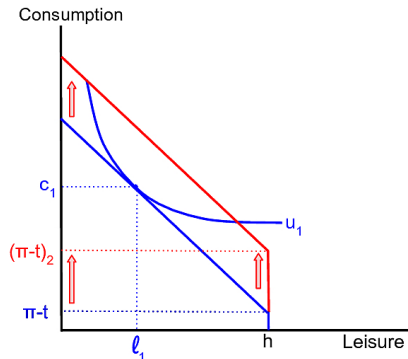
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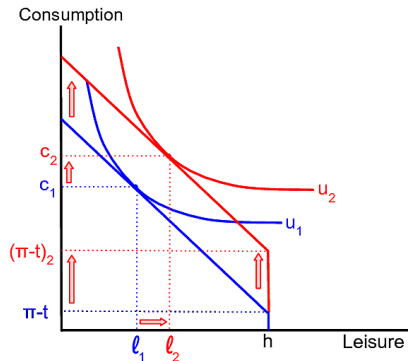
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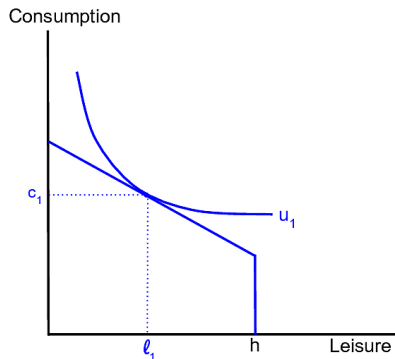

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Increase in the Wage

Consumption / Leisure Model

Utility Maximizing Choice

- Budget constraint gets steeper at kink/pivot point
- Optimal choice for consumption increase
- Impact on leisure choice is *indeterminate*

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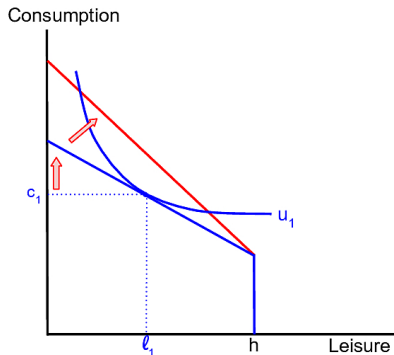
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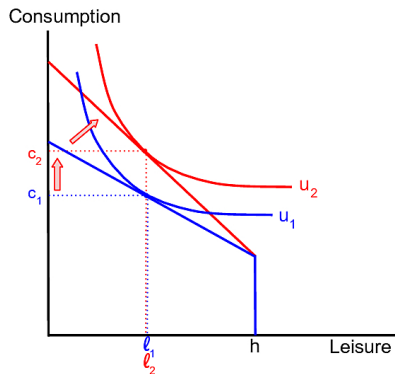- Impact on leisure choice is *indeterminate*

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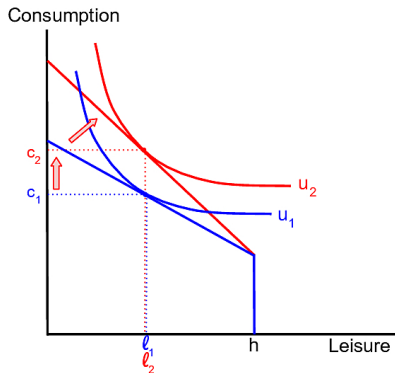
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Substitution and Income Effects

Substitution Effect

- The effect from *only* the increase in the relative price of the good, holding constant the effect price changes have on total purchasing power
- Graphically: Only the effect of the slope, not the effect of being on a higher or lower budget constraint or indifference curve
- Intuition: Increase in wage $\rightarrow$ leisure is more expensive $\rightarrow$ enjoy less leisure, substitute more consumption instead

Income Effect

- The effect of how a price change affects total income
- Graphically: Only the effect of the position of the budget constraint or indifference curve, not the effect of the slope
- Intuition: Increase in wage $\rightarrow$ More income $\rightarrow$ enjoy more of everything: leisure and consumption

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Substitution and Income Effects   16/ 27

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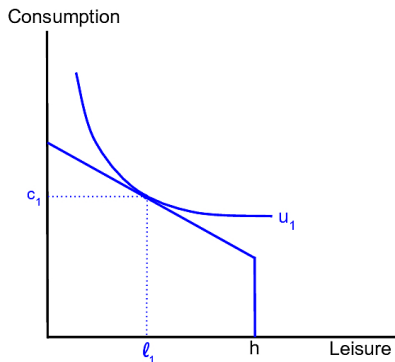
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Income and Substiution Effects

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- Pivot budget line (think about slope effects, position effects)
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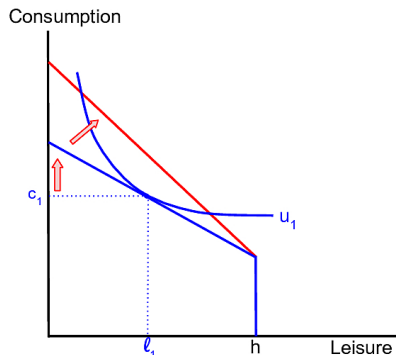
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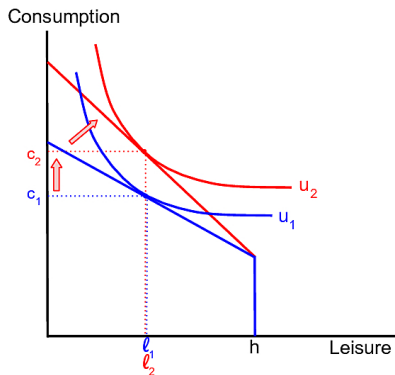
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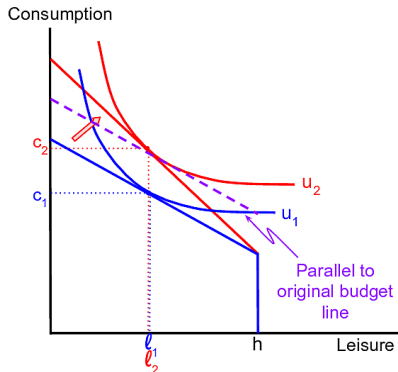- Imaginary point to final: Substitution effect

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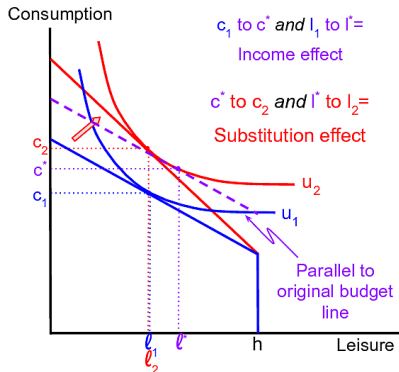
Consumption / Leisure Model

c_1 to c^* and l_1 to l^*=
Income effect

c^* to c_2 and l^* to l_2=
Substitution effect

Parallel to original budget line

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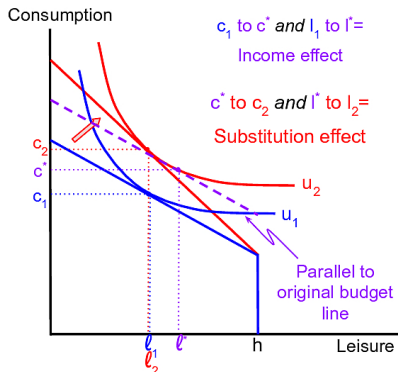
Consumption / Leisure Model

Consumption

c_1 to c^* *and* l_1 *to* l^*=
Income effect

c^* to c_2 *and* l^* *to* l_2=
Substitution effect

c_2
c^*
c_1

u_2

u_1

Parallel to original budget line

ℓ_2^1
ℓ^1
ℓ^*
h

Leisure

Consumer Optimization
Producer Profit Maximization

Production Function
Profit Maximization
Impact of Increase in Wages
Impact of Improvement in Productivity

Production Functions

- First produce a single output good, y
- Corresponds with real GDP in aggregate expenditure equation
- Firms produce y using labor (n) and capital (k)

Production Function:

$$y = zf(k, n)$$

- $f(.)$ some mathematical function that describes how capital and labor influence total production
- z: Total factor productivity, i.e. technological and practical possibilities
- Improvements in technology $\rightarrow$ increase in z
- Global production disruptions $\rightarrow$ decrease in z

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Production Functions   18/ 27

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- Firms produce y using labor (n) and capital (k)

Production Function:

$$y = zf(k, n)$$

- $f(.)$ some mathematical function that describes how capital and labor influence total production
- z: Total factor productivity, i.e. technological and practical possibilities
- Improvements in technology $\rightarrow$ increase in z
- Global production disruptions $\rightarrow$ decrease in z

Consumer Optimization
Producer Profit Maximization

Production Function
Profit Maximization
Impact of Increase in Wages
Impact of Improvement in Productivity

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Maginal Product of Capital and Labor

Marginal Products

- **Marginal Product of Labor:** Additional output that can be produced with one additional unit of labor
- **Marginal Product of Capital:** Additional output that can be produced with one additional unit of capital
- Assume both are always positive

Law of Diminishing Returns

- **Diminishing Marginal Product of Labor:** As producer (or whole economy) increases employment, while capital stock and all else remains the same, marginal product of labor decreases
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Maginal Product of Capital and Labor 19/ 27

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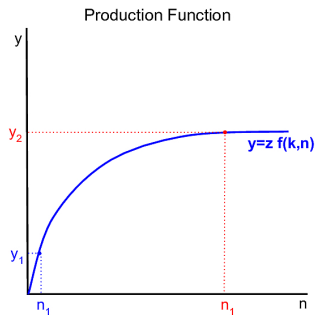
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Production Function

Production Function w/r to Labor

- Curve showing how different levels of employment lead to different production levels

- Upward sloping, because marginal product of labor is always positive

- Slope is the marginal product of labor

Production Function

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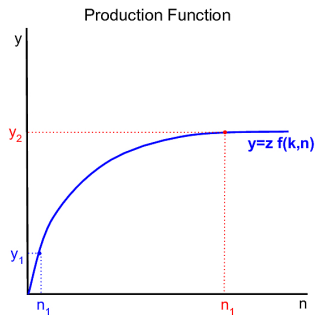- Slope is the marginal product of labor

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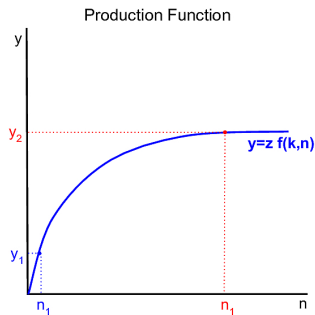- Slope is the marginal product of labor

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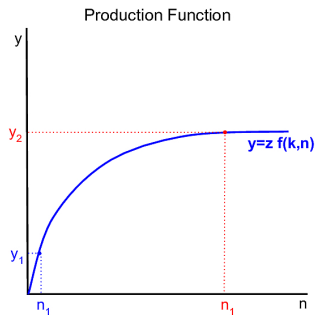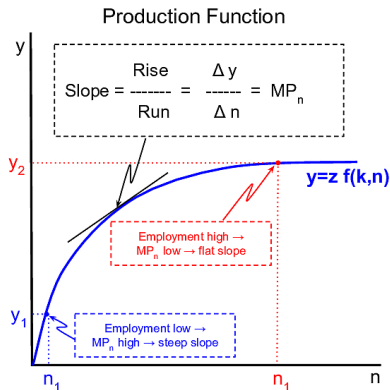- Slope is the marginal product of labor

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Slope of the Production Function

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- Slope is the marginal product of labor
- Diminishing returns gives it its concave shape

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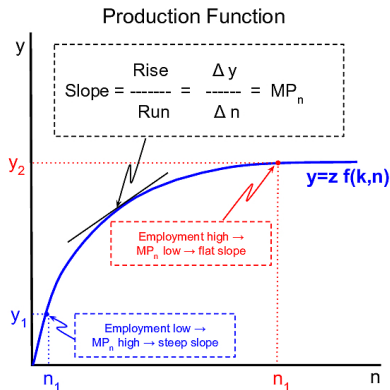
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Production Function

Slope = $\dfrac{\text{Rise}}{\text{Run}}$ = $\dfrac{\Delta y}{\Delta n}$ = MP_n

$y=z\,f(k,n)$

Employment high → MP_n low → flat slope

Employment low → MP_n high → steep slope

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Profit Maximization

Big Assumptions

- Perfectly competitive firms in the labor market, take wage as given
- Single point in time, capital pre-determined

Maximize Profits

- Objective: Choose employment, n, to maximize profits
- Total Revenue $= P\,y$
- Total Cost $= W\,n$
- Total Profit: $\Pi = P\,y - W\,n$
- Real profit: $\pi = y - wn$

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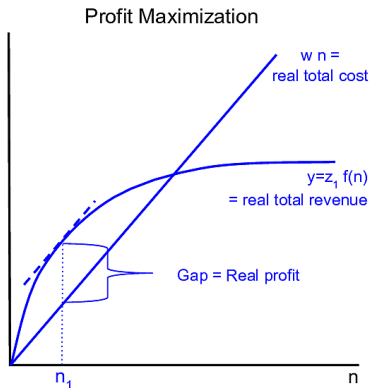- Single point in time, capital pre-determined

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Graphical Profit Maximization

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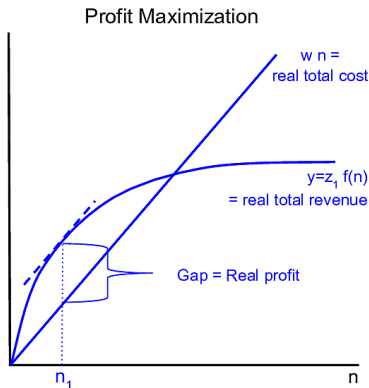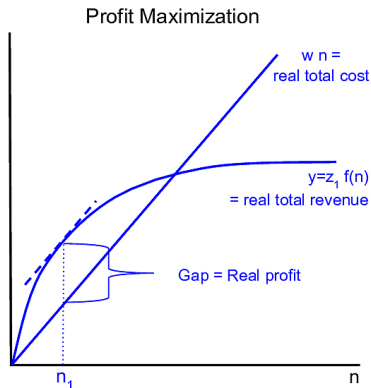 - What is the slope of $w\, n$?

- Gap between is the real profit

Profit Maximization

w n =
real total cost

$y = z_1\, f(n)$
= real total revenue

Gap = Real profit

n_1

n

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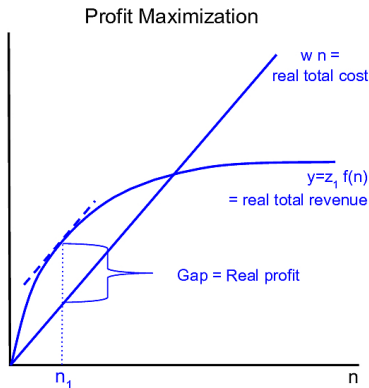 - What is the slope of $w \, n$?
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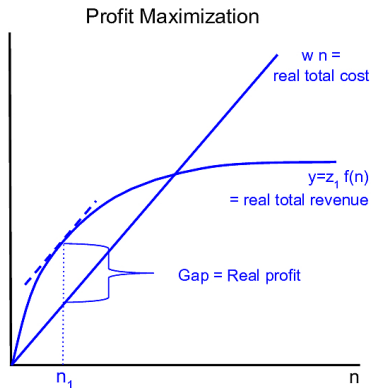   - What is the slope of $w\ n$?

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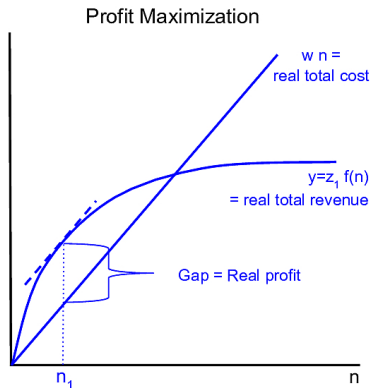 - What is the slope of $w\,n$?
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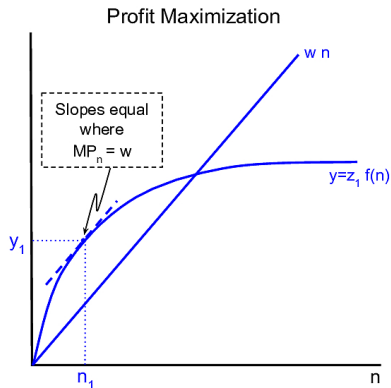 - What is the slope of $w\,n$?
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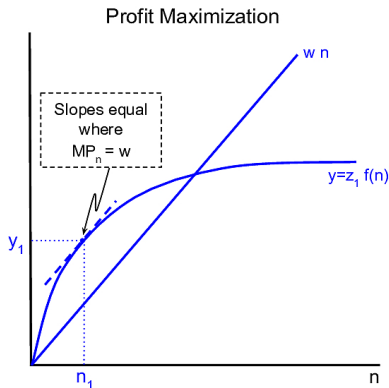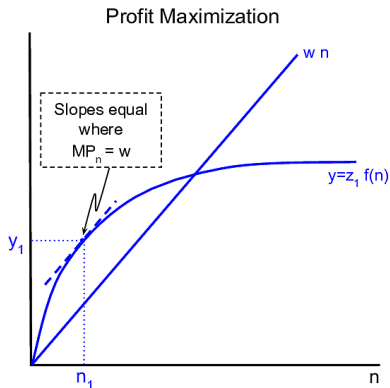Impact of Increase in Wages
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Profit Maximization Choice

Profit Maximizing Decision

- Choice of n is labor demand
- Choice of y is real GDP

Profit Maximization

Slopes equal where $MP_n = w$

w n

$y = z_1 f(n)$

y_1

n_1

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Profit Maximization: Increase in Wages

Increase in Wages

- Cost function pivots upward
- Find new place where slopes are equal
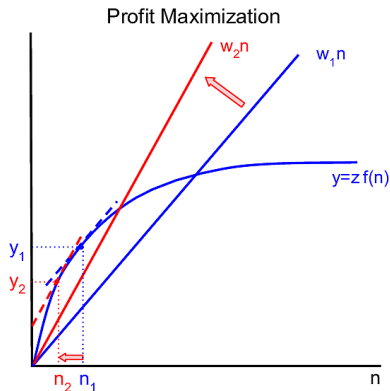- Labor demand (choice of n) decreases
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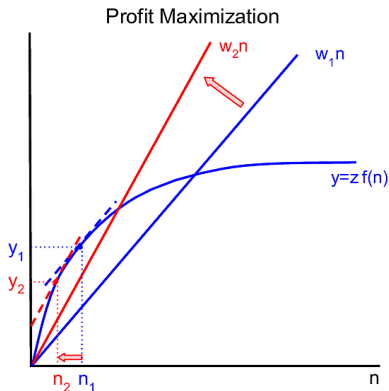- Labor demand (choice of n) decreases
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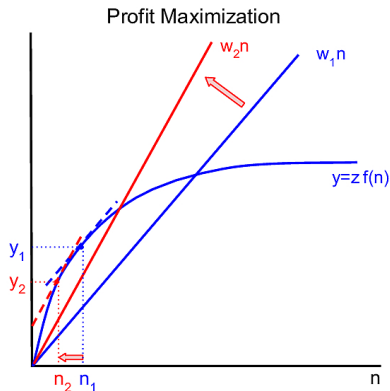- Production (choice of y) decreases

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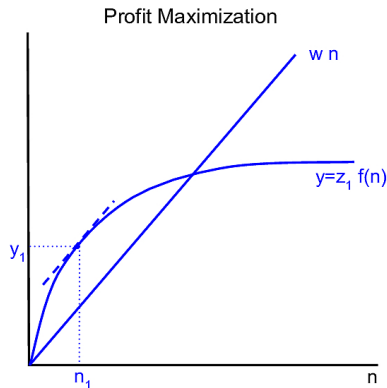- Labor demand (choice of n) decreases
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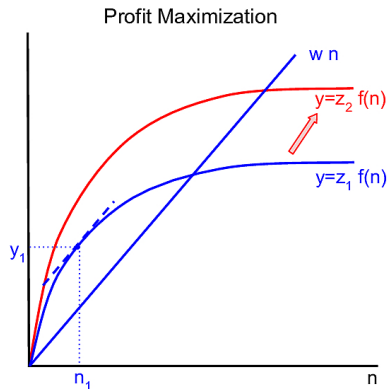**Impact of Improvement in Productivity**

Profit Maximization: Improvement in Productivity   26/ 27

Improvement in Productivity

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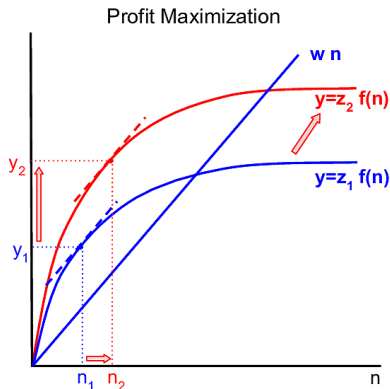**Impact of Improvement in Productivity**

Profit Maximization: Improvement in Productivity   26/ 27

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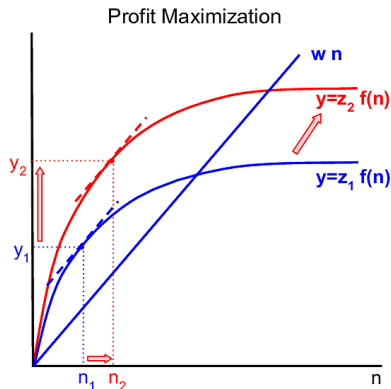**Impact of Improvement in Productivity**

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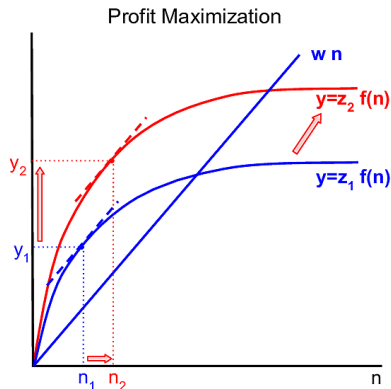**Impact of Improvement in Productivity**

Profit Maximization: Improvement in Productivity   26/ 27

Improvement in Productivity

- Production function pivots upward
- Find new place where slopes are equal
- Labor demand (choice of n) increases
- Production (choice of y) increases

Profit Maximization

Consumer Optimization
Producer Profit Maximization

Production Function
Profit Maximization
Impact of Increase in Wages
Impact of Improvement in Productivity

Profit Maximization: Improvement in Productivity 26/27

Improvement in Productivity

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Profit Maximization

- Williamson, Chapter 4, pp. 98-117

- Williamson, Chapter 4, pp. 122-135

- Canvas Quiz due Wednesday 11:59 PM.
  Multiple-choice, 10 questions, unlimited attempts allowed,
  only best score counts

- Homework/In-class Exercise due Friday 11:59 PM. We
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