Chapter 3 :A Closed Economy One-Period Macroeconomic Model (Part 1. Consumer and Firm Behavior)

EE312

Macroeconomics, Stephen Wiliamson, Chapter 4,5

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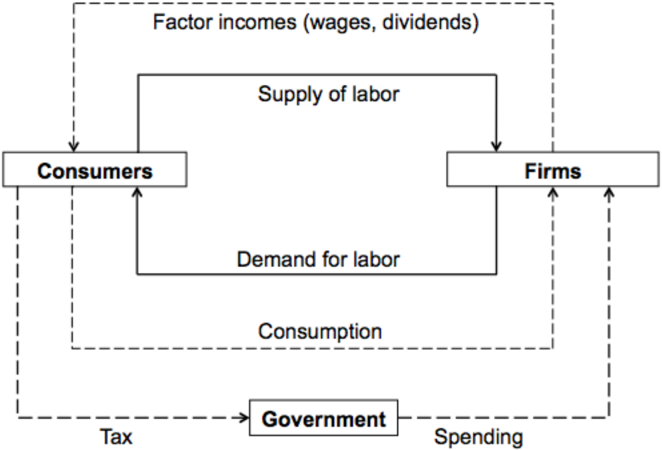
* *Note: Much of the contents in this lecture presentation are borrowed from Dr.Pichit's. He kindly allowed us to use his lecture presentation. All credits and rights go to Dr.Pichit. Please note that I modified/added some parts on my own. Hence, any mistake is my own responsibility. Please notify me if you find any. Thank you!*

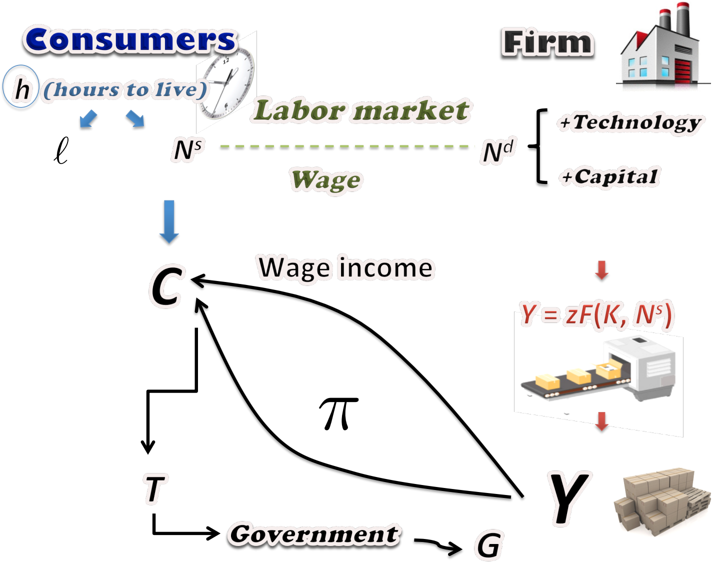
Outline

1. One-period decisions (Part 1)
2. Consumer: work-leisure decision and labor supply (Part 1)
3. Firm: profit maximization and labor demand (Part 1)
4. Government sector (Part 2)
5. Competitive equilibrium and Pareto optimality (Part 2)
6. Model application: Changes in government spending and total factor productivity (Part 2)

- Optimization by consumers and firms.
- One period decisions; static analysis:
  - Consumers: consumption demand and labor supply.
  - Firms: supply of goods and demand for labor.
  - No investment, no saving.
- Government collects taxes and spends (G = T).
- No foreign trade; a barter economy.
- The foundation of all macro analysis.

- Circular flow




Consumers
h (hours to live)
ℓ
N^s
Labor market
Wage
N^d
+Technology
+Capital
Firm
C
Wage income
Y = zF(K, N^s)
π
T
Y
Government
G

2.1. Representative Consumer

- Preference over consumption and leisure represented by indifference curves.
- A budget constraint of wage and non-wage incomes.
- Combination of consumption and leisure which maximizes utility, given the budget constraint.
- Effects of an increase in non-wage income and the real wage rate.

2.2. The utility function

$$U = U(C, \ell),$$

where U = the utility function;
C= amount of consumption;
ℓ = amount of leisure

$$U = U(C1, \ell 1).$$

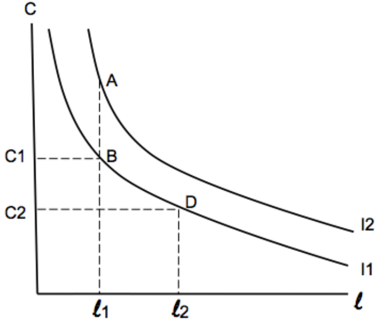
= level of utility derived from the consumption bundle of C1 and $\ell 1$.
[consumption bundle $(C1, \ell 1)$ is strictly preferred to consumption bundle $(C2, \ell 2)$ if $U(C1, \ell 1) > U(C2, \ell 2)$.
consumption bundle $(C2, \ell 2)$ is strictly preferred to consumption bundle $(C1, \ell 1)$ if $U(C2, \ell 2) > U(C1, \ell 1)$. and the consumer is indifferent between the two consumption bundles if $U(C1, \ell 1) = U(C2, \ell 2)$.]

2.2.1 Properties of consumer preference

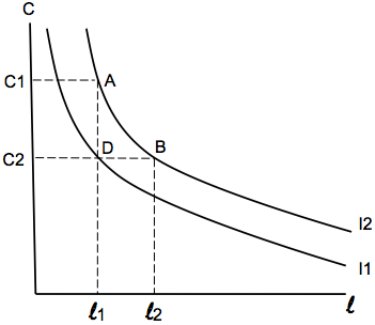
- **'More is preferred to less.'**
  - If $U(C2, \ell 2) > U(C1, \ell 1)$, then consumption bundle $(C2, \ell 2)$ is strictly preferred to consumption bundle $(C1, \ell 1)$.
- **'The consumer has preference for diversity in his/her consumption bundle.'**
  - $(C2, \ell 1)$ is preferred to $(C3, 0)$
- **'Consumption and leisure are normal goods'.**
  - The consumer will demand more as income increases.

2.2.2 The indifference curves

- The indifference curve (IC) gives different bundles of the two goods which the consumer is indifferent (equal utility).
  - (1) ‘More is preferred to less.’: ICs slope downwards.
  - (2) ‘Preference for diversity’: ICs are convex towards the origin.
- The indifference map: a set of ICs for the representative consumer.



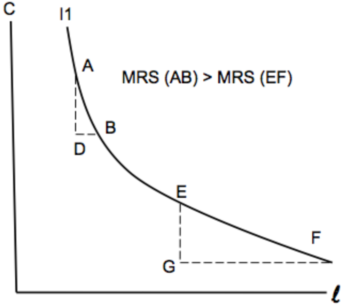
- A is strictly preferred to B.
- The consumer is indifferent between B and D.



(1) "More is preferred to less"

- If C1 (at A) drops to C2 with the same $\ell 1$, the consumer is on a lower I1.
- To get the initial I2 (with the same C2, raise $\ell 1$ to $\ell 2$ (at B).
- Same C, more ℓ is preferred.
- Same ℓ, more C is preferred.

- ***Marginal rate of substitution (MRS)***
  - The marginal rate of substitution of leisure for consumption ($MRS_{\ell,C}$) is the rate at which the consumer is willing to substitute leisure for consumption goods.
  - The slope of the IC passing through a given (C, ℓ).
  - Willingness to sacrifice given consumption for more leisure.
  - $MRS_{\ell,C}$ is decreasing as the consumer moves from consumption to more leisure.



(2) “Preference for diversity”

- From A to B, a small amount of L (BD) is needed for a given sacrifice (AD) of C to make the consumer indifferent.
- From E to F, larger leisure (FG) is needed for the same (EG=AD) amount of consumption.

2.3. Consumer's budget constraint

- The consumer is subject to competition.
  - The consumer is a price-taker.
  - The market prices are given.
  - Individual action has no influence on the market price.
- The consumer allocates time between leisure and work.
  - He/She receives wages from work and non-wage incomes from non-labor services.

2.3.1 The consumer's time constraint
h = hours of time available;
ℓ= time allotted to leisure;
N^S= time spent working (labor supply)

$$\ell + N^s = h$$

2.3.2 Real disposable income

$$Y^d = WN^S + \pi - T$$

- The real disposable income is the sum of wage and dividend incomes minus taxes.
  - Y^d = Disposable Income
  - W= the real wage in the units of consumption goods;
  - π= real dividend income (profits) in the unit of consumption goods received from the firm;
  - T = a lump-sum tax.

2.3.3 The consumer's budget constraint

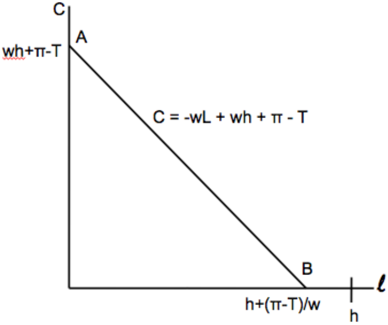
- The consumer's disposable income is spent on consumption goods.
- Disposable income (Y^d) = consumption expenditure (C);

$$C = wN^S + \pi - T$$

$$C = w(h - \ell) + \pi - T$$

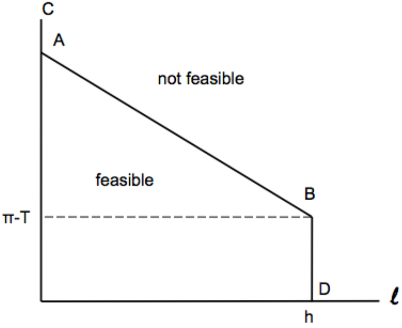
$$
\begin{aligned}
C &= w(h-\ell)+\pi-T \\
C &= -w\ell+wh+\pi-T \\
C+w\ell &= wh+\pi-T
\end{aligned}
$$

- The implicit real disposable income ($wh+\pi-T$) is split into expenditures on consumption goods and leisure ($C+w\ell$).
- W = the market price of leisure.
- The slope = – w; the intercept = ($wh+\pi-T$)



(1) The budget constraint ($T > \pi$)

- AB = the budget line.
- The vertical intercept is ℓ = 0;
- The horizontal intercept is T = 0. Slope = -w

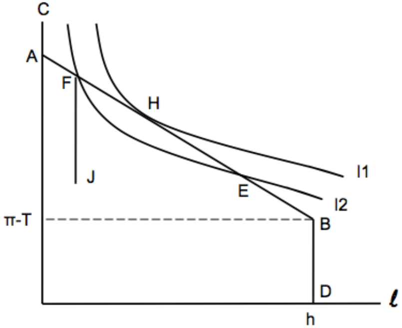


(2) **The budget constraint ($T < \pi$)**

- The budget line is kinked at B.
- Along BD, works = 0;
- $\ell = h$, and $C \geq \pi - T > 0$.

2.4 Consumer optimization

- The consumer is rational.
  - Knowledge of his/her own preferences and budget constraint.
  - Combination of consumption and leisure (consumption bundle) which maximizes utility.
- The consumer chooses the consumption bundle that is on his/her highest indifference curve subject to his/her budget constraint.



- H = optimal consumption bundle;
- E and F are feasible but not optimal.

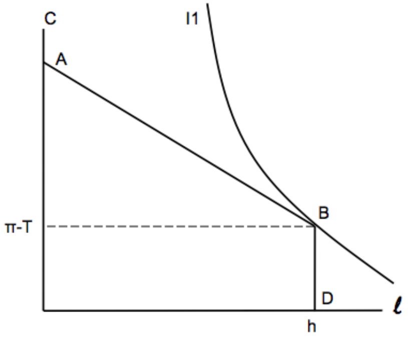
(J lies inside the budget constraint. Point F is clearly preferred by consumer to J.)

- Optimization condition
  - The rate of marginal substitution of leisure for consumption is equal to the real wage.
  - The real wage is the relative price of leisure in terms of consumption goods.

$$MRS_{\ell,C} = w$$

Marginal Rate of Substitution of leisure for consumption	=	the real wage

- Corner solution

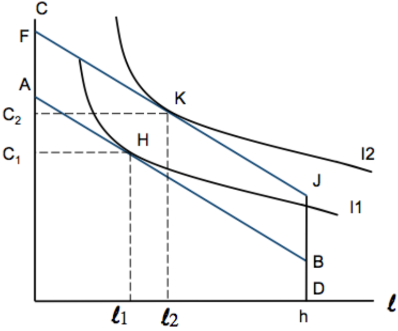


- The consumer chooses not to work at B.
- $\ell = h$
- This is a situation that cannot happen, taking into account consistency the actions of the consumer and of firms.
- "A rentier is a person or entity that receives income derived from economic rents, which can include income from patents, copyrights, brand loyalty, real estate ..."

- Corner solution: impossible
  - The consumer may choose not to work and consume only leisure.
  - Impossible solution:
    - No labor service to the firm, no incomes.
    - No production by the firm, no consumption goods.
    - The consumer's preference for diversity.
  - Real life? Consumers do not repeat their mistakes.

- Changes in dividends or taxes
  - Assuming consumption and leisure are both normal goods.
  - An increase in dividends or a decrease in taxes ($\pi - T$)
  - causes the consumer to increase both consumption and leisure (and to reduce the quantity of labor supply).
  - The pure income effect.

Table:



An increase in $\pi - T$

- An increase in $\pi - T$ (by JB) causes the consumer to increase both C and L.

- A higher $\pi - \text{T}$ raises C and ℓ

$$
\begin{array}{ccccccc}
\pi \uparrow & & & & & & C \uparrow \\
 & \searrow & & & & \nearrow & \\
 & & (\pi - T) \uparrow & \rightarrow & Y^d \uparrow & & \\
 & \nearrow & & & \text{(implicit)} & \searrow & \\
T \downarrow & & & & & & \ell \uparrow \\
 & & & & & & \downarrow \\
 & & & & N^s \downarrow & \leftarrow & (h - \ell) \downarrow
\end{array}
$$

An increase in the market real wage

- **Substitution effect**: an increase in the real wage (the price of leisure) causes the consumer to substitute consumption for leisure.
- **Income effect**: the consumer's income increases, causing both consumption and leisure to increase.
- Consumption increases, but leisure may rise or fall.

A higher wage raises C

$$
w \uparrow \quad
\begin{array}{l}
\nearrow \quad \begin{array}{c} \text{income effect} = C \uparrow \\ \text{substitution effect} = C \uparrow \end{array} \quad \Rightarrow \quad C \uparrow \\[2em]
\searrow \quad \begin{array}{c} \text{income effect} = \ell \uparrow \\ \text{substitution effect} = \ell \downarrow \end{array} \quad \Rightarrow \quad \ell ?
\end{array}
$$

$$
w \uparrow \begin{cases} \nearrow \quad \begin{array}{c} \text{income effect=}\ell \uparrow \\ \text{substitution effect =}\ell \downarrow \\ \text{[Stronger Substitution Effect]} \end{array} \begin{array}{cc} < & \Rightarrow \\ & \Rightarrow \\ & \Rightarrow \end{array} \begin{array}{c} \ell\ldots.. \\ (h-\ell)\ldots.. \\ N^s\ldots\ldots \end{array} \\ \searrow \quad \begin{array}{c} \text{income effect = } \ell \uparrow \\ \text{substitution effect = } \ell \downarrow \\ \text{[Stronger Income Effect]} \end{array} \begin{array}{cc} > & \Rightarrow \\ & \Rightarrow \\ & \Rightarrow \end{array} \begin{array}{c} \ell\ldots.. \\ (h-\ell)\ldots.. \\ N^s\ldots\ldots \end{array} \end{cases}
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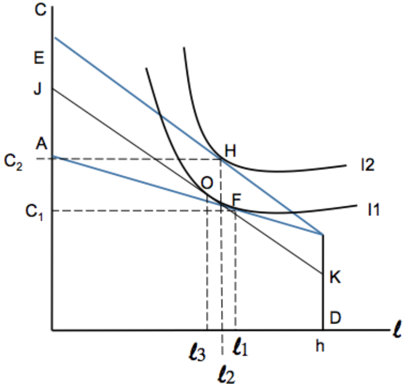
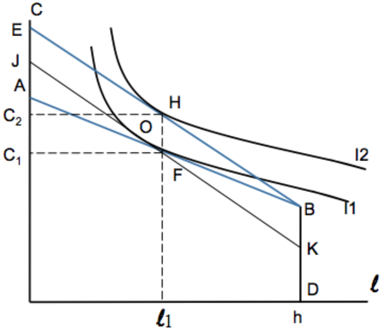


Stronger substitution effect

- Substitution effect = FO.
- Income effect = OH.
- FO > OH, C increases and ℓ decreases.
- So N increases.



Equal effect

- Substitution effect = FO.
- Income effect = OH.
- FO = OH, C increases; but ℓ (and N) is the same.

2.5 The labor supply function

- $\ell(w)$ is a function that tells us how much leisure the consumer wishes to consume, given the real wage rates.
- Then, the labor supply curve is given by

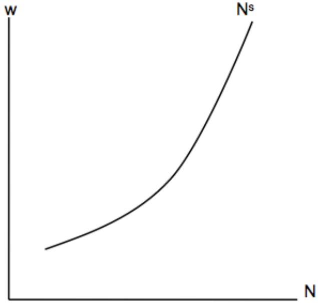
$$N^S(w) = h - \ell(w)$$

$$\frac{\partial N^S}{\partial w} > 0$$

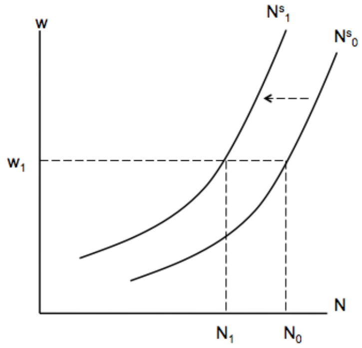
- $N^S =$ the labor supply function
- h = the maximum hours avaiable
- $\ell(w)$ = the leisure function, given the real wage. Assuming the stronger substitution effect.

[We typically assumes that the substitution effect of an increase in real wage dominates the income effect, so that the labor supply curve is upward-sloping.]

The labor supply curve



- The quantity of labor supply is a positive function of the real wage.
- Assuming the stronger substitution effect.



Effect of an increase in $(\pi - T)$.

- A rise in $(\pi - T)$ causes the consumer to reduce labor supply, given the real wage (positive income effect).

3.1. Representative firm

- The firm demands labor and supplies consumption goods.
  - Source of wage and dividend incomes for the consumer.
  - The production function combines labor service to produce consumption goods.
- Profit maximization and labor demand function.

3.2. The firm's production function

$$Y = zF(K, N^d)$$

where:

- Y = output of consumption goods;
- K = capital input;
- N^d= labor input (hours);
- z = total factor productivity (TFP).

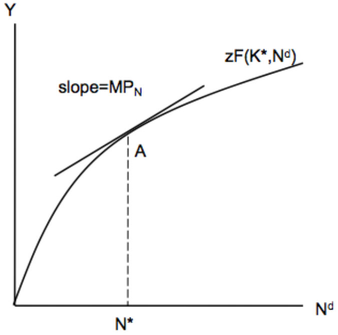
3.2.1 Total factor productivity (TFP)

- z = the degree of sophistication of the production process.
- A production function with the same K and N^d as another but with a larger z will produce more output.
  - Production organization;
  - Managerial input;
  - Social and physical infrastructures.

3.2.2 Properties of the production function

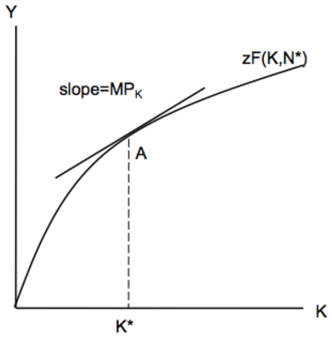
- Constant returns to scale:
  - $zF(xK, xN^d) = xzF(K, N^d)$
  - Increase each input by x times will raise the total output by x times.
- Output increases if either labor or capital increases.
  - $MP_N = \dfrac{\partial Y}{\partial N^d} > 0$;
  - $MP_K = \dfrac{\partial Y}{\partial K} > 0$.
  - Upward slope of the production function.

- The marginal product of labor (MP_N) decreases as the labor input increases, given the capital input.
  - The production function is concave; the slope is decreasing as output increases.
- The marginal product of capital (MP_K) decreases as the capital input increases, given the labor input.
- The marginal product of labor increases as the quantity of the capital input increases.



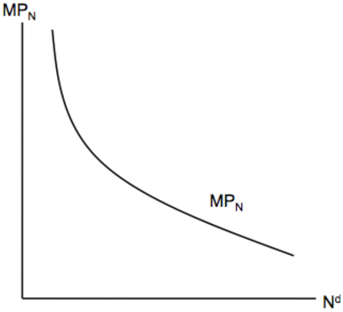
Production function, fixed capital

- The slope at A is MP_N when N = N*.
- MP_N is falling as the labor input increases, given the capital input.



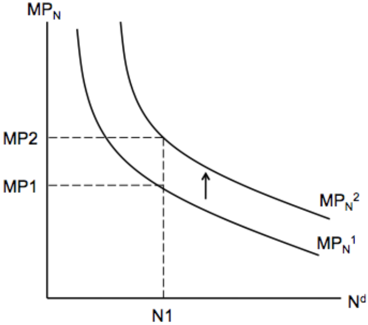
Production function, fixed labor

- The slope at A is MP_K when K = K*.
- MP_K is falling as the capital input increases, given the labor input.



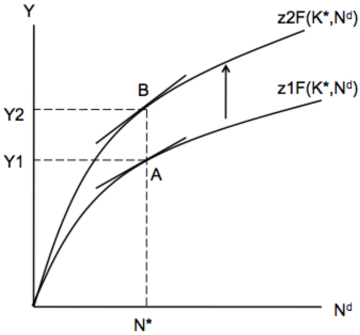
Marginal Product of Labor (MP_N)

- The marginal product of labor decreases as the labor input increases.
- Downward slope MP_N.



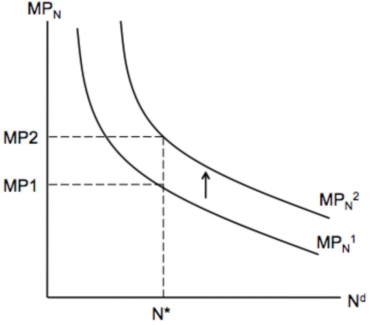
MP_N **increases as K increases.**

- The marginal product of labor increases as the capital input increases.



Increases in total factor productivity (z)

- An increase in z causes MP_N and output (Y) to rise at N^*.

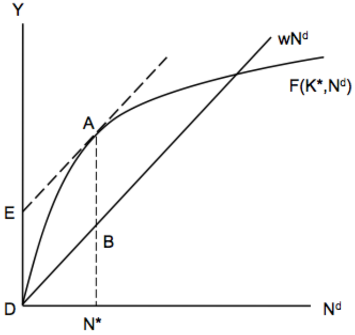


Effect of rising z on MP_N

- An increase in z causes MP_N at N^* to rise.

3.2.3 The firm's profit maximization

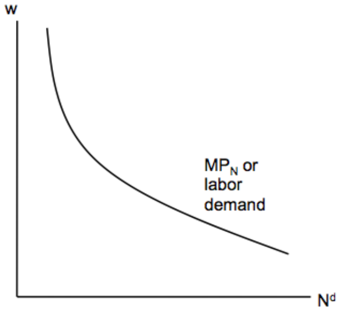
- Y = total revenue = $zF(K, N^d)$;
- wN^d = total variable cost;
- $\pi = zF(K, N^d) - wN^d$
- Maximized profit where
  - Slope of Y = slope of wN^d;
  - MR = MC
  - $MP_N = w$ or the firm's labor demand function.
  - The MP_N is the firm's labor demand curve.



Profit Maximization

- Y = revenue;
- MP_N = marginal revenue;
- wN^d = variable cost;
- w = marginal cost;
- Profit = $Y - wN^d$;
- Max profit = AB where $MP_N = w$.

3.2.4. The firm's labor demand curve



- Profit-max: the firm hires labor up to the point where $N^d = w$.

Labor input (workers)	Total product (number of goods)	Marginal product of labor
0	0	—
1	9	9
2	17	8
3	22	5
4	25	3
5	26	1