EE312 Chapter 7
A Closed-Economy One-Period Macroeconomic Model

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1 Introduction

- Brief history of macroeconomic thought
  - 1930s: the emergence of traditional macroeconomics.
  - 1940s: Become increasingly popularized since Timbergen, Frisch, Klien, Havelmo (and many others) have combined the framework with statistical analysis.
  - 1950s/1960s: The golden era of traditional macroeconometrics and central-planning policy
  - 1970s: Loosing its ground since the oil shocks.
- What's wrong with the traditional framework?
  - Overly relying on data-driven reasoning; empirical fitness of statistical model with a "loosely-grounded theoretical foundation".
  - Phillips curve is a good example; this had lured economist to believe that permanent trade-off exists.
  - Structural analysis with deep economic reasoning by Friedman et.al. has suggested otherwise; trade-off works only when inflation is near zero.
- To guard against the temptation, macroeconomics should be based on "micro-foundation".

- Lucas doubted that policy analysis under traditional framework can be helpful - The famous Lucas's critique in 1976.
- Agent's behaviors normally change with "environment" and "rule of the game".
  - All these combined is call "regime".
  - Example: Ricardian equivalence
- Lucas's critique inspired thoughts to many economists whose interest centered on business cycles studies.
- A new framework for business cycles was developed, and known as the real business cycles theory - Kydland and Prescott (1981)
- The framework has been subsequently developed into a unified framework called the Dynamic Stochastic General Equilibrium model (DSGE model).
- Micro-foundation of modern macroeconomics is an alternative approach in macroeconomics studies.
  - Macro behavior is the sum of microeconomic decisions by consumers and firms.
  - Model building from the micro behavior to the aggregate levels. (bottom-up approach)
  - Giving details about "environment" and "rule of the game" at the very primitive level.

2 General Equilibrium Macroeconomy and Circular Flow of Macroeconomy

- Basic structure of a micro-foundation macroeconomic model.
  - Actors: consumers, firms, government, the rest of the world.
  - The set of goods that consumers consume.
  - Single goods v.s. sectoral goods (Durable/non-durable/service)
  - Domestic/imported

  - Consumer's preference over goods.
  - Firms' production technology.
  - Resources available.

- Model structure:
  - Consumer preferences: Consumer optimization.
  - Production technology: Firm optimization.
  - Government taxes and spending.
  - The current account. (for open-economy)
  - The decisions by all actors will determine the outcome: income, employment, productivity, and other macroeconomic variables. "General "

- Our plans ahead are:
  - Start from a simple one-period model
  - Extend into multi-period model
  - Using the model understand the propagation of shocks (exogenous variations).

- **Close-economy one-period macroeconomic model**
  - 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 savings (no financial market).
  - Government collects taxes and spends (G = T).
  - No foreign trade; a barter economy (no money).
  - No uncertainty; random shocks
  - The foundation of all macro analysis.

- Circular flow

3 Optimizing-agent Decision

3.1 Household

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

3.2 Utility function

- Utility function:

$$U = U(C, l)$$

  U = utility function

  C = the amount of consumption goods

  l = the amount of leisure

  $U(C_1, l_1)$ = level of utility derived from the consumption bundle of consumption goods C_1 and leisure l_1.

3.2.1 Properties of consumer preference

- More is preferred to less.

  If $U(C_2, l_2) > U(C_1, l_1)$, then

  $U(C_2, l_2)$ is strictly preferred to $U(C_1, l_1)$.

- The consumer has preference for diversity in his/her consumption bundle.

  $U(C_2, l_1)$ is preferred to $U(C_3, 0)$.

- Consumption goods and leisure are normal goods.

  The consumer demands more as income rises.

3.2.2 Indifference curve

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

More is preferred to less:

- The marginal rate of substitution of leisure for consumption goods ($MRS_{l,C}$) 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.
  - $MRS_{l,C}$ is decreasing as the consumer moves from consumption goods to more leisure.

  Preference for diversity:

3.2.3 Consumer's budget constraint

- Consumer's budget constraint: limited resources need to allocate them efficiently (maximum utility)
  - 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.

- Consumer's time constraint

$$l + N^s = h$$

where

h = hours of time available;

l = time allotted to leisure;

N^s = time spent working (labor supply)

- The real disposable income is the sum of wage and dividend incomes minus taxes.

$$Y^d = wN^s + \pi - T$$

  - 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.

- Equation for consumer's budget constraint: the consumer's disposable income is spent on consumption goods, meaning consumption expenditure (C)=Disposable income (Y);

$$\begin{aligned} C &= wN^s + \pi - T \\ C &= w(h - l) + \pi - T \\ C &= wh - wl + \pi - T \end{aligned}$$

$$\underbrace{C + wl}_{\text{Consumption on C and l}} = \underbrace{wh + \pi - T}_{\text{implicit real disposable income}}$$

$$C = \underbrace{-w}_{\text{slope}}\, l + \underbrace{wh + \pi - T}_{\text{intercept}}$$

The implicit real disposable income $(wh + \pi - T)$ is split into expenditures on consumption goods and leisure $(C + wl)$.

w = the market price of leisure.

The slope $= -w$; the intercept $= wh + \pi - T$

Budget constraint $T > \pi$:

Budget constraint $T < \pi$:

3.2.4 Consumer optimization

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

The optimal consumption bundle:

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

$$MRS_{l,C} = w$$

Corner solution:

The consumer may choose not to work and consume only leisure but it is an impossible solution (equilibrium):

No labor service to the firm, no incomes.

No production by the firm, no consumption goods.

The consumer's preference for diversity.

- Effects of changes in dividends and taxes to (C, l): Pure income effect

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

- Effects of an increase in the market real wage to (C, l): Substitution Vs income effects

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

- **The labor supply function:**

$$N^s(w) = h - l(w)$$

where $\frac{\partial N^s}{\partial w} > 0$, assuming the stronger substitution effect.

N^s = the labor supply function;

h = the maximum hours available;

$l(w)$ = the leisure function, given the real wage.

- Effects of an increase in $\pi - T$ to N^s

3.2.5 Consumer demand function

- **The consumption demand function:**

$$C^d(w) = wN^s(w) + \pi - T$$

where $\frac{\partial C^d(w)}{\partial w}$

C^d = the consumption demand function;

Consumption demand function is an increasing function in w.

Hence, a decreasing function in $\frac{1}{w}$

- Conventionally, consumer demand curve should be graphically plotted as a downward sloping curve (in its own price.)
  - It doesn't make sense to plot the amount of consumption in terms of real wage (w).
  - What is the price of the consumption goods? The answer is 1/w, i.e. the reciprocal of real wage (w).

w = real wage

- Interpretation:

- Price of a unit of labor (leisure) hour in terms of units of consumption goods acquired (forgone)

$\frac{1}{w}$ = price of consumption goods

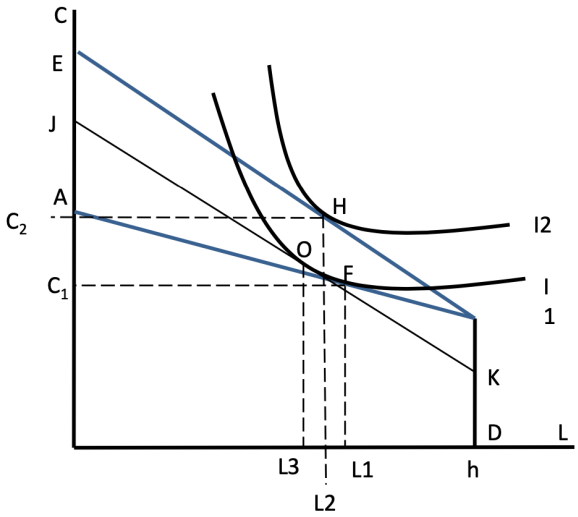
- Interpretation:

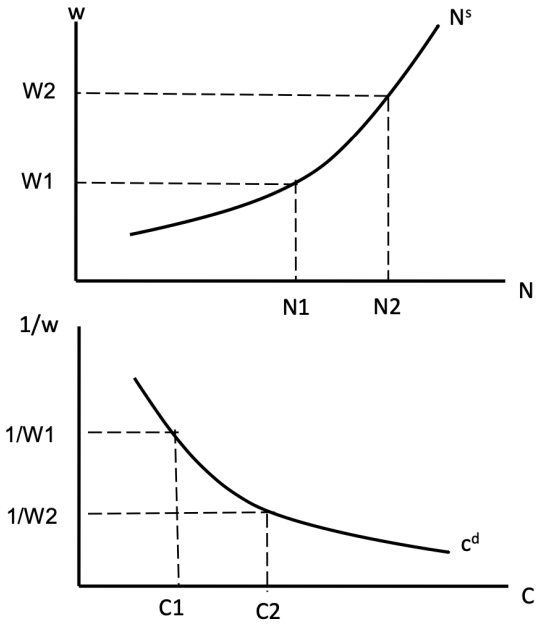
- Price of a unit of consumption goods in terms of units of working hours forgone.

Consumer demand curve

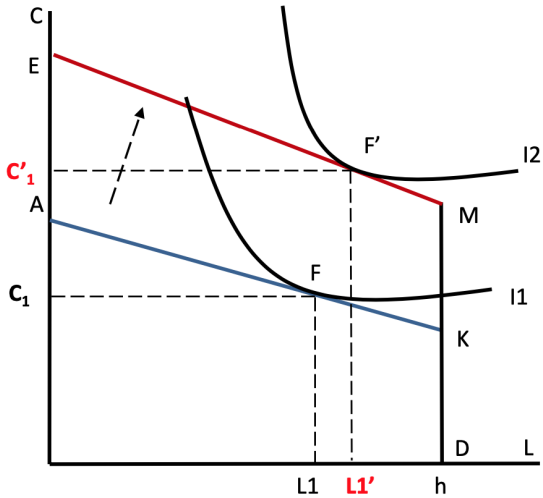
- Effect of a decrease in $\pi - T$

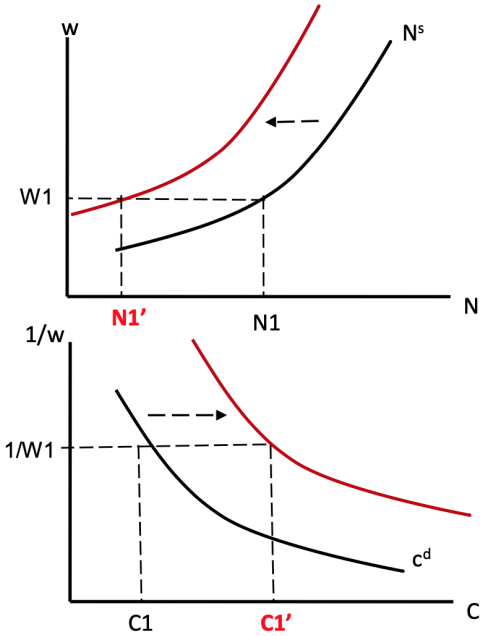
- Recap Household behavior: The labor supply and (Private) consumption demand





- **Effect of "wage" on leisure, and hence working hour**
  - **Substitution effect = FO.**
  - **Income effect = OH.**
- **FO > OH, C increases and L decreases**
- **So N increases.**





An increase in π-T (by KM) causes the consumer to increase both C and L.

3.3 Firms

- 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.
- **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.

3.3.1 Total factor productivity

- Total factor productivity 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.
  - A change in z comes from: Technology; Production organization; Managerial process of inputs; Social and physical infrastructures.

3.3.2 Properties of the production function

- Constant returns to scale: $zF(x \cdot K, xN^d) = x \cdot Y = x \cdot zF(K, N^d)$
- Output increases if either labor or capital increases: $MP_N = \frac{\partial Y}{\partial N^d} > 0$, $MP_K = \frac{\partial Y}{\partial K} > 0 \Rightarrow$ Upward slope of the production function in K and N

- **The marginal product of labor** (MP_N) decreases as the labor input increases, given the capital input ⇒ The production function is concave in labor; 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

3.3.3 Firm's profit maximization

- **The firm's profit**:

$$\pi = zF(K, N^d) - wN^d$$

where

$Y = zF(K, N)$ = total revenue

wN^d = total variable cost;

Maximized profit where

Slope of Y = slope of wN^d;

MR = MC

MPN = w or the firm's labor demand function.

The MPN is the firm's labor demand curve.

Profit Maximization

3.3.4 Firm's labor demand

- **The firm's labor demand curve:**

  At profit-max, the firm hires labor up to the point $MP_N = w$.

  As w changes, the firm moves along MP_N curve.

- Effect of an improvement in z and K

3.3.5 Firm's output supply

- **Firm's output supply function**

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

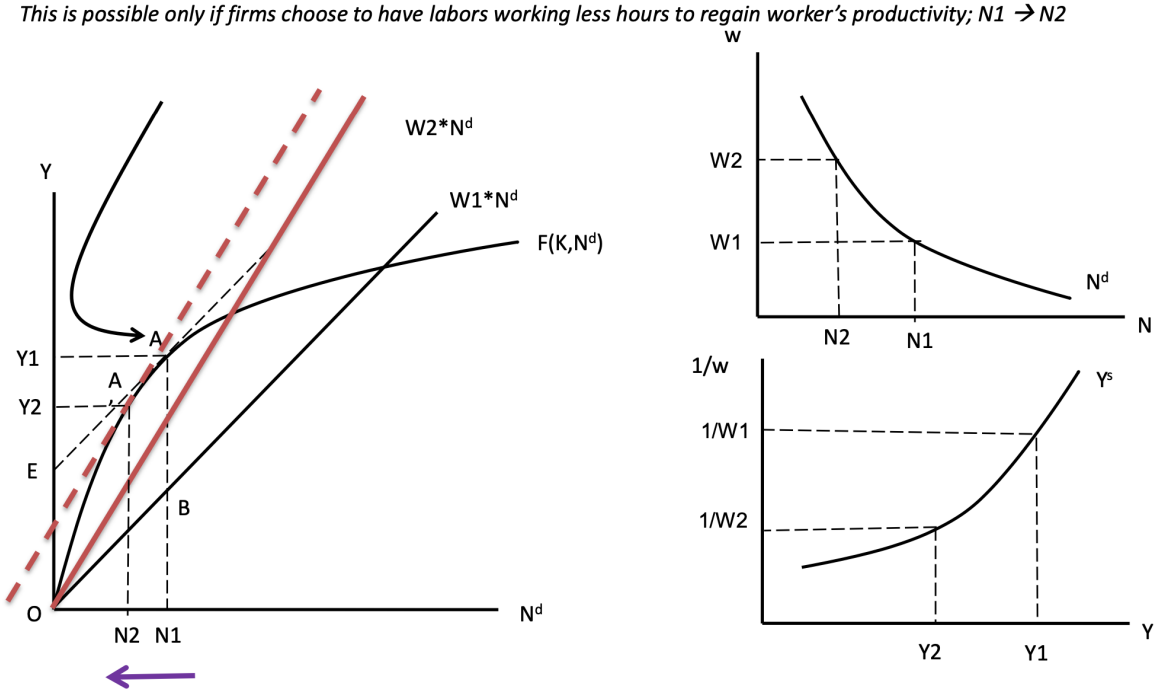
where $\frac{\partial Y^s}{\partial w} < 0$
$Y^s(w)$ = the amount of output supplied at a given w.

Output supply curve: a plot of Y^s with respect to the price of consumption goods, i.e. $\frac{1}{w}$, yielding us the conventional shape of output supply when the amount of output supplied is an increasing in its own price.

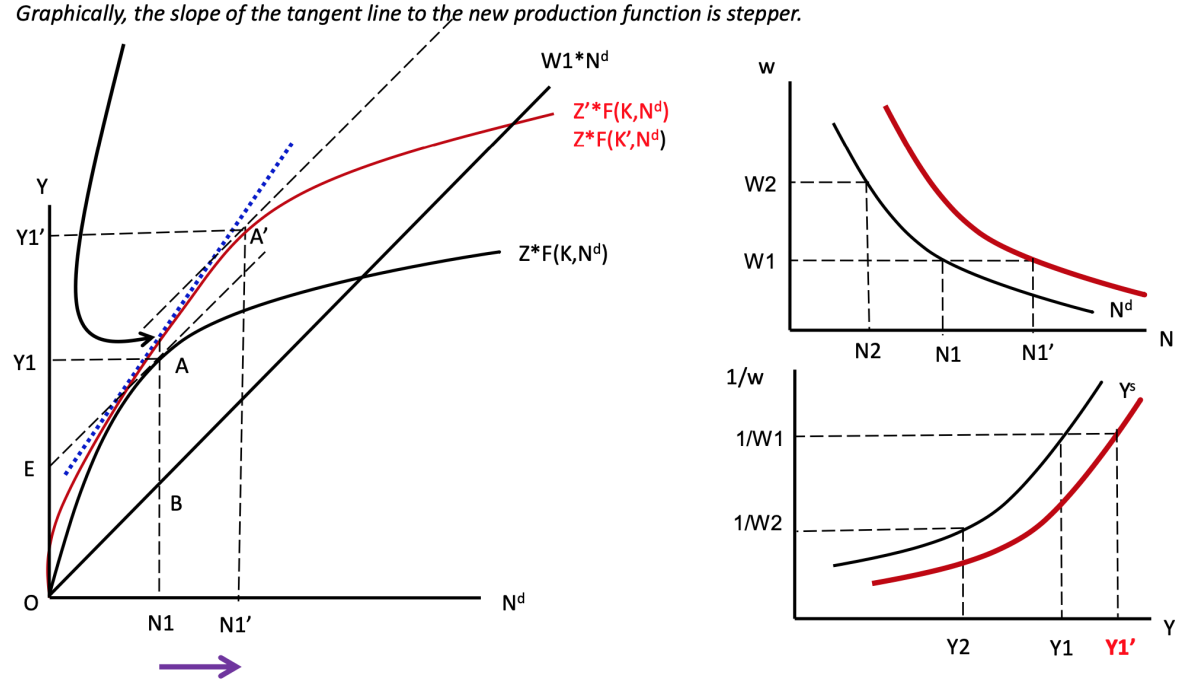
- Effect of an improvement in z and K

- Recap Firms' behavior: The labor demand and output supply

With higher wage, firms will effectively overpay the worker if N1 is chosen.
Hence, firms need to choose for a new N where marginal productivity matches with higher wage.
This is possible only if firms choose to have labors working less hours to regain worker's productivity; N1 → N2



Both higher z and higher K lead to an increase in MPN at every level of working hours.
Graphically, the slope of the tangent line to the new production function is stepper.



3.4 Government

- Government (G) spends on consumption goods.
  - Spending is financed totally by taxes (T).
  - The government's budget constraint: $G = T$
  - G is exogenous.
- Type of variables:

  Exogenous variables: values are determined outside the model.

  Endogenous variables: values are determined inside the model.
- One-period macroeconomic model

Exogenous variables:

Endogenous variables:

4 Competitive equilibrium and Pareto optimality

4.1 Definition

- **Competitive equilibrium** is a set of endogenous quantities, C (consumption), N^s (labor supply), N^d (labor demand), T (taxes), and Y (aggregate output), and an endogenous real wage w, such that, given the exogenous variables G (government spending), z (total factor productivity), and K (capital stock), the following are satisfied:

  1. **The representative consumer** chooses C (consumption) and N^s (labor supply) to make himself or herself as well off as possible subject to his or her budget constraint, given w (the real wage), T (taxes), and π (dividend income).

  2. **The representative firm** chooses N^d (quantity of labor demanded) to maximize profits, with maximized output $Y = zF(K, N^d)$, and maximized profits $\pi = Y - wN^d$. The firm treats z (total factor productivity),K (the capital stock), and w (the real wage) as given.

  3. **The market for labor** clears: $N^d = N^s$.

  4. **The government budget constraint** is satisfied: $G = T$.

- **Walras's law:** If we have N markets, and N-1 of which have been cleared, the last market will be automatically cleared.

  Consider our one-period macroeconomic model: If labor market is cleared, then the goods market is cleared as well.

$$
\begin{aligned}
C &= wN^s + \pi - T \\
\text{as } \pi &= Y - wN^d \text{ and } G = T \\
C &= wN^s + Y - wN^d - G \\
C &= \underbrace{(wN^s - wN^d)}_{\text{if labor mkt clear} = 0} + Y - G \\
C &= Y - G \\
Y &= C - G
\end{aligned}
$$

  In equilibrium, $N^s = N^d$ and the equation is reduced to $Y = C + G$

Implication: we may analyze the equilibrium upto "N-1 markets"; the last one is warranted to be cleared.

4.2 Equilibrium Analysis

- Two approaches for equilibrium analysis:

  1. Demand and supply approach
  2. Edgeworth box approach

4.2.1 Demand and supply approach

- Graphical illustration of General equilibrium

- Given the optimizing behavior of agents, the economy is under the equilibrium when all markets clear!

  Labor market in equilibrium: $N^d = N^s$

  Goods market in equilibrium:

$$Y^D = Y^S \Leftrightarrow C + G = Y^S$$

  G is treated as an exogenous

Equilibrium allocation and price: (N^*, C^*, Y^*, W^*)

- Equilibrium adjustments:

  Notice that W_2, we have ES for labor market and ED for goods $\Rightarrow$

  - ES for labor in labor market: Wage should be falling, resulting in drop in labor supplied, and increased in labor demanded

  - ED for goods in goods market: Consumption price should increase, resulting in drop in private consumption and aggregated quantity demanded.

  Notice that W_3, we have ED for labor and ES for goods $\Rightarrow$

  - ED for labor in labor market: Wage should be rising, resulting in an increase in labor supplied, and a decrease in labor demanded

  - ES for goods in goods market: Consumption price should decrease, resulting in an increase in private consumption and hence the aggregated quantity demanded.

4.2.2 Edgeworth box approach

- Edgeworth box diagram incorporate all relevant information for the graphical illustration of general equilibrium

  - Optimizing by consumers, producers
  - Market clearing allocation
  - Market clearing prices (goods price and factor prices)

- Elements of the Edgeworth box diagram

  - Production possibility frontier
  - Isoprofit curve and corresponding wage line
  - Illustration of firm's optimization using PPF
  - Illustration of consumer's optimization using the corresponding wage line
  - Market clearing allocation and associated equilibrium prices

- **PPF : Production possibility frontier**

  - The PPF can be defined in several ways.
  - In our context, we define PPF as the combination of "C" and "l" that could be attainable, given production technology and resource constraints

- Production function: In equilibrium, $N^d = N^s = N$; and $N = h - l$, therefore:

$$Y = zF(K, N) = zF(K, h - l)$$

- Output as a function of leisure $Y = zF(K, h - l)$: The relation between Y and l is a mirror image of the production function with slope $= -MP_N$

- Private consumption as a function of leisure:

$$\begin{aligned} Y &= zF(K, h-l) \\ \text{and } C &= Y - G \\ C &= zF(K, h-l) - G \end{aligned}$$

  The relation between C and l, given z, K, G.

  Total output is deducted by G to give the net amount available for consumption — the PPF.

- PPF gives the trade-off between consumption goods and leisure, given technology

  The slope of PPF is the marginal rate of transformation (MRT) of l to C, the rate at which leisure is converted to consumption through work, given technology.

$$MRT_{l,C} = -MP_N = -\text{slope of PPF}$$

- The producer's max profit: The Edgeworth box diagram can also illustrate the profit-maximizing allocation: isoprofit curve and corresponding wage
- **Isoprofit curve:** the combination of 'C' and 'l' that generates the same level of the profit. The isoprofit curve is a straight line, with correspondingly slope equal to $-w$.

$$\begin{aligned}\pi &= Y - wN^d \\ &= (C + G) - w(h - l) \\ &= C + wl - wh + G\end{aligned}$$

  - Slope of Isoprofit curve $= \frac{dC}{dl} = -w$

  - Isoprofit curve is steeper when real wage increases.

  - With higher level of profit, the Isoprofit curve shifts out. Isoprofit curve is increasing in both C and L.

- The slope of Isoprofit curve (in its absolute) is equal to the real wage. Sometimes, it is easier to refer to the Isoprofit curve as the wage line (associated to the profit).
- The producer's max. profit: As a profit-maximizing producer, firm chooses to produce where $MP_N = w$
  - For a given "w", firm chooses "N" where $MP_N = w$
  - Slope of PPF = w

- With varied "w", optimal point changes
  - For example, with higher W D from W0 to W1, firm needs to relocate for a new level of consumption-leisure where MP = W1
  - From the graph, this must be to the right of point-0 as MPN increases with respect to more leisure, i.e. less working hours.
  - We assume that the new point is point-1 in the figure.

- **The consumer's maximized utility**: The consumer trades off between C and l to maximize utility, given w.

- **PPF and the consumer: combing the two problems into one**

  - The firm chooses the point on PPF which maximizes profits: $MRT_{l,C} = -MPN = -w$
  - The consumer's budget constraint has a slope: $MRS_{l,C} = -w$.
  - That point is on the firm's PPF and on the consumer's budget constraint - tangent point.

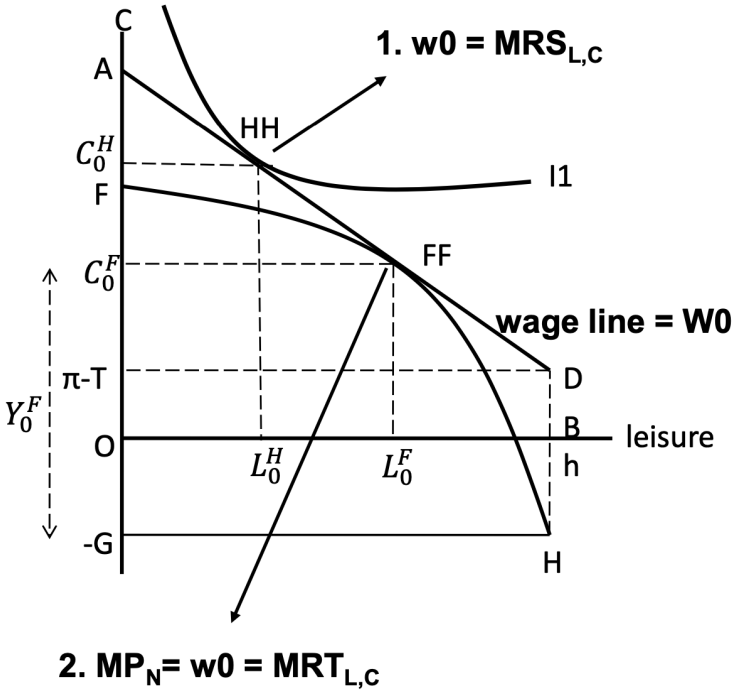
- Such point is the equilibrium consumption bundle (C^*, l^*) with w^* as the equilibrium wage because:
  - For the given w^*, consumer maximizes the utility because $w^* = MRS_{l,C}$
    - The consumer maximizes utility at J subject to the budget constraint:
    - ADB is the budget constraint; the slope $= -w^*$.
    - DB = the consumer's dividend income minus taxes $= \pi^* - T = \pi^* - G =$ the firm?s max. profit minus G.
    - OC^* = consumption goods obtained by the consumer = quantity of consumption goods supplied by the firm to the consumer.
    - OG = consumption goods taken by government.
    - $h - l^*$ = quantity of labor supplied by the consumer = quantity of labor demanded by the firm;
    - l^*= leisure desired by the consumer.
    - Point J on AD is also tangent to the consumer?s highest indifference curve where $MRS_{l,C} = w^*$.
  - For the given w^*, firm maximizes the profit because $w* = MP_N = MRT_{l,C}$
    - The firm maximizes profits at J, given technology:
    - $MP_N = w^* = MRT_{l,C}$ = slope of the budget line AD.
    - The firm pays the real wage $= w^*$ = the real wage received by the consumer.
    - The firm demands labor equal to $h - l^*$ and produces $Y^* = zF(K, h - l^*)$.
    - Max. profit: $\pi^* = zF(K, h - l^*) - w(h - l^*)$=DH
    - DB $= \pi^* - G = \pi^* - T$.
  - Demand = Supply in both markets
    - At such point, we know that total output is equal to total private consumption demand plus government spending; goods market is cleared.
    - At such point, labor demand is equal to labor supply.

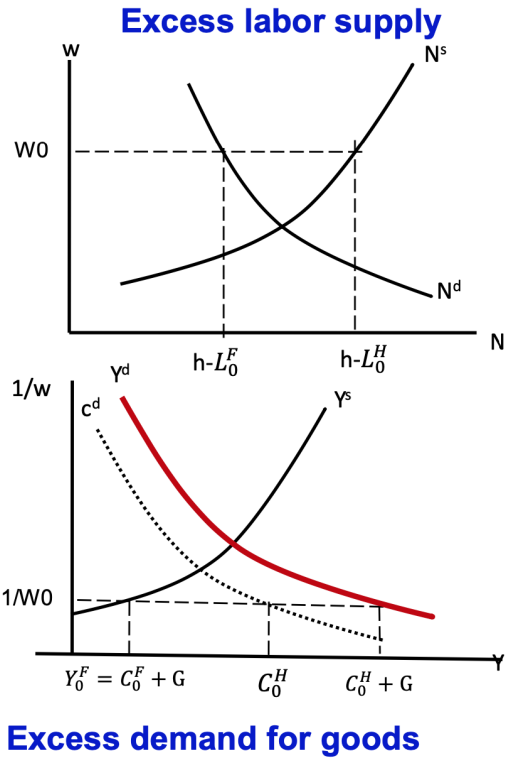
- Equilibrium in production and consumption:

$$MRS_{l,C} = w^* = MRT_{l,C} = MP_N$$

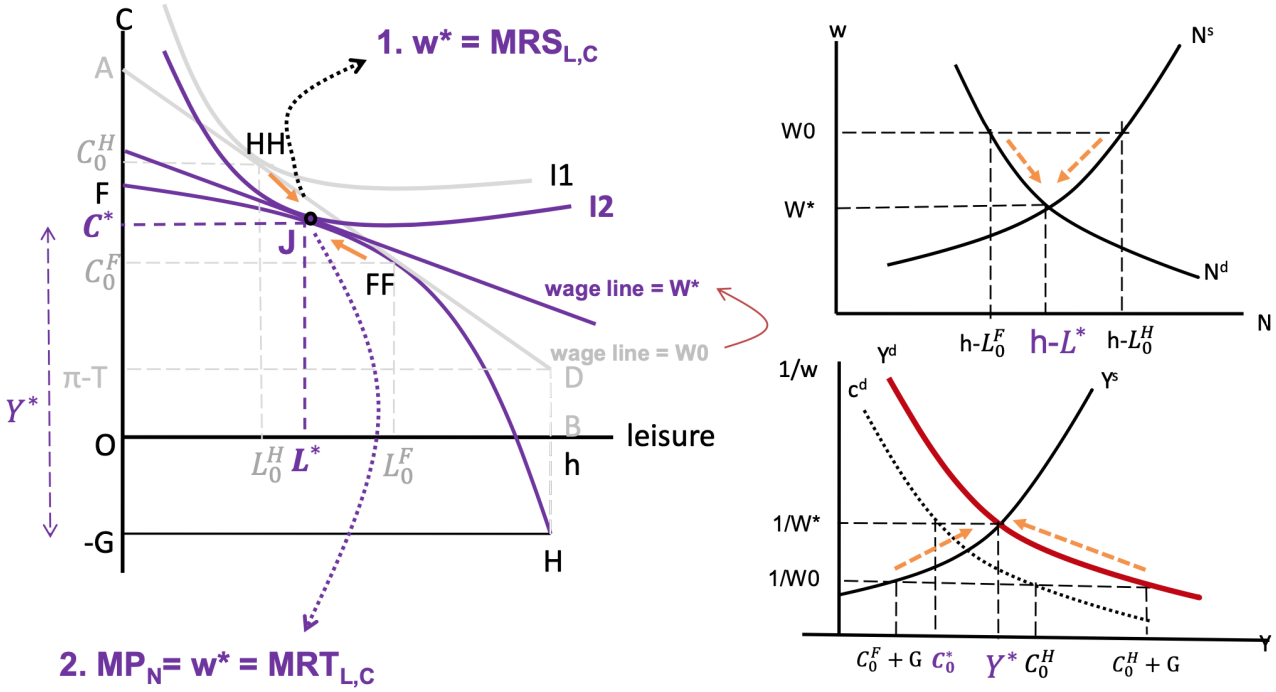
  - A competitive equilibrium is achieved when both the consumer and the firm optimize, given z, G and K.
  - Interpretably, the real wage (w^*) is the price signal for both parties to adjust and achieve a simultaneous equilibrium.

- Disequilibrium:





- Adjustment toward general equilibrium



4.3 Pareto Optimality

Questions: Is the competitive equilibrium efficient? Are there any other ways to obtain a better outcome?

- A competitive equilibrium is Pareto optimal if there is no way to rearrange production or to reallocate goods so that someone is made better off and no one is made worse off.
- Since there is only one consumer, we can ignore how consumption goods are allocated among consumers.
- Rather, we focus on how production is arranged.
- An allocation of C, l (and Y) at which an increase in the utility of one agent cannot be made without reducing the utility of another agent.
- The maximum efficiency is achieved as the competitive outcome.

$$MRS_{l,C} = w^* = MRT_{l,C} = MP_N$$

4.3.1 Social Planner

- **Social Planner's Problem**: Consider a social planner who runs the representative firm and chooses the quantities C and l so as to maximize consumer?s utility.

  Graphically, the social planner chooses a consumption bundle that is on the PPF and is on the highest possible indifference curve for the consumer.

- Comparison between Social Planner's solution and Competitive Equilibrium
  - Representative consumer faces a linear or kinked budget constraint
  - Social planner faces a concave PPF.
  - The Pareto optimum is at B where the equality holds $MRS_{l,C} = MRT_{l,C} = MP_N$. We have the same condition for a competitive equilibrium.

4.3.2 Fundamental theorems in welfare economics

- Assuming convex and monotone preferences and technologies.
  - **First welfare theorem:**
    - Under certain conditions, a competitive equilibrium is Pareto optimal. Competition results in a socially efficient outcome.
    - Adam Smith's "the Wealth of Nations" (1776).

      A competitive market economy with self-interested consumers and firms could achieve the allocation of resources and goods which is socially efficient.

      Competition is 'the invisible hand' which guides individuals to act in the way which benefit both themselves and society.
  - **Second welfare theorem:**
    - Under certain conditions, a Pareto optimum is a competitive equilibrium

  Note that Pareto optimality ignores the distribution issue among individuals and is thus a narrow concept of social optimality.

4.3.3 Sources of Social Inefficiencies

A competitive equilibrium may not be Pareto optimal due to:

- Externalities
  - An externality is any activity for which an individual firm or consumer does not take account of all associated costs and benefits.
  - All the benefits or costs are not captured by the price of the goods.
  - Positive externalities: social benefit ¿ private benefit (e.g., education, innovation, health care).
  - Negative externalities: social cost ¿ private cost (e.g., pollution, noise).

  - The root cause of an externality is that it is too costly, if not impossible, to set up a market to trade for the benefits and costs associated with the externalities (Market Failure).

- Distorting taxes, e.g., proportional income tax (t) on wages:

$$w(1-t) = MRS_{l,C} < MP_N = MRT_{l,C}$$

- Imperfect competition: firms which are not price-takers – Undersupply of the goods:

$$P > MR = MC.$$

- But government intervention to solve market failure may make the inefficiency worse.

- The competitive model is still very powerful.

  - A large number of real-world markets are close to perfect competition.
  - Benchmark for analysis of inefficiency and possible private solutions.

5 Model Application

- Predicting the effect of exogenous factor on endogenous equilibrium
  - Effect of G
  - Effect of z and K

- The comparative static equilibrium analysis

5.1 Effects of an increase in G

- A pure neg. income effect (as G=T increases).

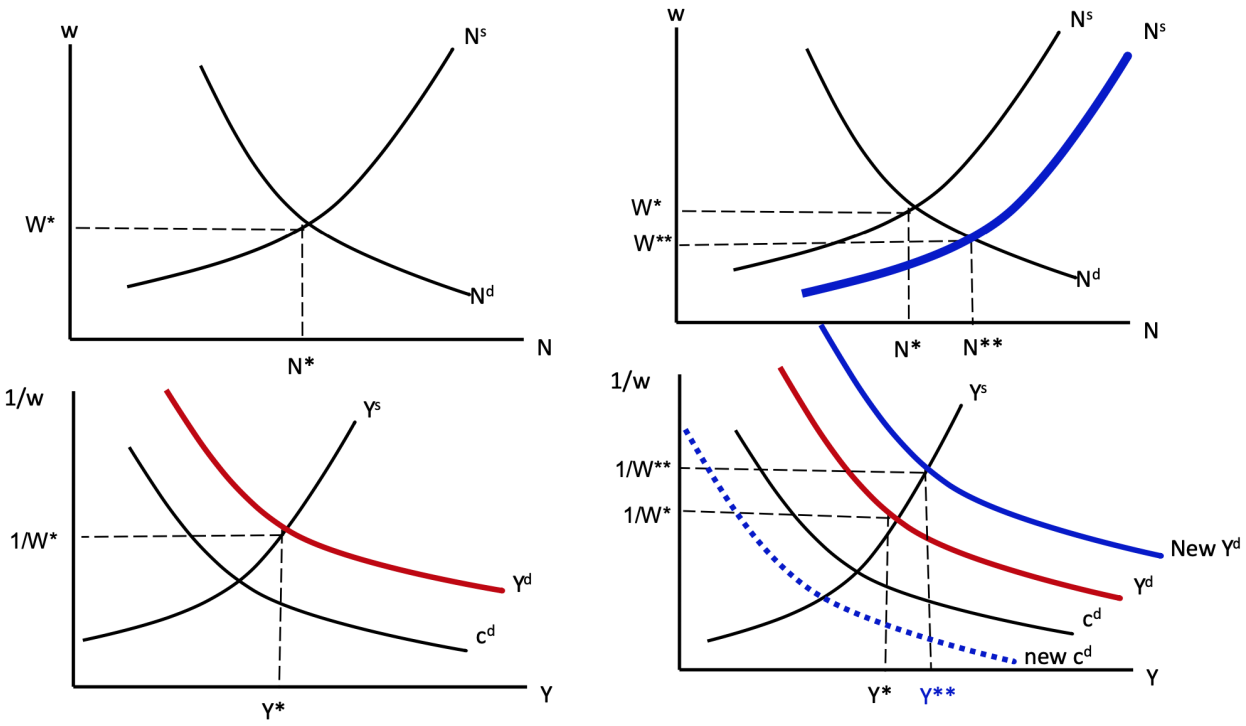
  - Dividend income $(\pi - T)$ and disposable income fall;
  - Both C and l decrease (normal goods).
  - Employment $(N = h - l)$ increases.
  - Output $Y = zF(K, N)$ rises.

  - Private consumption falls by how much?

- Consumption:
  - $\Delta G = AD > AE = -\Delta C$.
  - C decreases, but does not drop as much as the increase in G.
  - Private consumption is partially crowded out by the increase in government spending.
- What happens to the real wage?
  - The slope of PPF_2 at B is less steep than PPF_1 at A.
  - So the real wage fall.
  - The consumer supplies more labor ($N = h - l$ increases).
  - Given K, more labor input causes MP_N to fall.
  - The firm optimizes by paying lower $w = MPN$.
  - The lower real wage (w) induces the firm to raise employment (N).
  - The consumer works more, receives a lower real wage and consumes less.

- A higher G crowds out C

- Equilibrium analysis: Effect of G



An increase in G is financed by the lump-sum tax. As net disposable income decreases, optimizing-based household will lower consumption and leisure. Graphically, labor supply will shift to the blue one while consumption demand will drop to the dotted blue.

- Model prediction:
  - $G \uparrow \Rightarrow Y^*$.....

    N^*..... pro-cyclical

    w^*..... counter-cyclical

    C^*..... counter-cyclical

  Vs Business cycle stylized facts:

  $Y \uparrow$

  $N^* \uparrow$ pro-cyclical

  $w^* \uparrow$ pro-cyclical

  $C^* \uparrow$ pro-cyclical

- Therefore, government spending shocks do not appear to be a good candidate as a cause of business cycles. Whatever the primary cause of business cycles, it is unlikely to be the fact that governments change their spending plans from time to time

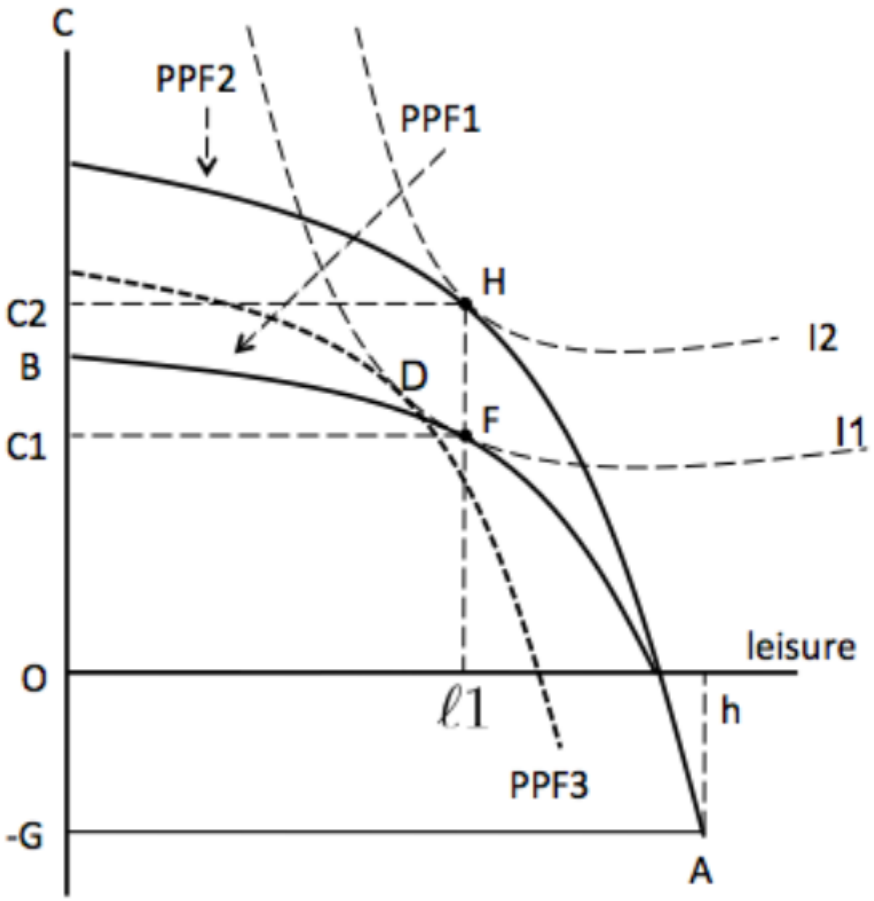
5.2 Effects of an increase in z

- An increases in z means better technology/management.
  - The production function and PPF rotate upwards.
  - Higher MP_N, given N with better technology. More demand for labor by the firm. The real wage increases ($MP_N = w$). Employment and leisure ($N = h - l$) may rise or fall.

- Output and consumption increase, given $G(Y \uparrow = C \uparrow + G)$; higher social welfare.
- Production function after a rise in z:
  - The production function rotates upwards with higher MP_N, given N.
  - Not only more Y can be produced given N, but the MP_N i.e. the slope of the production function also increases for each N.
  - Later, we will see that the new PPF is steeper than the original one.

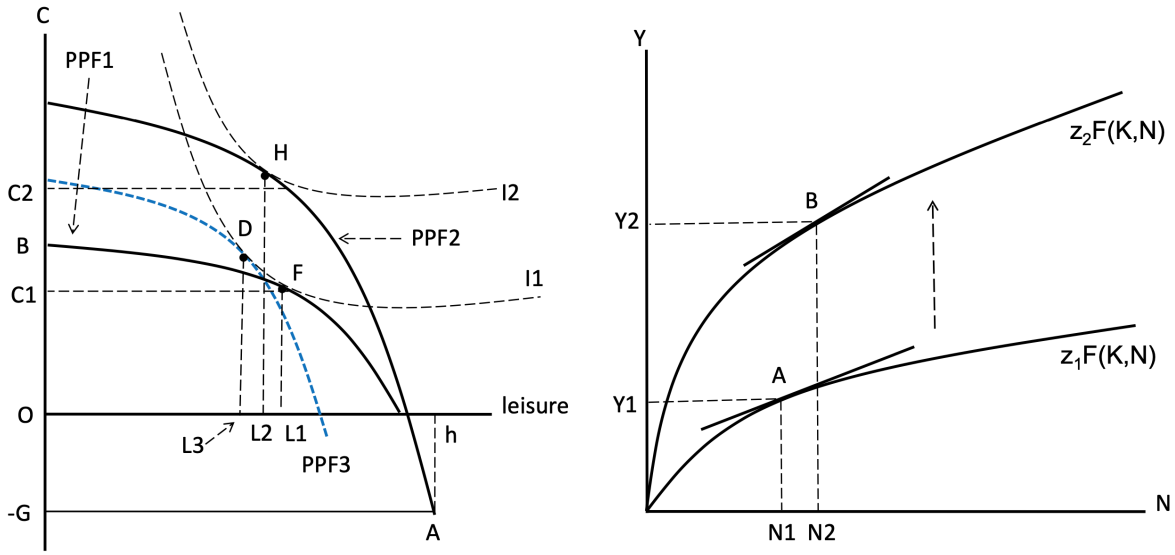
- PPF after a rise in z:
  - The PPF rotates upwards.
  - C, Y, MP_N and w increase. N and l may rise or fall.

- A higher z raises w, Y, C
  - FD = substitution effect (rising C and N, falling l).
  - DH = income effect (rising C and l).
  - Equal effects: no change in l and N.



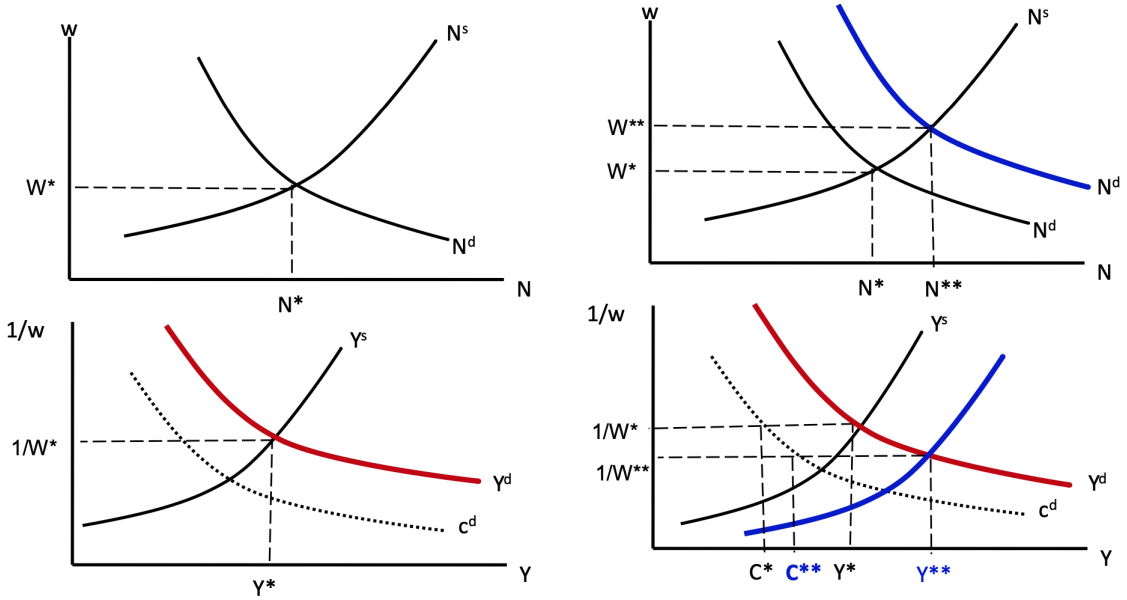
- If SE $\lessgtr$ IE, what will happen to N and l?

- Case 1. Stronger substitution effect



  - FD = substitution effect (rising C, falling l).
  - DH = income effect (rising C and l).
  - Lower l and larger N.

- Equilibrium analysis: Effect of technology



Improvement in Z results in an increase in labor demand (shitted to the blue one). At the same time, Output supply increases (shifted to the blue one). Overall effects are (i) increase in wage an working hour, (ii) higher Y* and C* along with falling implicit price of consumption goods.

- Model prediction with a stronger substitution or equal effect
  - $z \uparrow \Rightarrow Y^*$.....

    N^*..... pro-cyclical (SE.....IE), uncertain (SE.....IE)

    w^*..... pro-cyclical

    C^*..... pro-cyclical

  Vs Business cycle stylized facts:

  $Y \uparrow$

  $N^* \uparrow$ pro-cyclical

$w^* \uparrow$ pro-cyclical

$C^* \uparrow$ pro-cyclical

- Therefore, fluctuations in total factor productivity could be the primary cause of business cycle.
- The role of TFP shock:
  - In lights of the finding we knew, if one believes that the model explains how agents make decision and interact, TFP shock is more likely to explain the observed pattern of business cycles than the government shock does
  - Kydland and Prescott (1982) supported this idea under the so called **"real business cycle theory"**: They argued that two-thirds of the US postwar business cycles can be explained by the variations in TFP level.