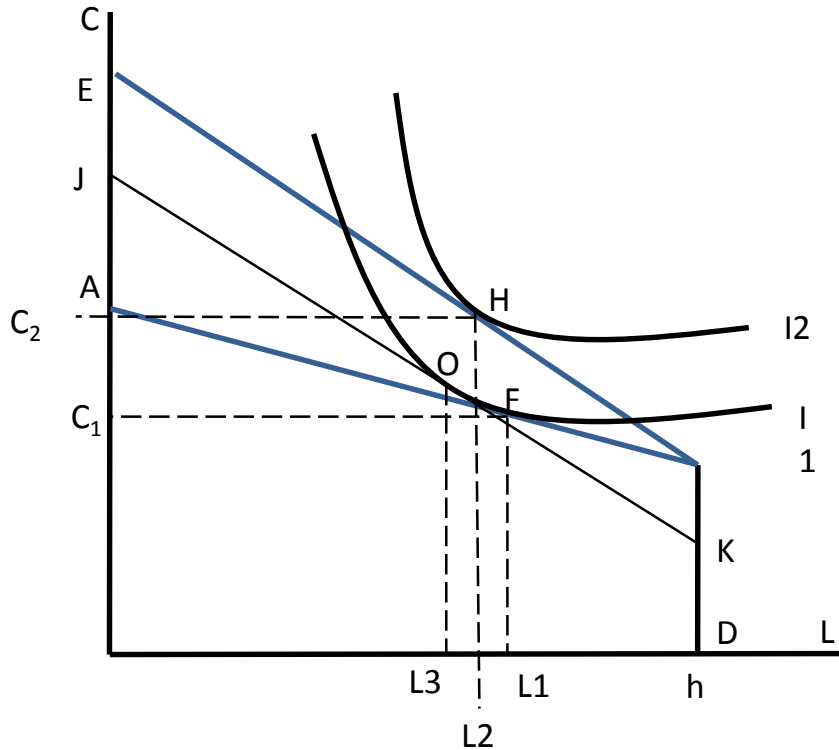


EE312 Macroeconomic Theory

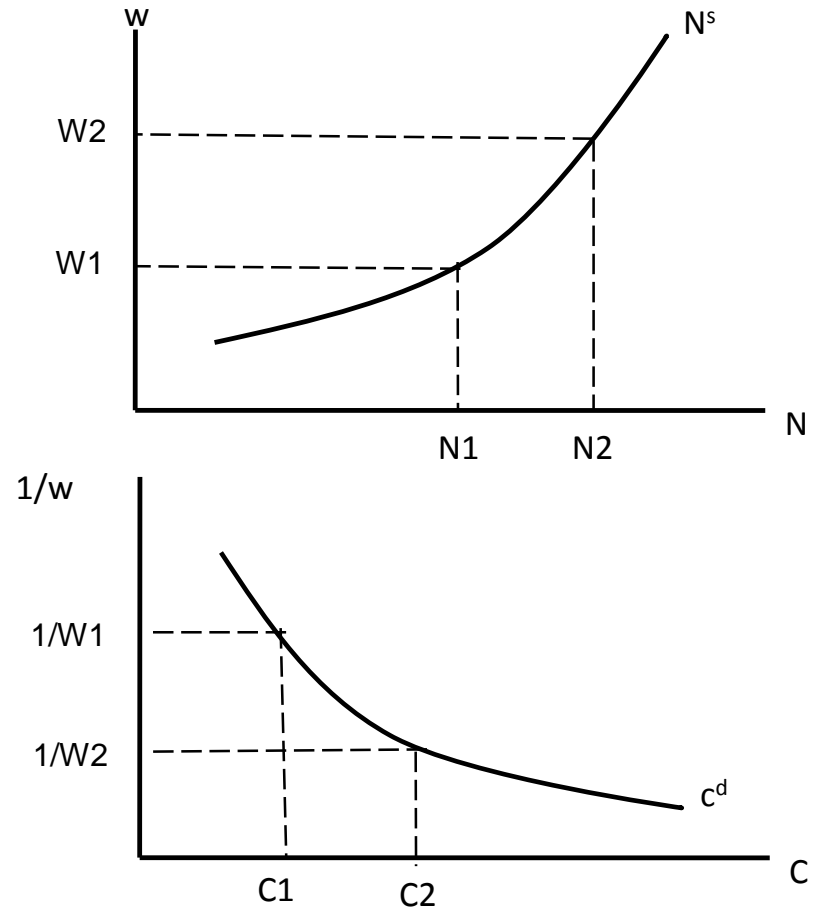
Chapter 5

A Closed-Economy One-Period Macroeconomic Model

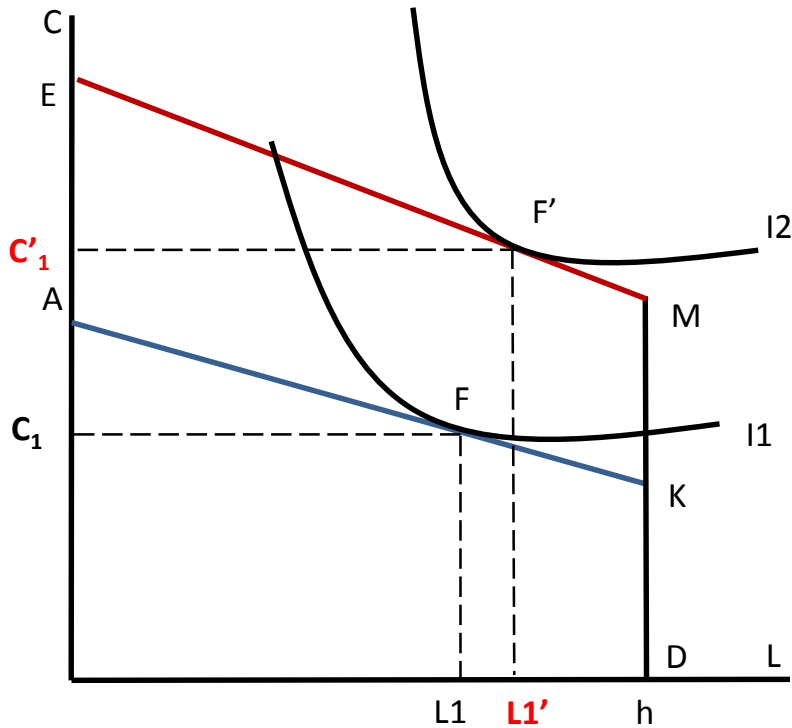
Recap on Household's behavior: The labor supply and (Private) consumption demand



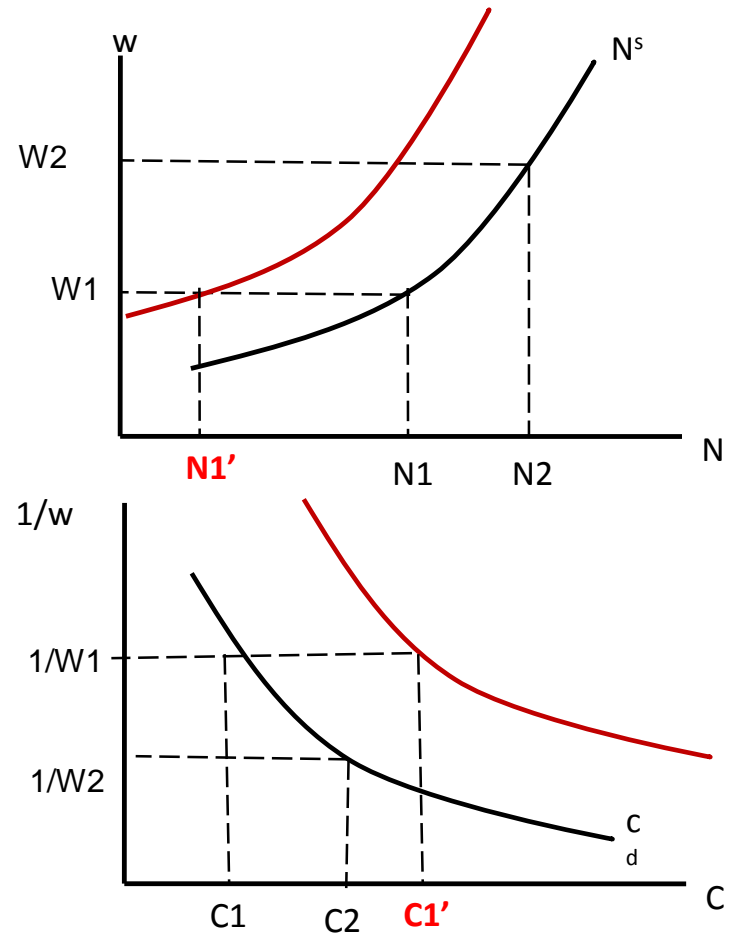
- **Effect of “wage” on leisure, and hence working hour**
 - Substitution effect = FO .
 - Income effect = OH .
- $FO > OH$, C increases and L decreases
- So N increases.



Recap on Household's behavior: The labor supply and (Private) consumption demand (effect of T)



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

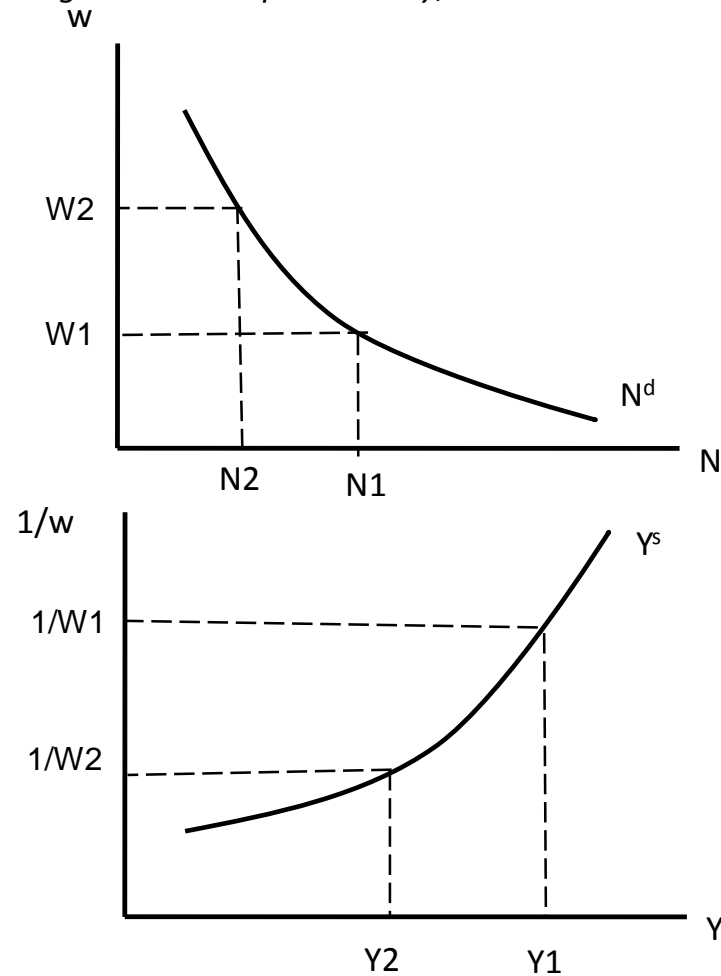
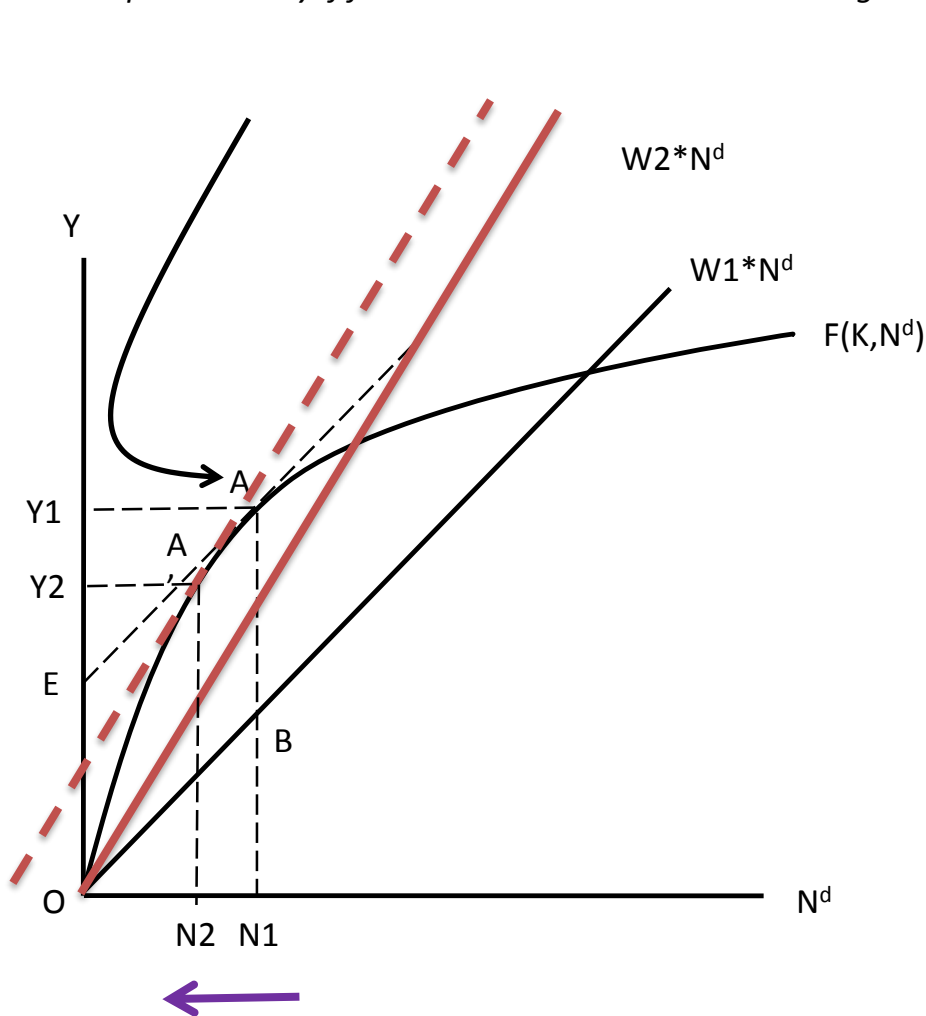


Recap on Firms' behavior: The labor demand and output supply

With higher wage, firms will effectively overpay the worker if $N1$ is chosen.

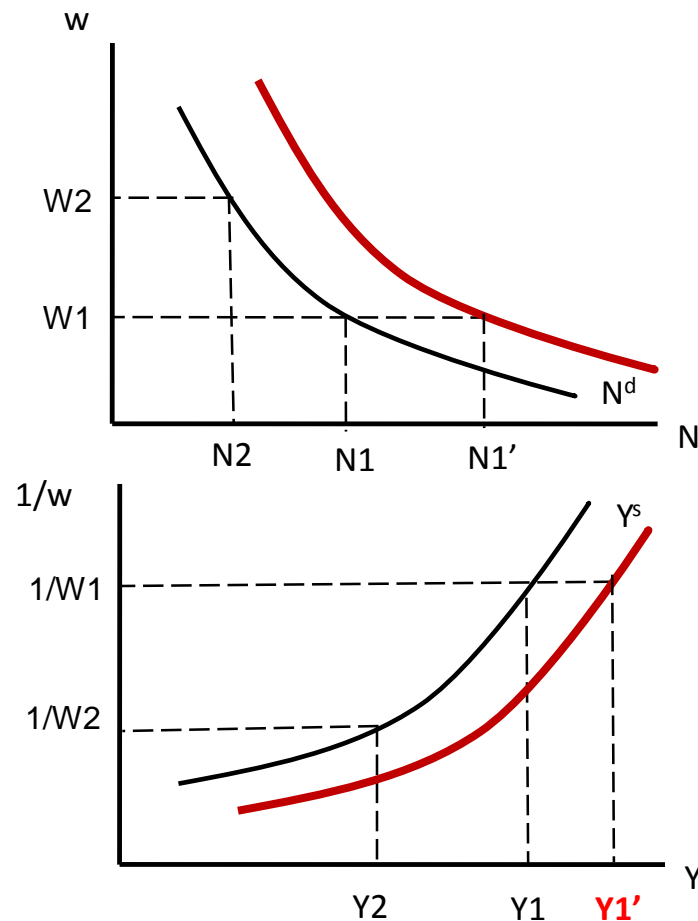
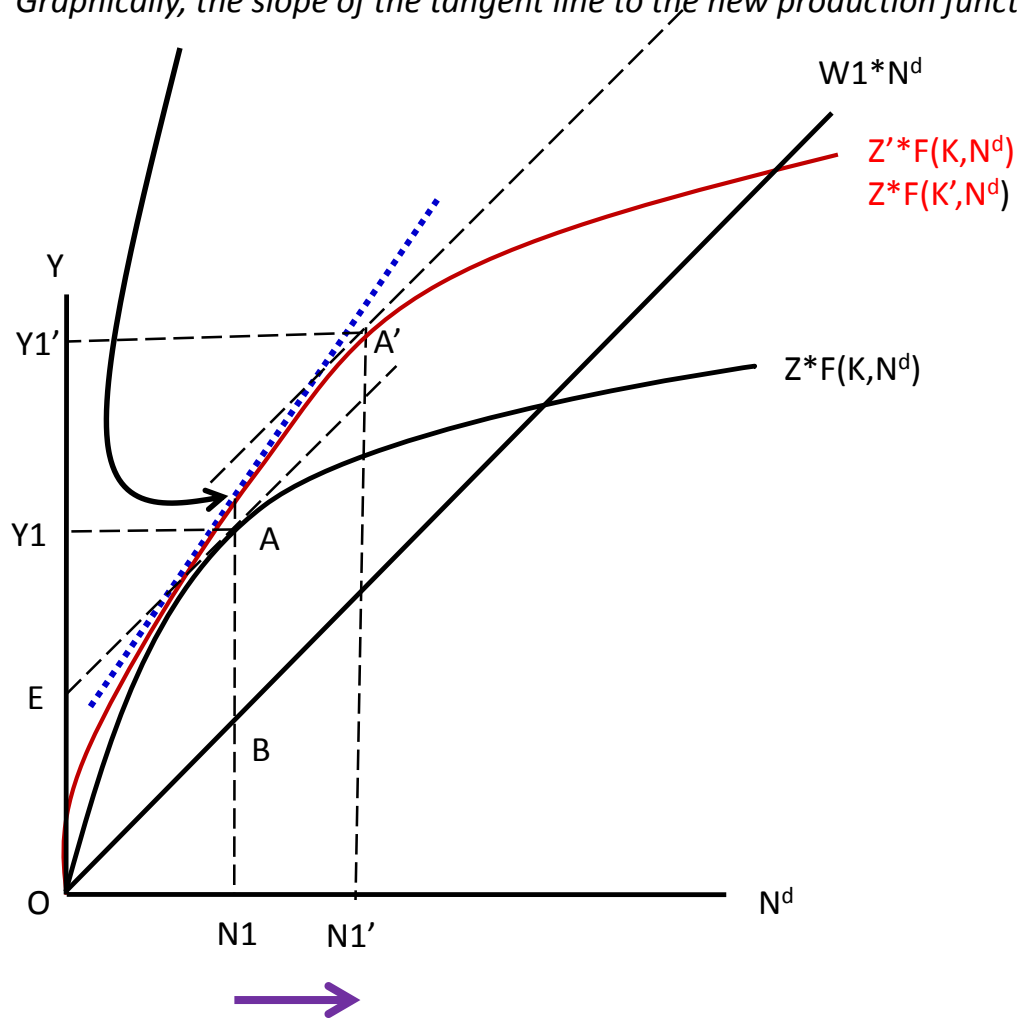
Hence, firms need to choose for a new N where marginal productivity matches with higher wage.

This is possible only if firms choose to have labors working less hours to regain worker's productivity; $N1 \rightarrow N2$



Recap on Firms' behavior: The labor demand and output supply (effect of z and K)

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 steeper.



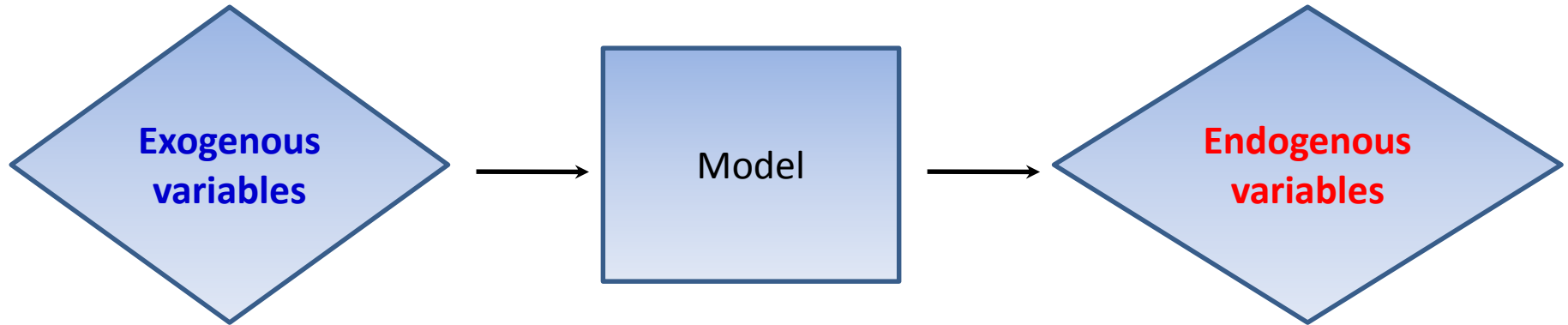
Closed-economy one-period model

- ~~• Representative consumer.~~
- ~~• Representative firm.~~
- Government and Competitive equilibrium
- Economic efficiency and Pareto optimality
- Applications of the one-period model

Government sector

- Government (G) spends on consumption goods.
- Spending is financed totally by taxes (T).
- The government's budget constraint: $G = T$
 - G is **exogenous**.
- **Exogenous variables**: values are determined outside the model.
- **Endogenous variables**: values are determined inside the model.

One-Period macroeconomic model



- Exogenous variables: **z, G and K.**
- Endogenous variables: **C, Y, N^d , N^s , w, T.**

Competitive equilibrium: definition

- The values of endogenous variables (C, Y, N^d, N^s, w, T) at which, given z, K and G :
 - **The representative consumer** chooses C and N^s so that utility is maximized, **given w, T and π** .
 - **The representative firm** chooses Y and N^d so that profit is maximized, **given w, z and K** .
 - **The labor market** clears: $N^d = N^s$.
 - **The government budget constraint**: $G = T$.

Income-expenditure identity

$$Y = C + G$$

- In a competitive equilibrium, the goods market clears:
 - Y = total output or income.
 - C = consumption expenditure.
 - G = government expenditure.

The consumer's budget constraint

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

as $\pi = Y - wN^d$ and $G = T$

$$C = wN^s + Y - wN^d - G$$

$$C = Y - G$$

$$Y = C + G$$

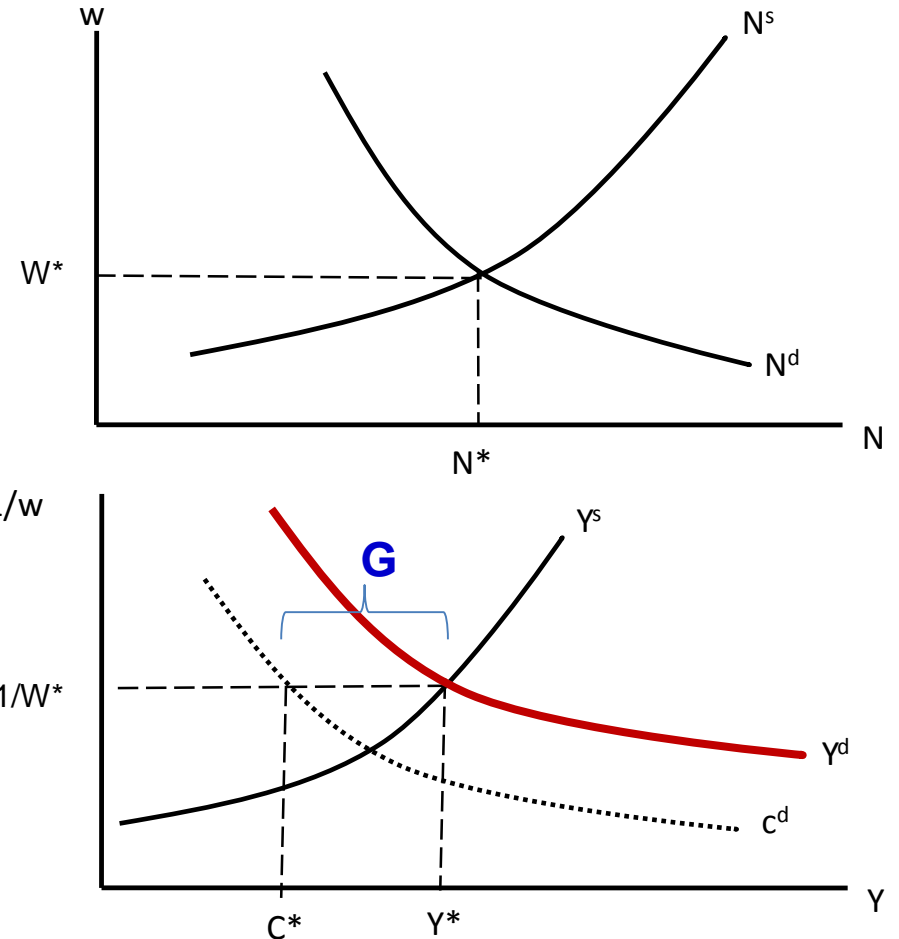
- In equilibrium, $N^s = N^d$ and the equation is reduced to $Y = C + G$.
- The famous **“Walras’ law”**

Two approaches for equilibriums analysis

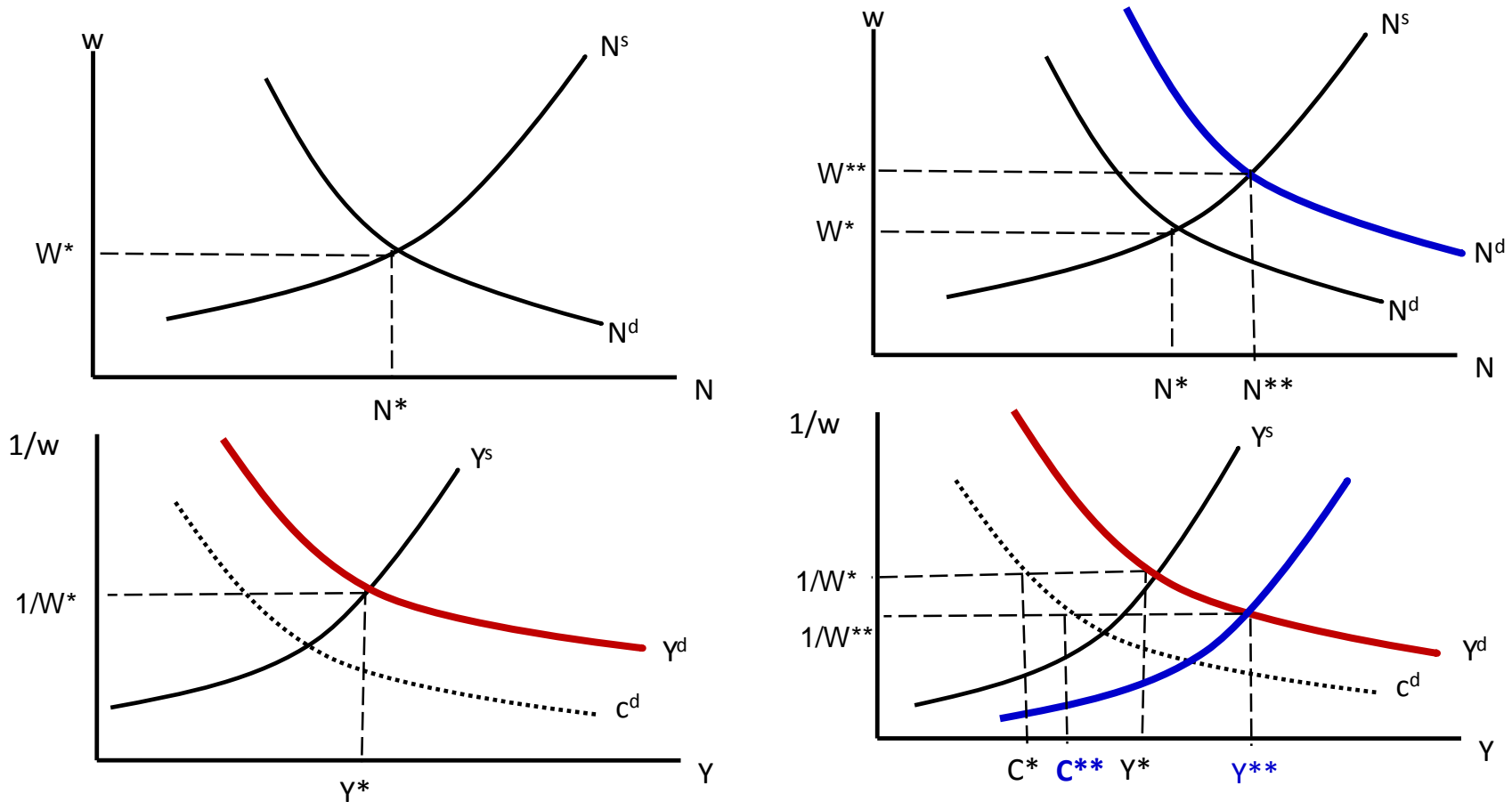
- **Demand and supply approach**
- Edgeworth box approach

Graphical illustration of General equilibrium: demand and supply diagram

- 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:
 $Y^d = Y^s \rightarrow C + G = Y^s$
 - G is treated as an exogenous!
- Equilibrium allocation and price:
 (N^*, C^*, Y^*, W^*)

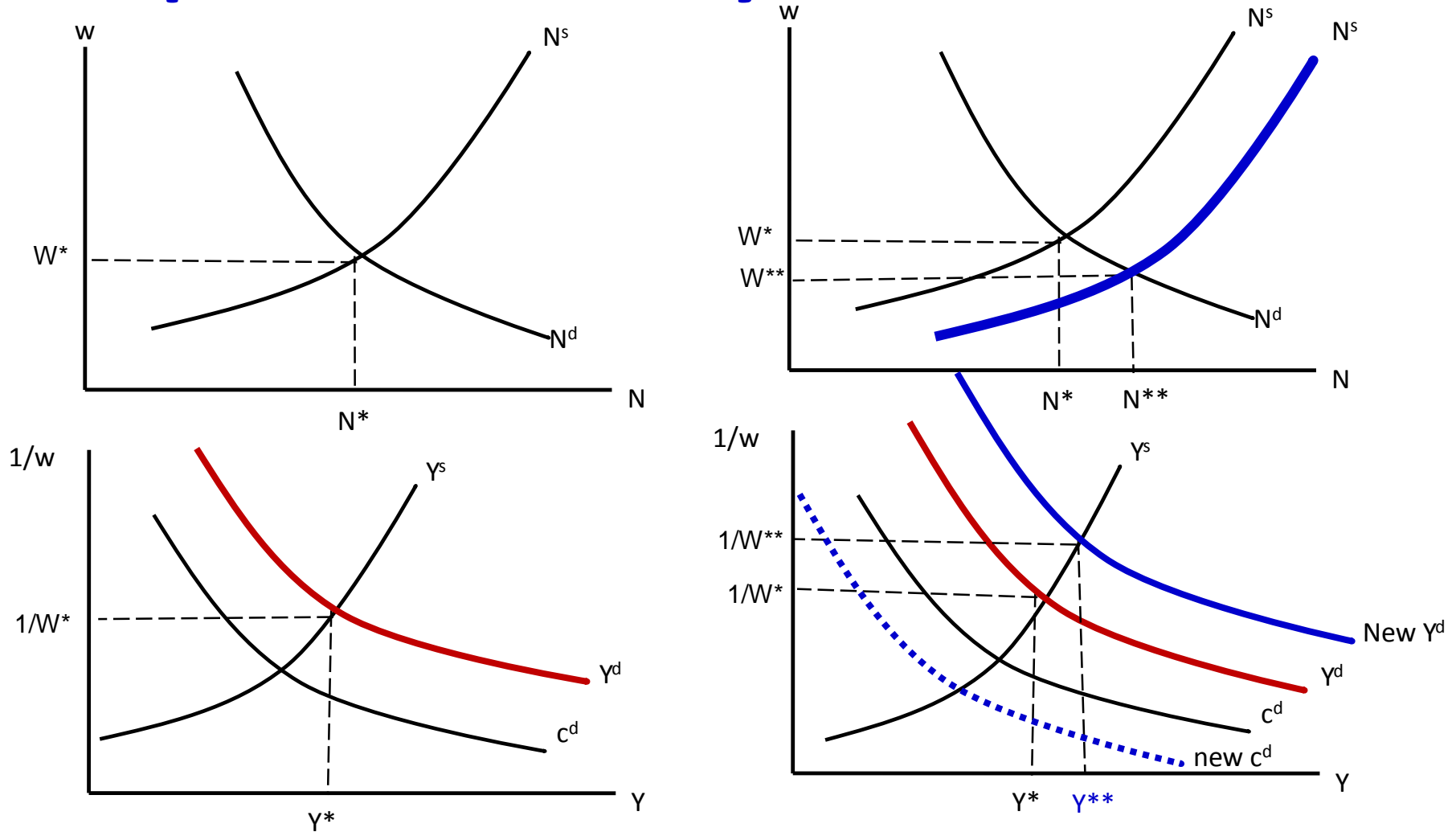


Equilibrium analysis: Effect of technology



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

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.

Two approaches for equilibriums analysis

- Demand and supply approach
- **Edgeworth box approach**

The production function

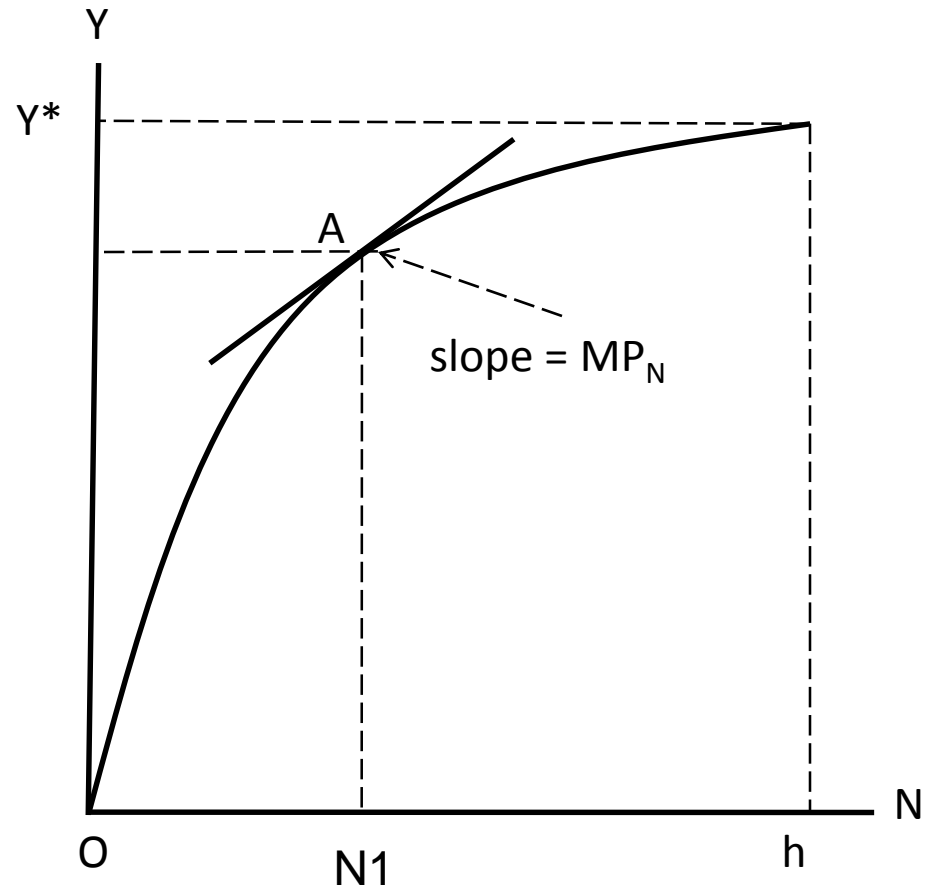
- In equilibrium, $N^d = N^s = N$; and $N = h - L$, therefore:

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

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

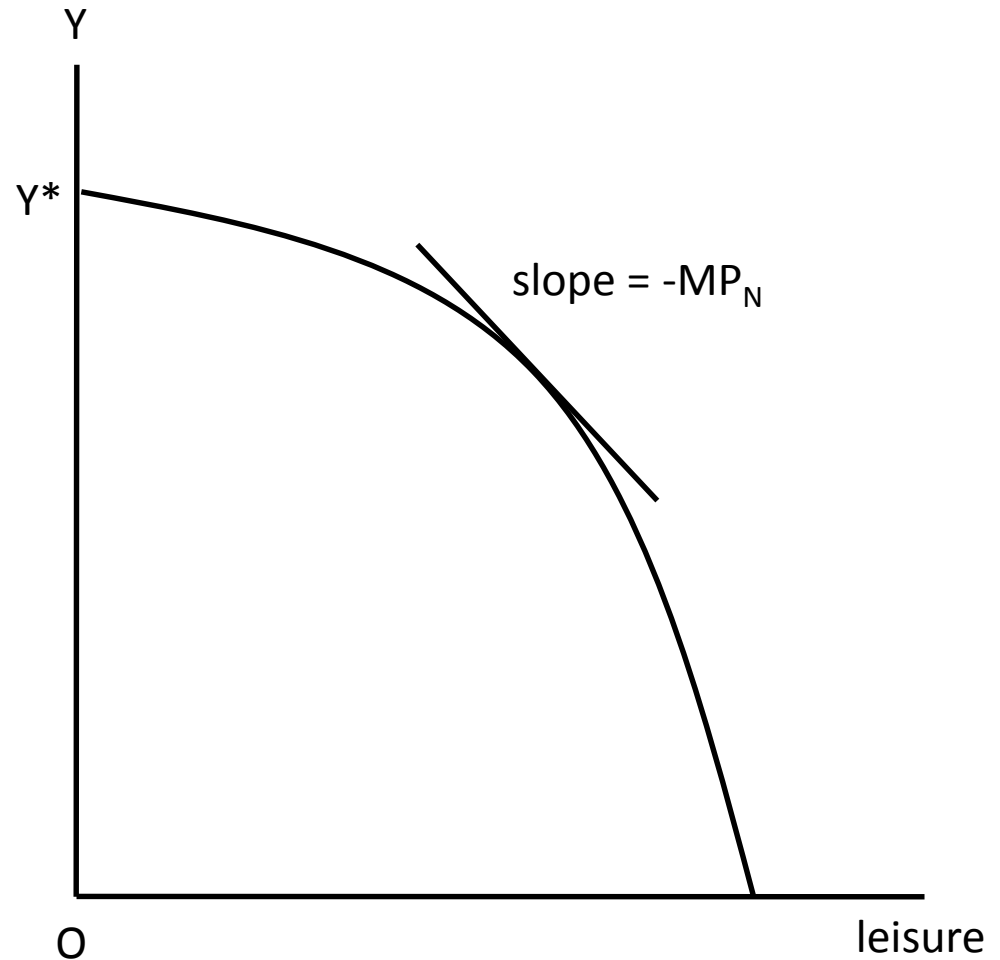
The production function

- $Y = zF(K, N)$.
- h = maximum labor supply available.
- $ON1$ = labor input.
- $N1h$ = leisure.



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

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

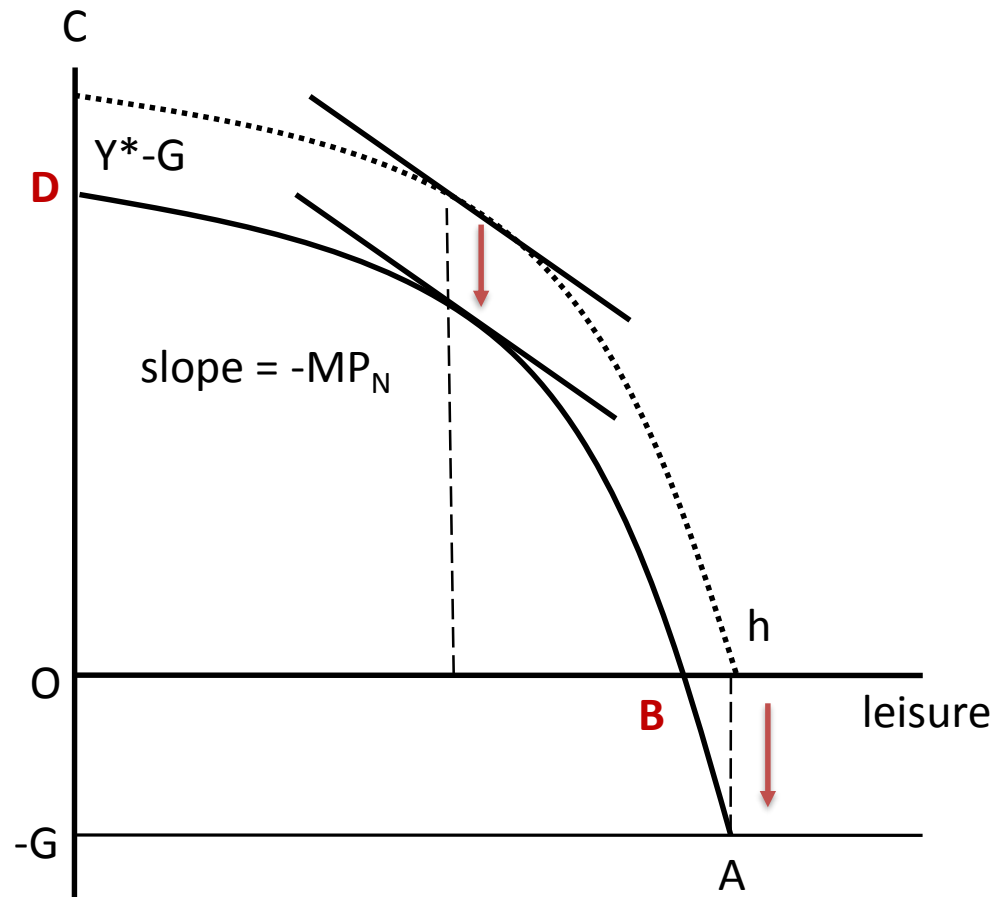
$$\text{as } C = Y - G$$

$$C = zF(K, h - l) - G$$

- 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**.

The production possibilities frontier

- PPF gives the **trade-off** between **consumption goods and leisure**, given technology.
- **BD** is feasible; **AB** is not feasible (**C** is negative).

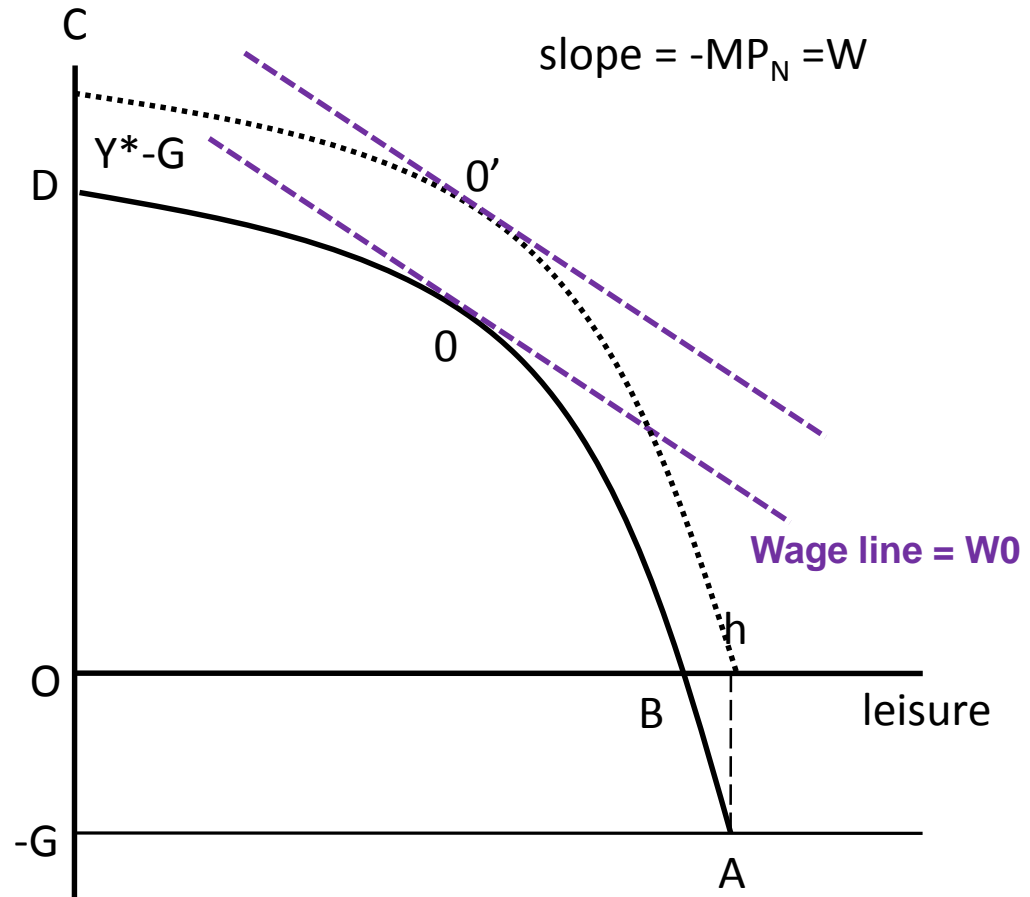


- The slope of PPF is **the marginal rate of transformation (MRT)** of L to C, the rate at which leisure is converted to consumption through work, given technology.

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

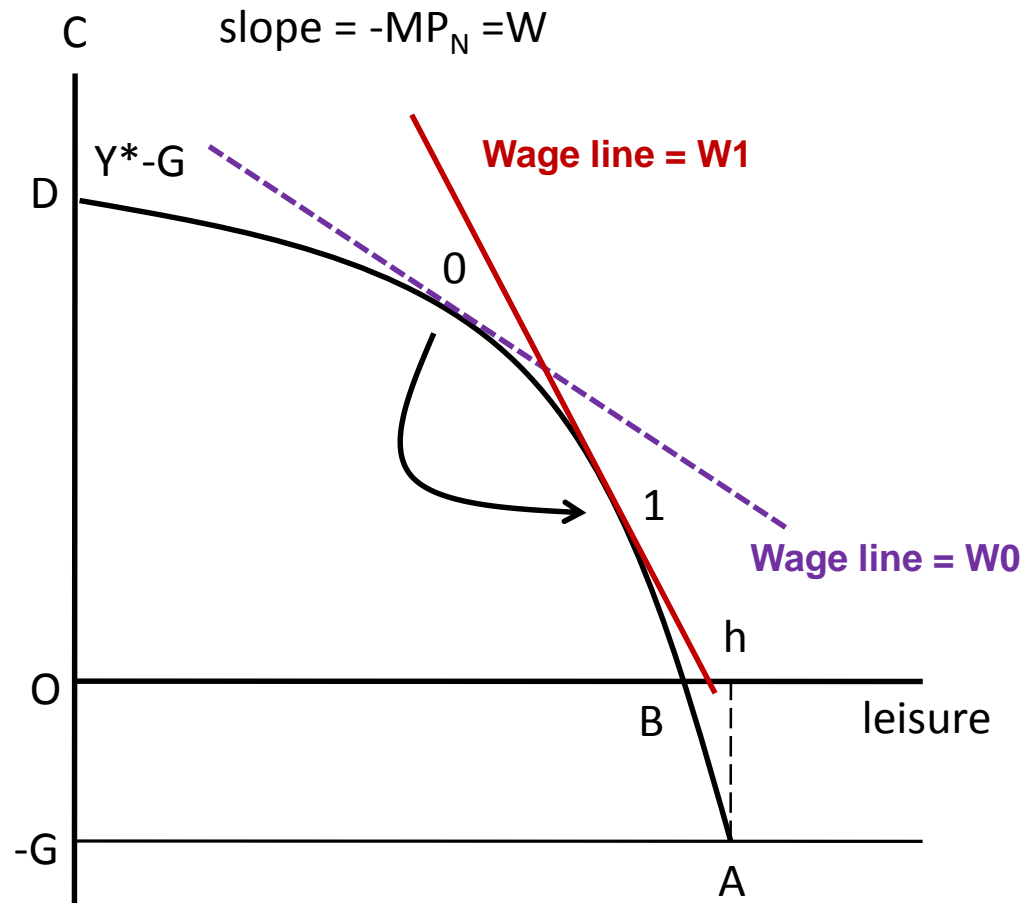
The producer's max. profit

- As a profit-maximizing producer, firm chooses to produce where $MP = W$
 - For a given “ W ”, firm chooses “ N ” where $MP = W$;
 - Slope of PPF = W



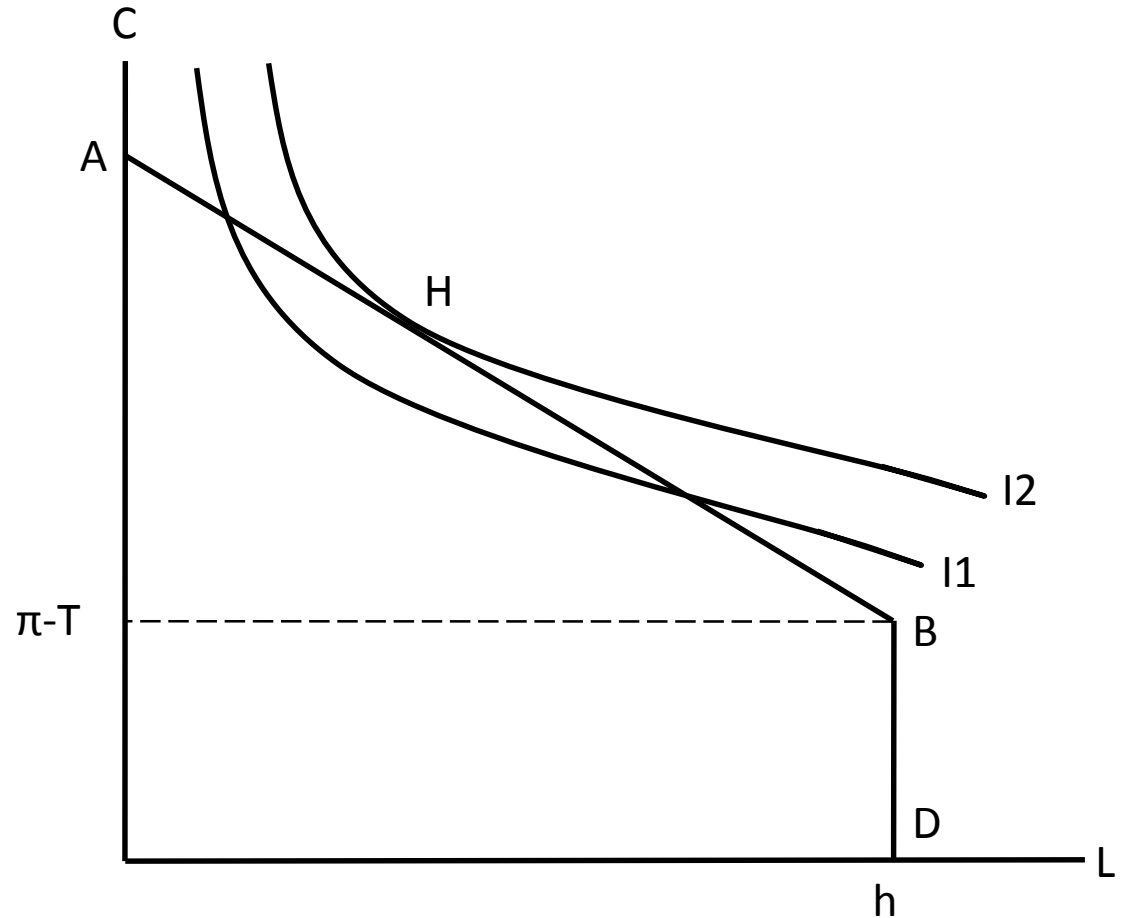
The producer's max. profit

- With varied “w”, optimal point changes
- For example, with higher W from W0 to W1, firm needs to relocate for a new level of consumption-leisure where $MP = W$
- From the graph, this must be to the right of point-0 as MP_N 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 max. utility

- The consumer trades off between C and L to maximize utility, **given w.**



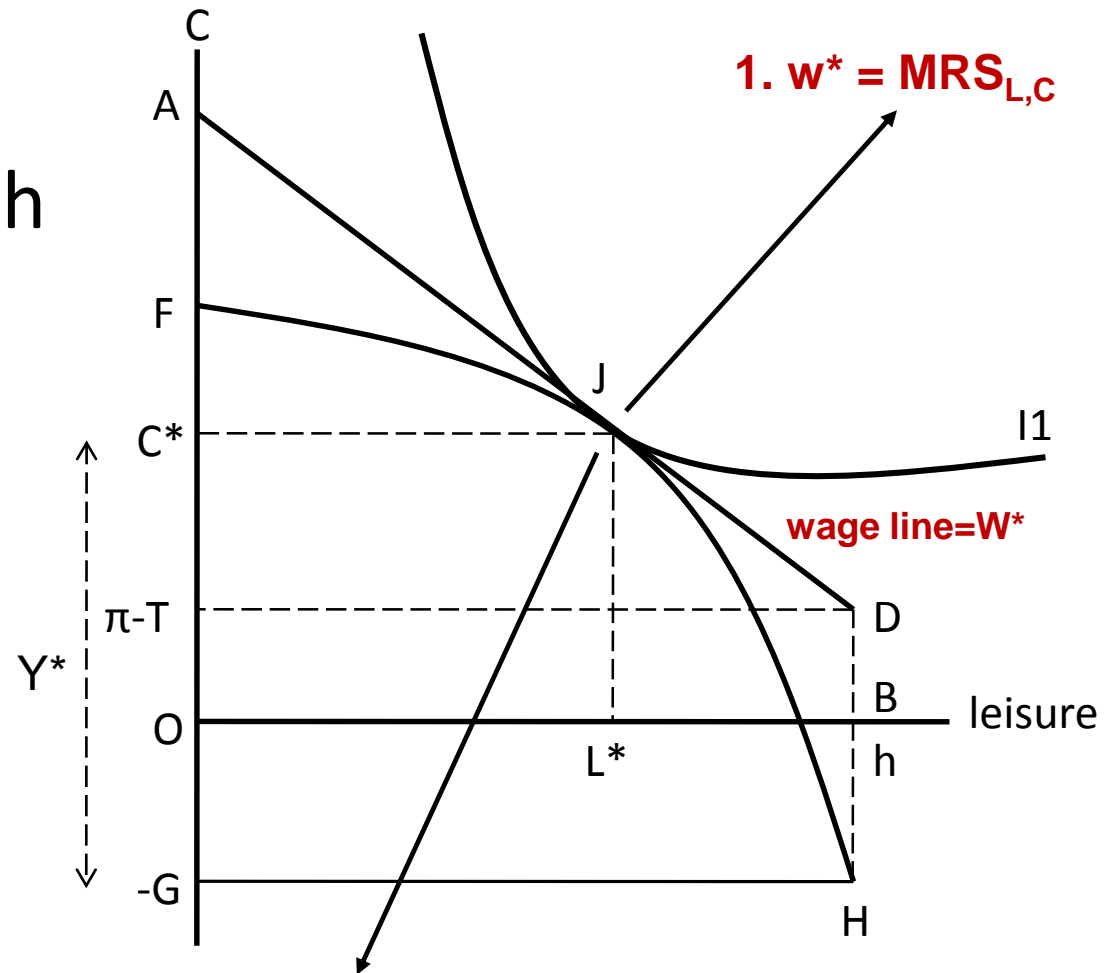
PPF and the consumer: combining the two problems in one figure!

- The firm chooses the point on PPF which maximizes profits.
 - $MRT_{L,C} = -MP_N = -w$
- 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.**

Competitive equilibrium

- J is the equilibrium consumption bundle (C^*, L^*) with W^* as the equilibrium wage.

- **Why?**



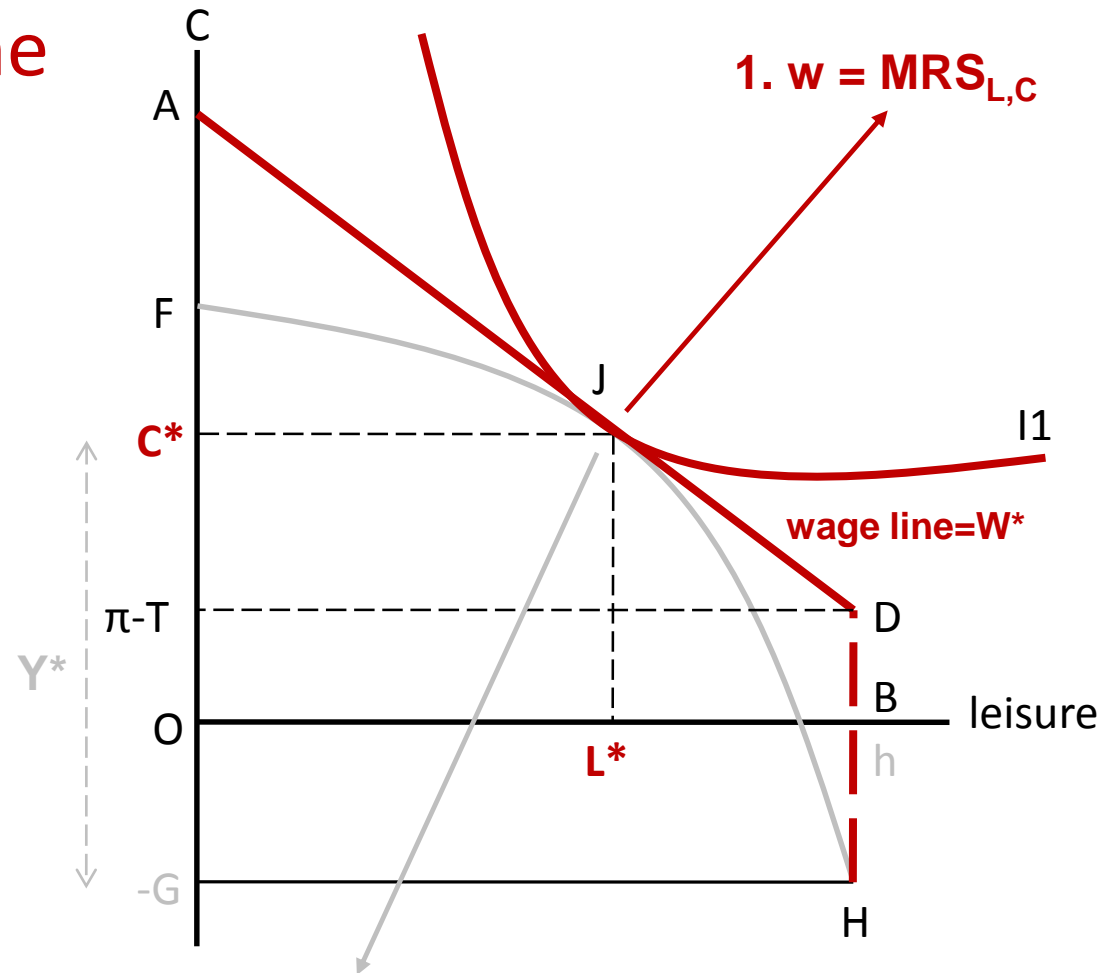
2. $MP_N = w^* = MRT_{L,C}$

To understand why, recall the definition and properties of competitive equilibrium

- The values of C , Y , N^d , N^s , w and T at which, given z , K and G :
 - **The representative consumer** chooses C and N^s so that **utility is maximized**, given w , T and π .
 - **The representative firm** chooses Y and N^d so that **profit is maximized**, given w , z and K .
 - **The labor market** clears: $N^d = N^s$.
 - **The government budget constraint**: $G = T$. ($Y = C + G$)

1. For the given W^* , consumer maximizes the utility because $w^* = MRS_{L,C}$

- Suppose the AD line is the household's budget constraint for the given W^* .
- C^* and L^* is the household's optimal bundle.



2. $MP_N = w^* = MRT_{L,C}$

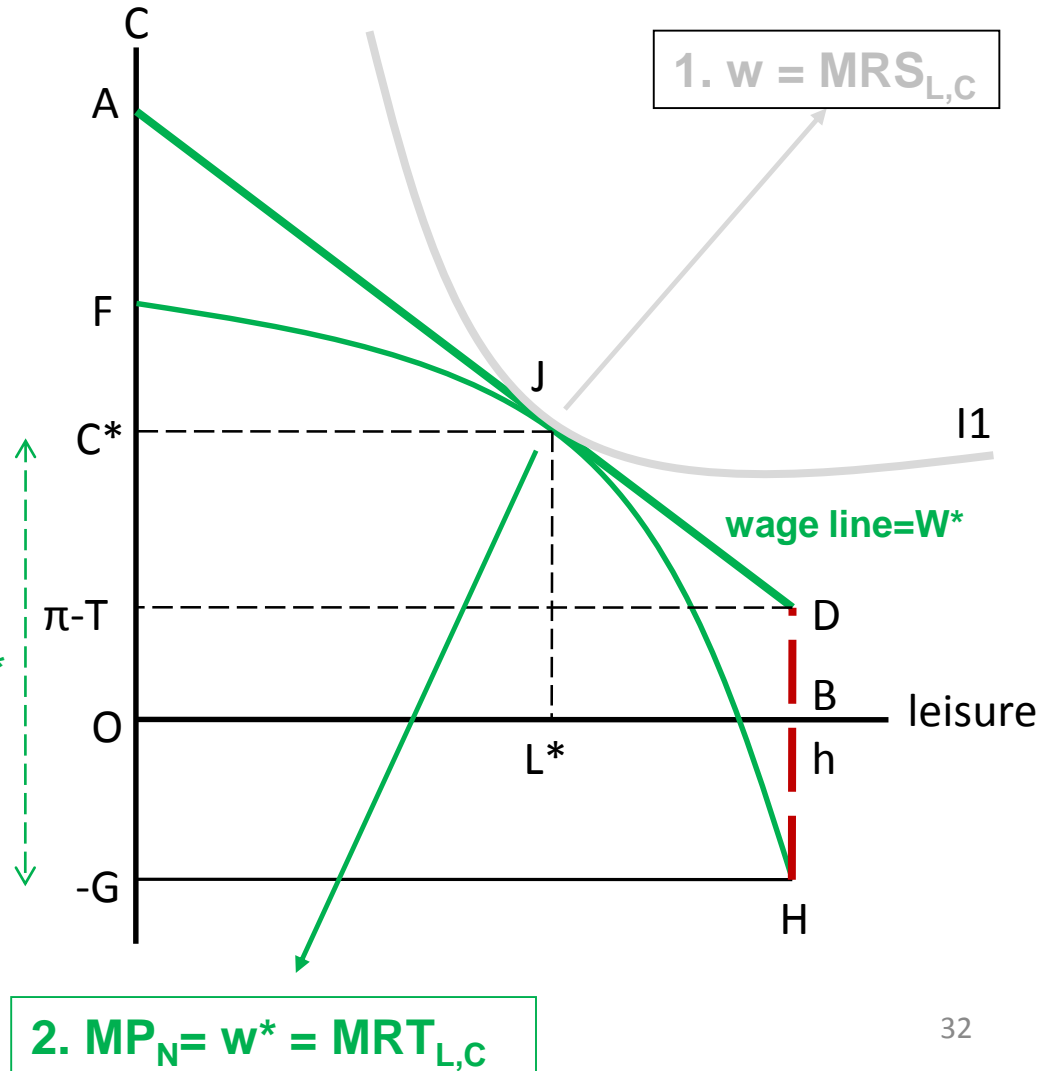
The consumer's optimization

- **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 $MRS_{L,C} = w^*$.

2. For the given W^* , firm maximizes the profit because $w^* = MP_N = MRT_{L,C}$

- For the given W^* , firm maximizes profit where $w^* = MP_N$
- From the figure, the slope of PPF is equal to W^* at point-J.
- Firm then maximizes profit if firm produces $Y = Y^*$, chooses $L = L^*$ and distributes $C = C^*$ to household

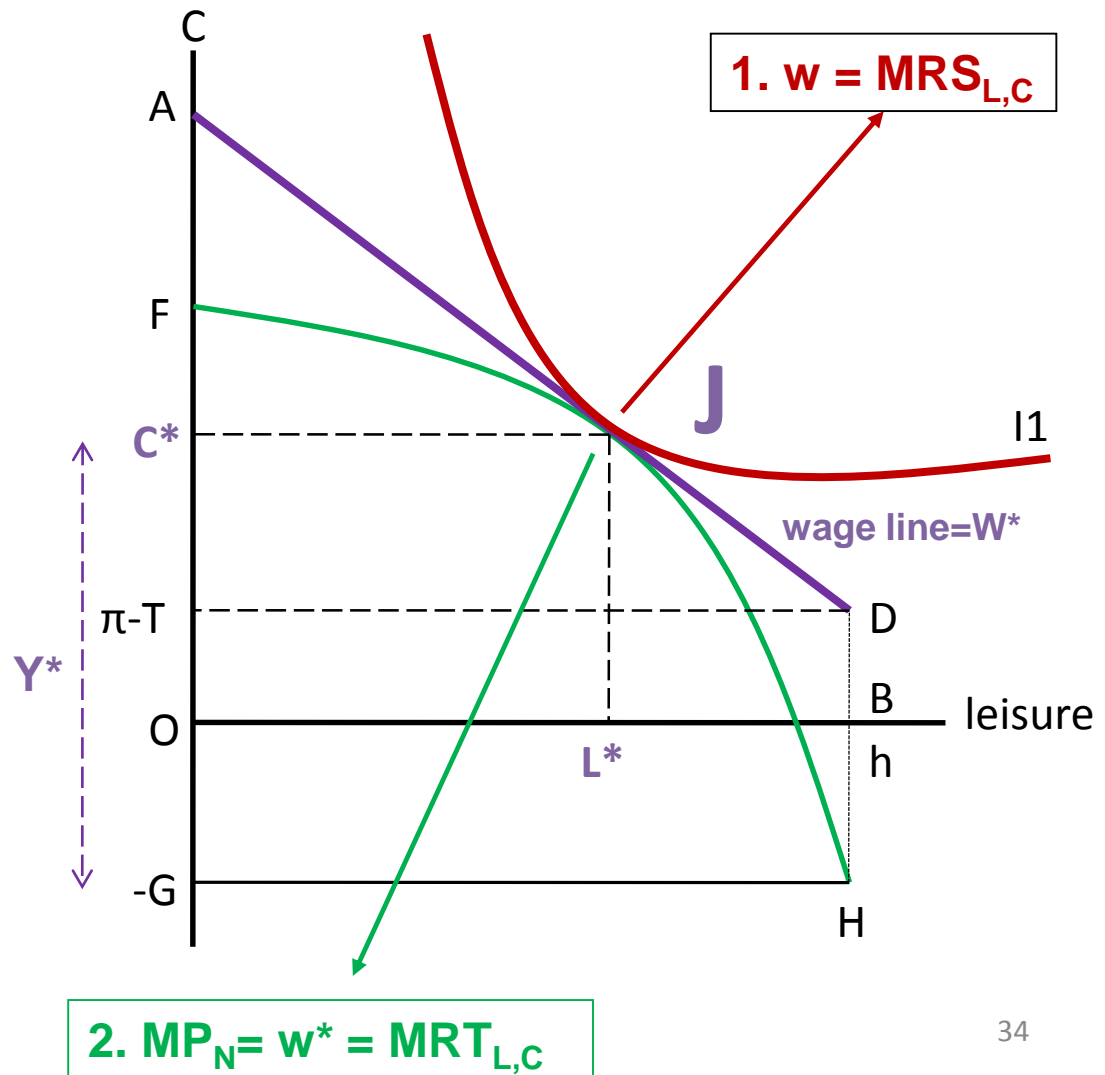


The firm's optimization

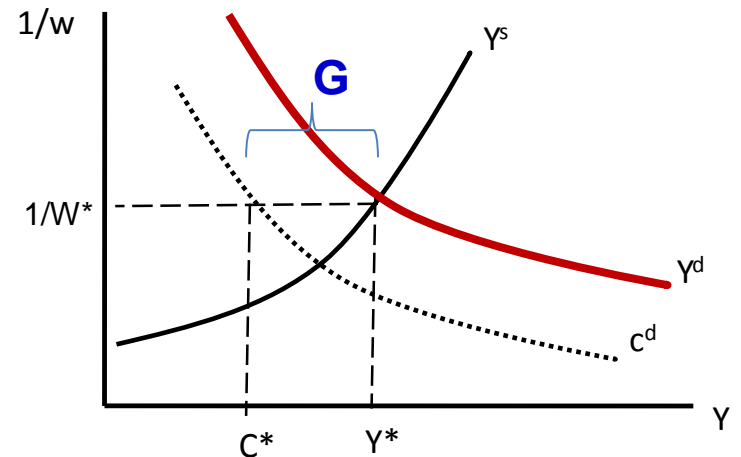
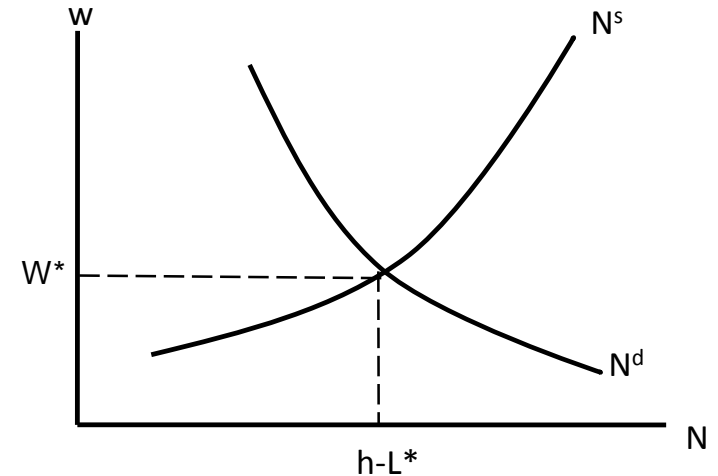
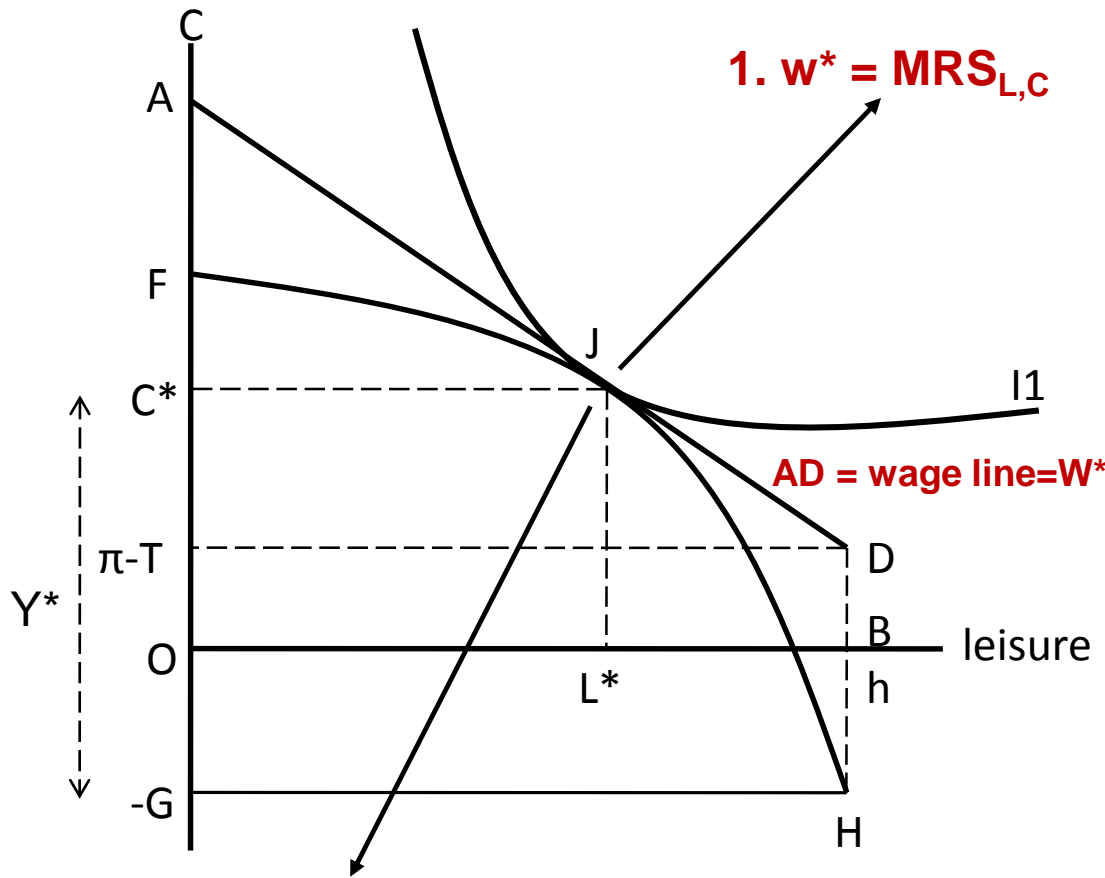
- **The firm maximizes profits at J, given technology:**
 - **$MP_N = w^* = MRT_{L,C} = \text{slope of the budget line AD.}$**
 - The firm pays the real wage = w^* = the real wage received by the consumer.
 - The firm demands labor equal to $h-L^*$ and produces $Y^* = zF(K, h-L^*)$.
 - Max. profit: $\pi^* = zF(K, h-L^*) - w(h-L^*) = DH$
 - $DB = \pi^* - G = \pi^* - T.$

3. Demand = Supply in both markets!

- At point-J, firm maximizes profit.
- At point-J, household maximizes utility.
- At point-J, we know that total output is equal to total private consumption demand plus government spending; goods market is cleared.
- At point-J, labor demand is equal to labor supply.
- Point-J is the general equilibrium with the market-clearing wage equal to W^* .



Competitive equilibrium: Linking the two alternative representations



2. $MP_N = w^* = MRT_{L,C}$

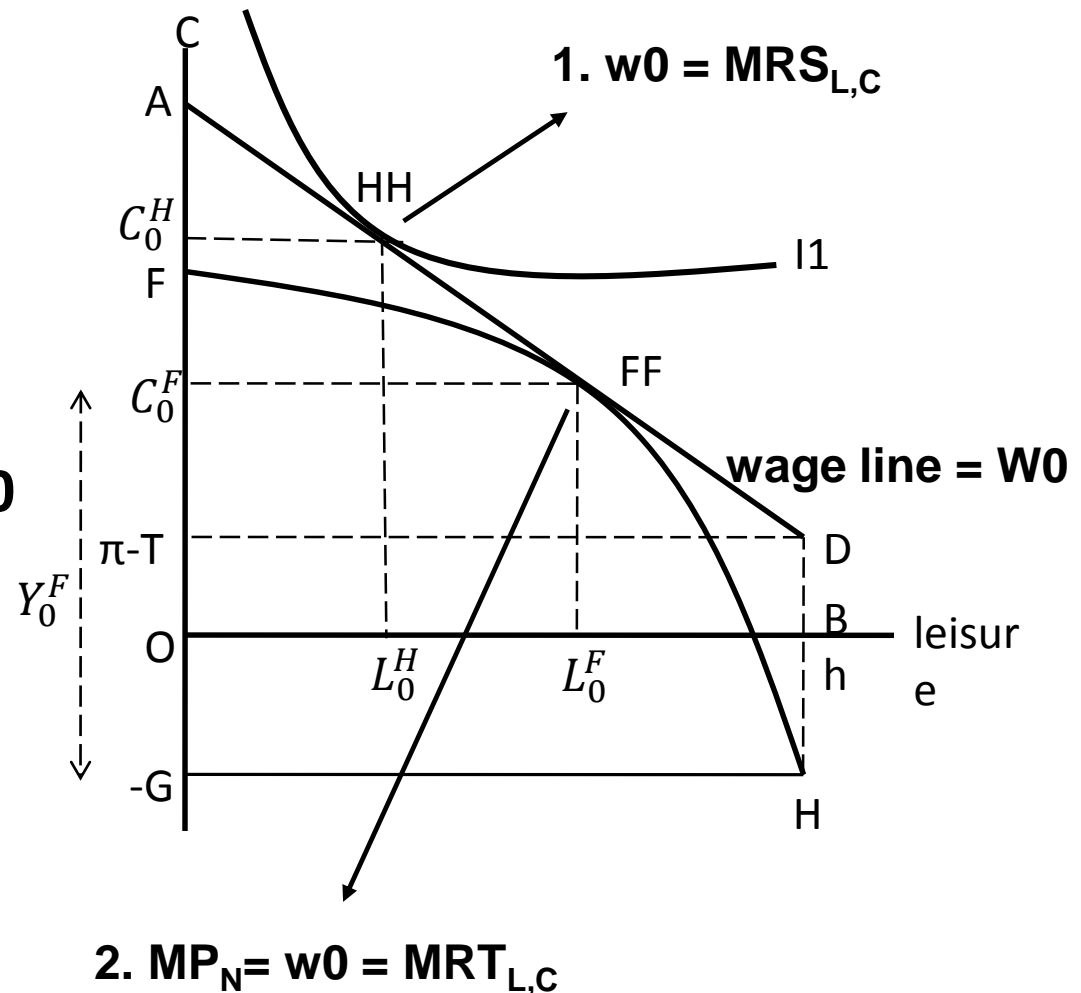
Equilibrium in production and consumption

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

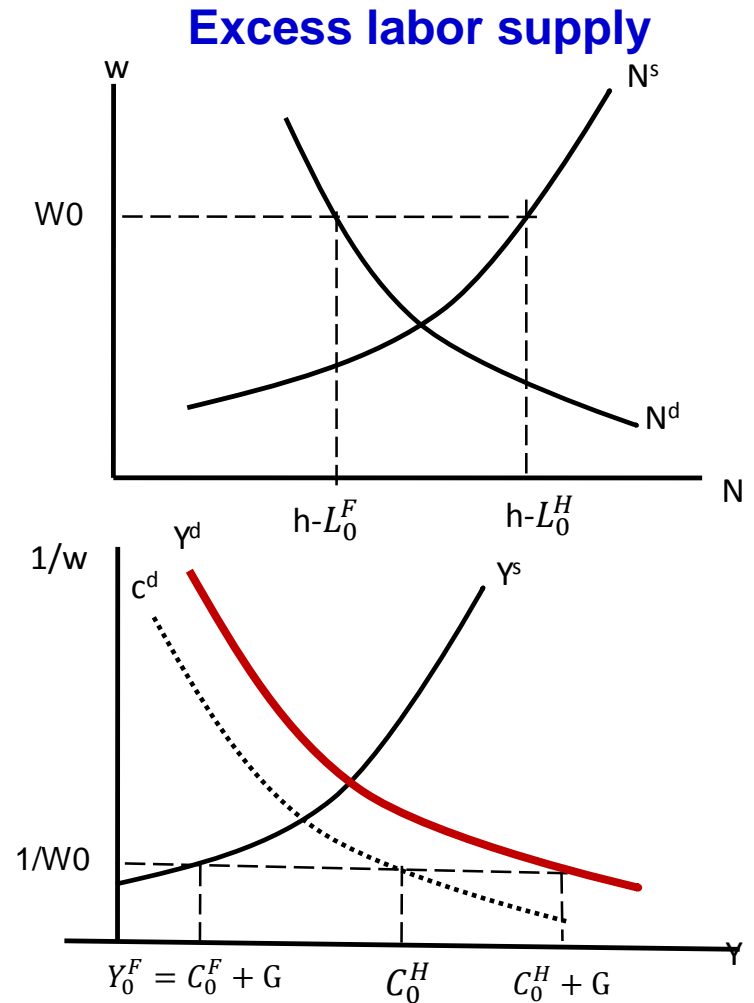
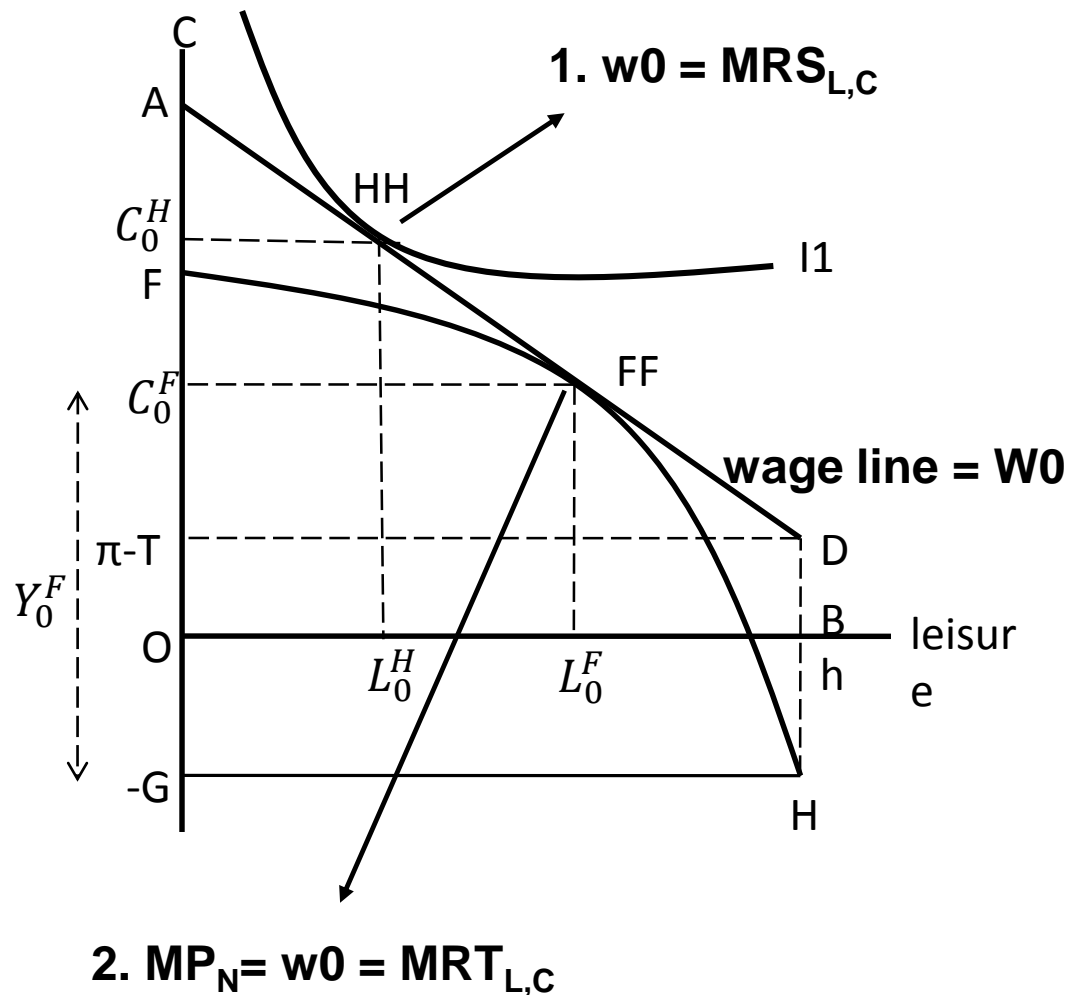
- A competitive equilibrium is achieved when both the consumer and the firm optimize, given z , G and K .
- **Interpretablely, the real wage (w^*) is the price signal for both parties to *adjust* and achieve a simultaneous equilibrium.**

The representation of disequilibrium

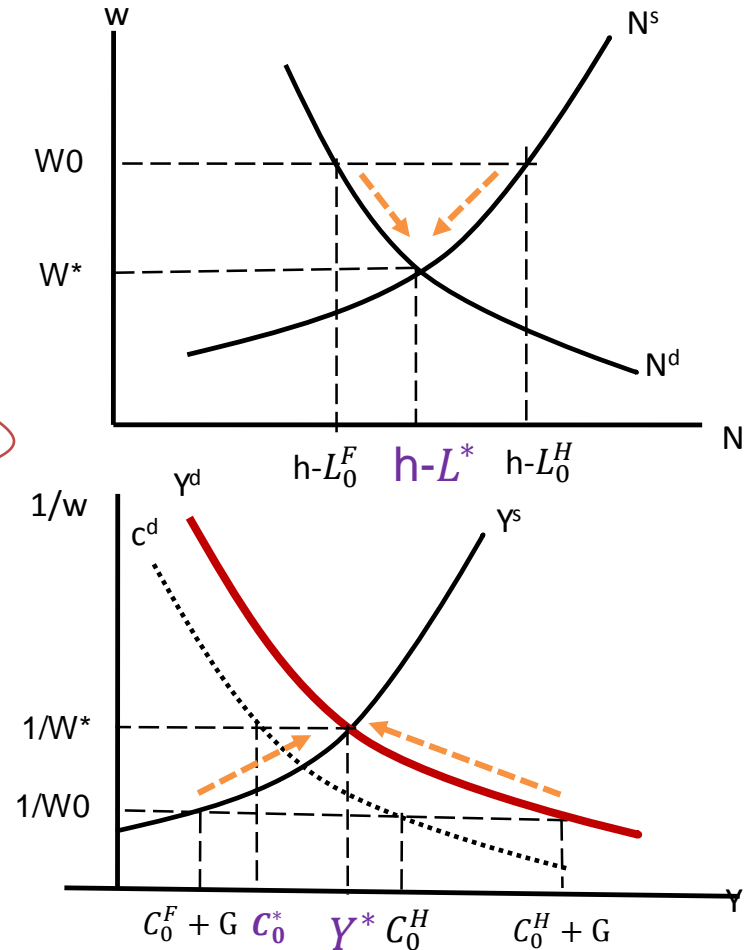
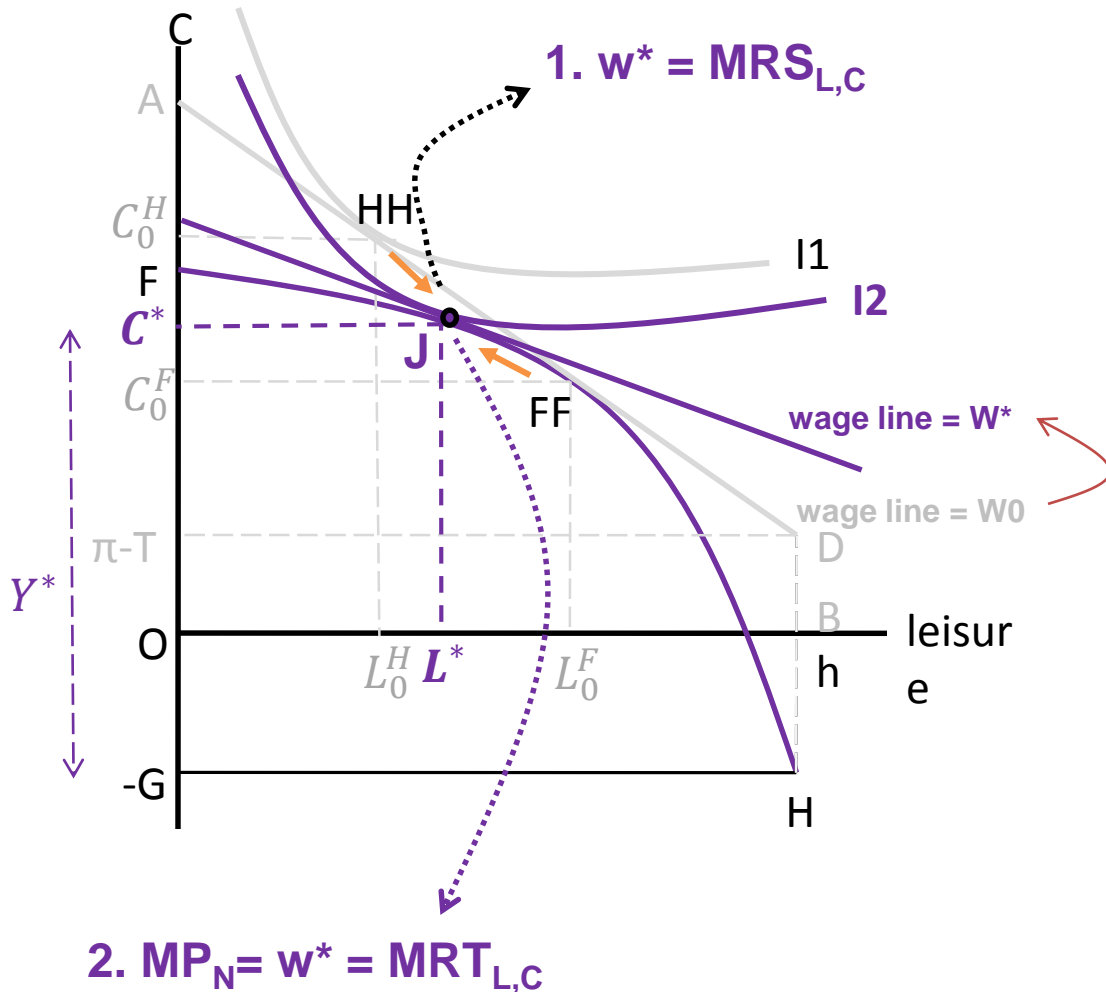
- Given W_0 , consumer maximizes utility at point-HH; $w_0 = MRS_{L,C}$
- Given W_0 , firm maximizes profit at point-FF; $MP_N = w_0 = MRT_{L,C}$
- BUT, W_0 is not the market-clearing wage; we are not under the general equilibrium!



The representation of disequilibrium: excess conditions



The representation of disequilibrium: wage should be falling to clear the excess!



Closed-economy one-period model

- ~~Representative consumer.~~
- ~~Representative firm.~~
- ~~Government and Competitive equilibrium~~
- Economic efficiency and Pareto optimality
- Applications of the one-period model

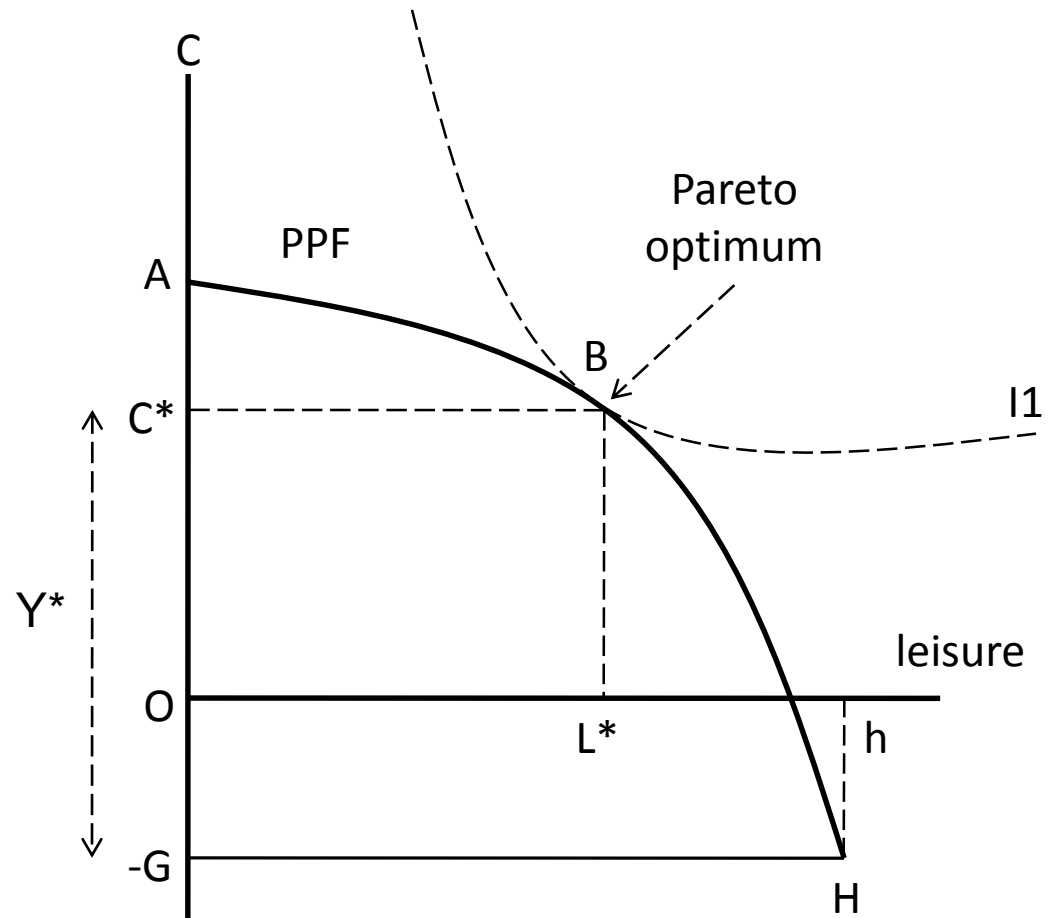
Pareto optimality

- 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 at the competitive outcome.

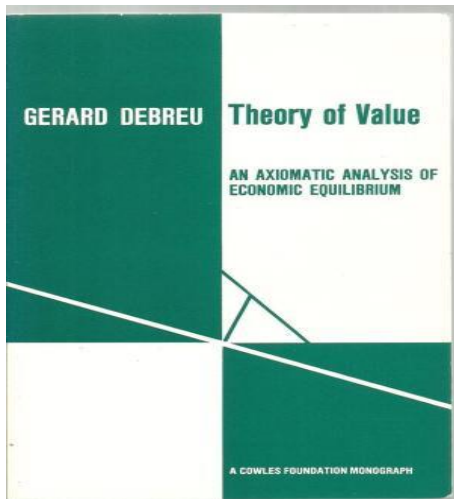
$$MRS_{l,C} = w = MRT_{l,C} = MP_N$$

Pareto optimality in production and consumption

- At B, the IC is tangent to the PPF.
- Highest consumer's utility, given technology.
- **(Benevolent) Social planner's problem**



Fundamental theorems in welfare economics



- Assuming **convex and monotone preferences and technologies**.
- **First welfare theorem:** Under certain conditions, **a competitive equilibrium is Pareto optimal**.
- **Second welfare theorem:** Under certain conditions, **a Pareto optimum is a competitive equilibrium**.
 - Public finance and Social choice issue

The invisible hand

- **First welfare theorem:** 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.

The price signals

- **Friedrich von Hayek (1899-1992):**
 - Market prices are sufficient signals for both consumers and firms to adjust to **changing scarcity**.
 - No detailed information on production technologies and consumers' preferences is needed.
 - **Consumers:** preferences, market prices.
 - **Firms:** technologies, market prices.



Friedrich von Hayek (1899-1992), Nobel Prize 1974.

Sources of inefficiency

- **Externalities:** 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).
- **Distorting taxes,** e.g., proportional income tax (t) on wages:
 - $W(1-t) = MRS_{I,C} < W = MP_N = MRT_{I,C}$

- **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.***

Closed-economy one-period model

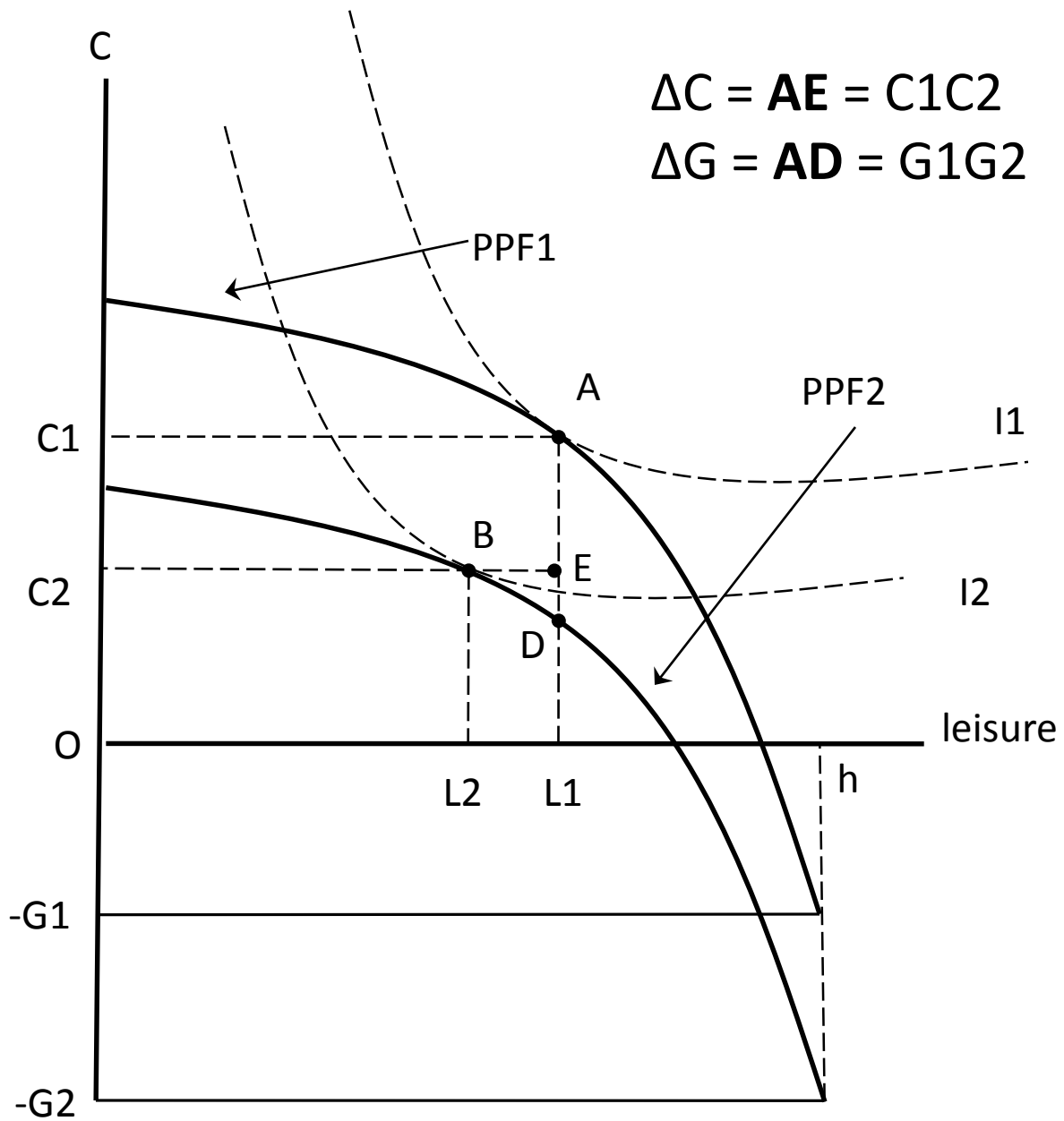
- ~~• Representative consumer.~~
- ~~• Representative firm.~~
- ~~• Government and Competitive equilibrium~~
- ~~• Economic efficiency and Pareto optimality~~
- Applications of the one-period model

Applications of the model

- Predicting the effect of exogenous factor on endogenous equilibrium
 - Effect of G
 - Effect of Z and K
- The **comparative static equilibrium analysis**

Effects of an increase in G

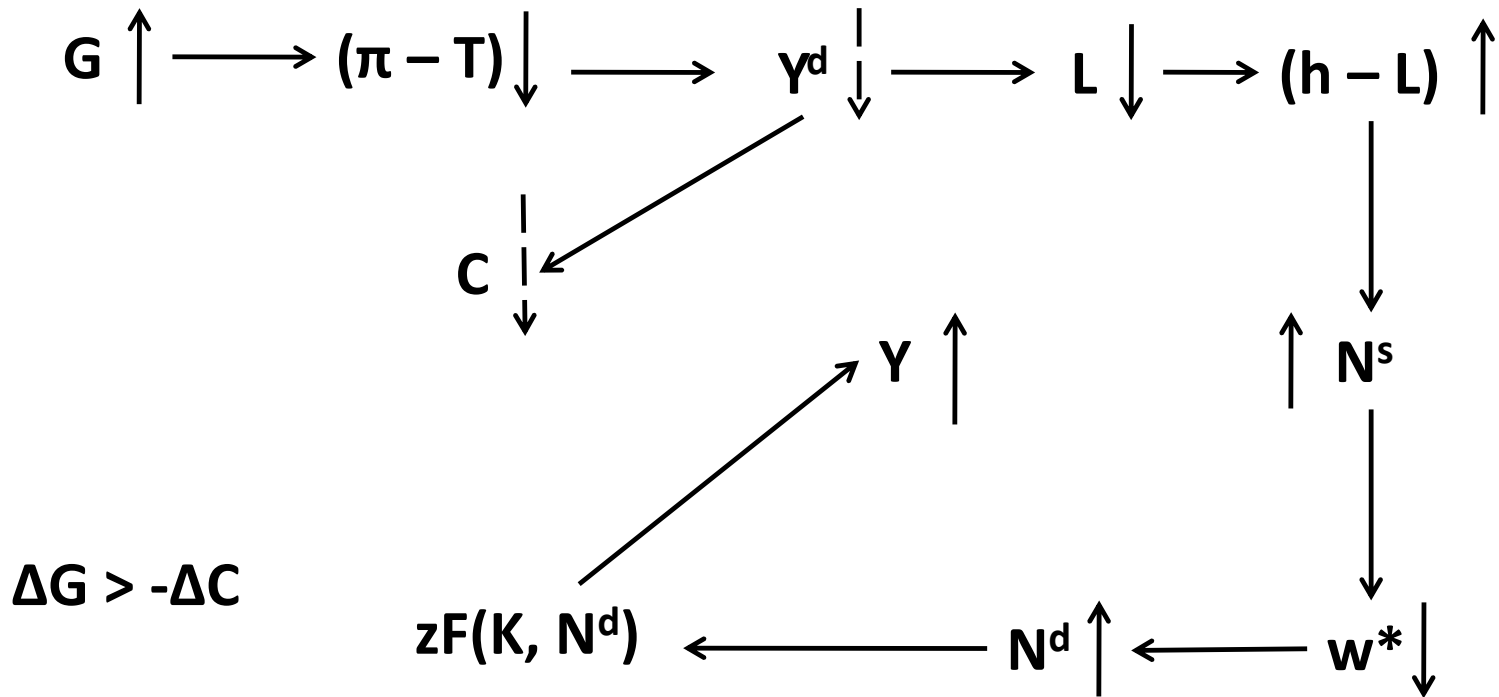
- A pure neg. income effect (as $G=T$ increases).
- Dividend income ($\pi-T$) and disposable income fall.
- Both C and L decrease (normal goods).
- Employment ($N = h-L$) increases.
 - Output $Y = zF(K,N)$ rises.
- **But what happens to *private* consumption?**



- $\Delta G = \Delta D > \Delta E = -\Delta C$.
- 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 PPF2 at B is less steep than PPF1 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 $w = MP_N$.
 - 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

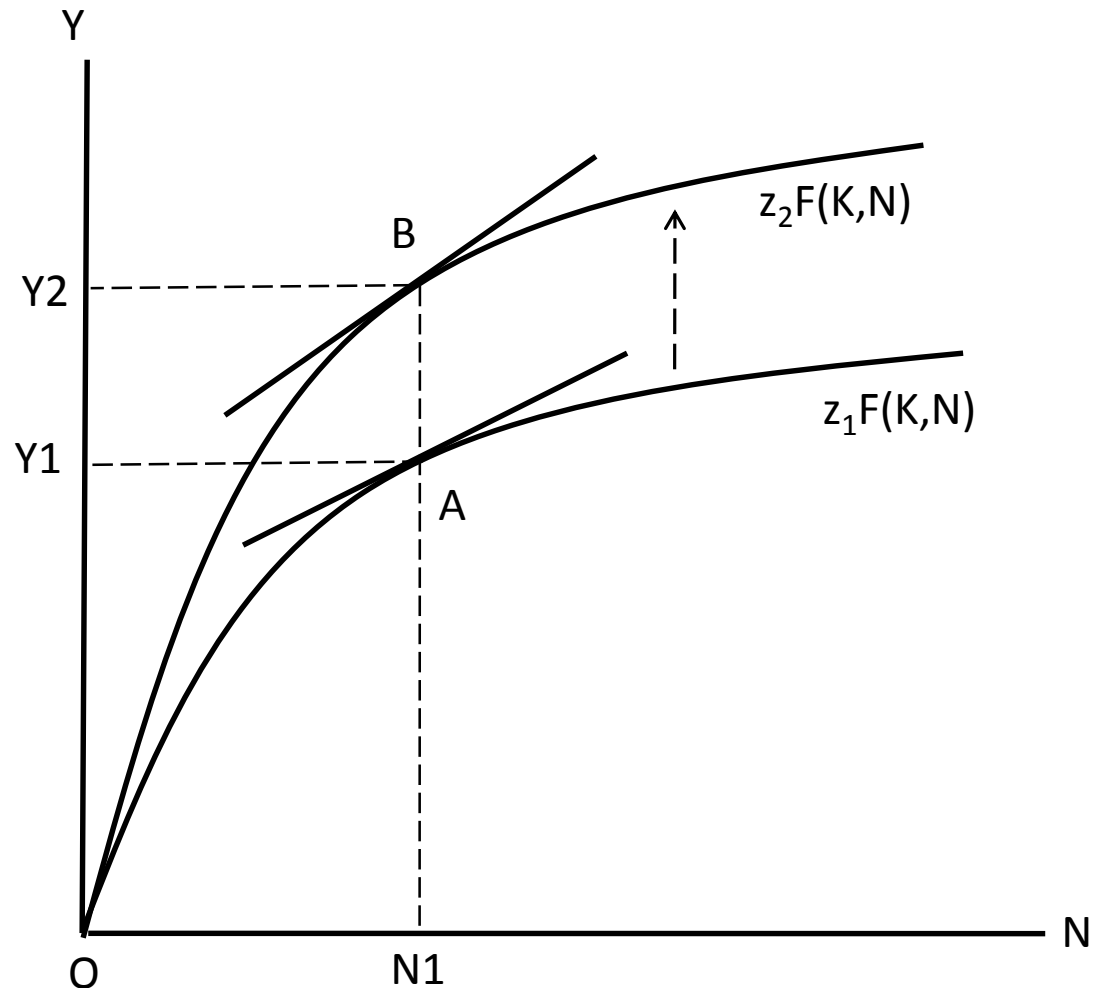


Effects of an increase in z

- Increases in z = improved technology or organization.
 - 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.

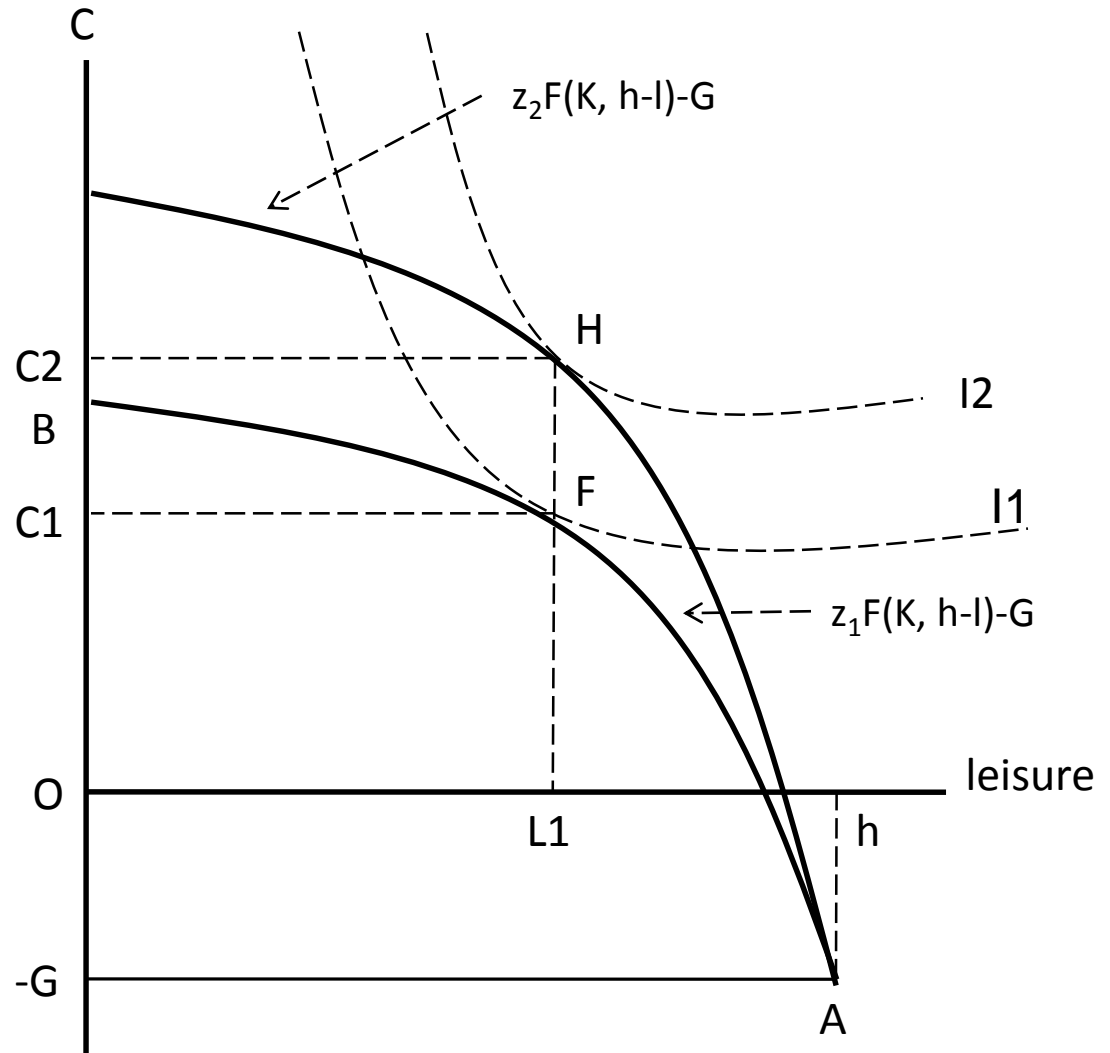
Effect of z on Production function

- The production function rotates upwards with higher MP_N at $N1$.



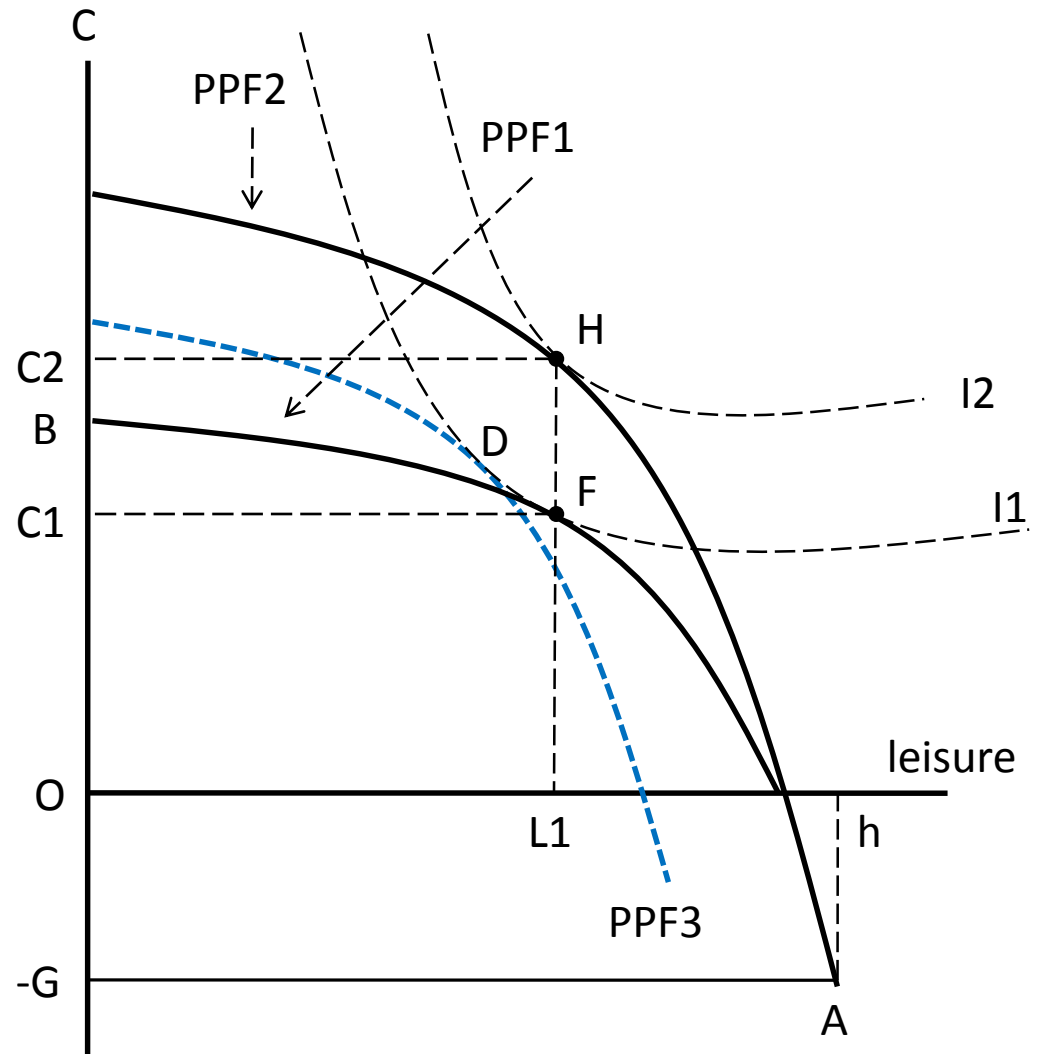
Effects of rising z on PPF

- The PPF rotates upwards.
- C , Y , MP_N and w increase.
- **N and L may rise or fall.**

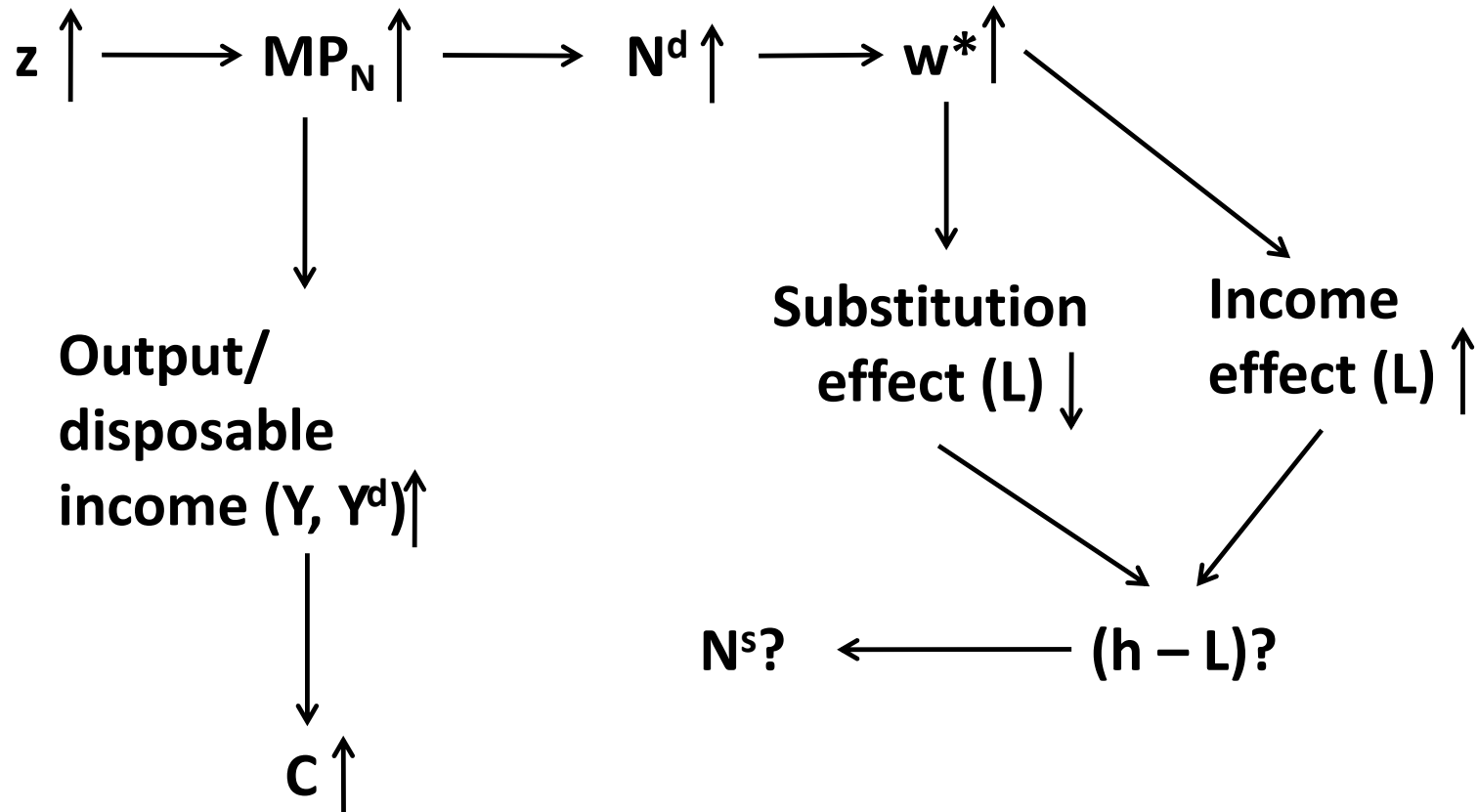


Income and substitution effects

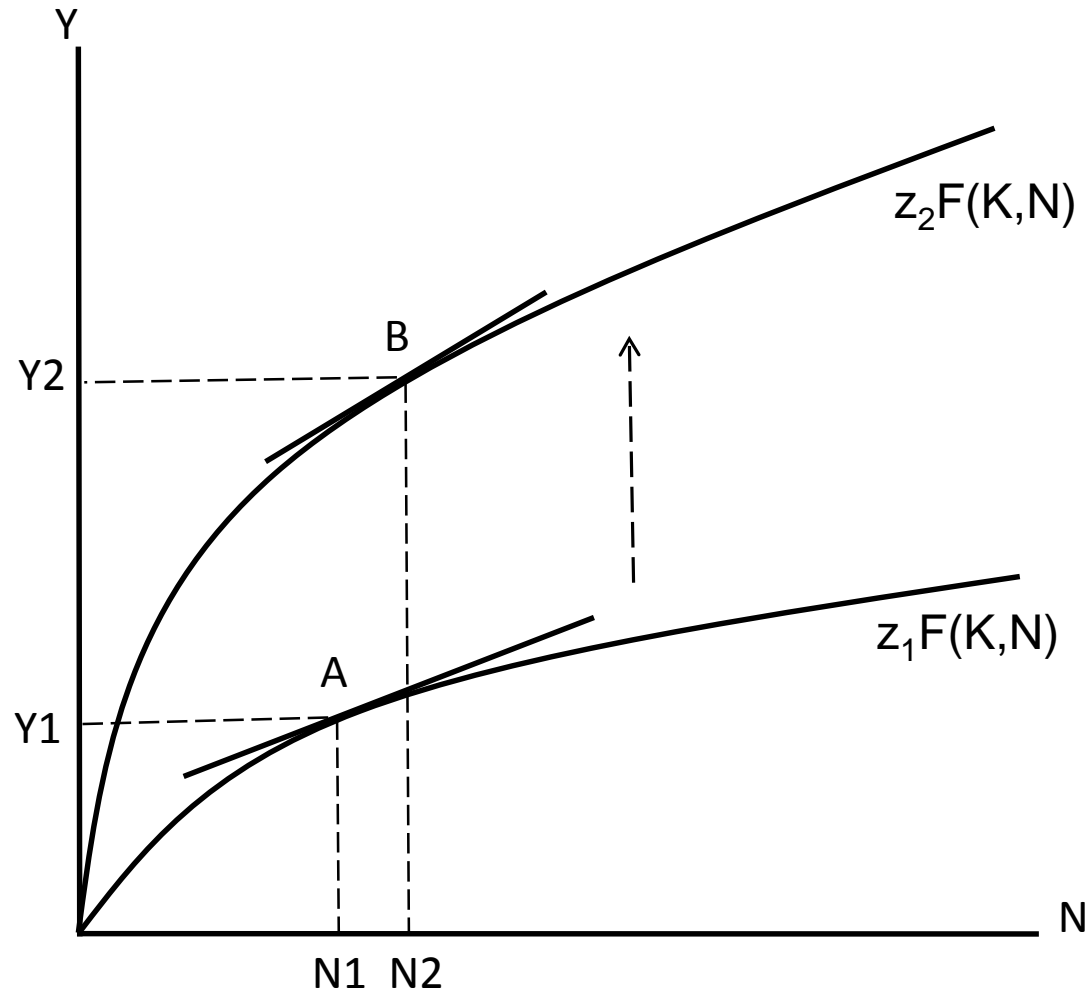
- $FD =$ **substitution effect** (rising C and N , falling L).
- $DH =$ **income effect** (rising C and L).
- **Equal effects:** no change in L and N .



A higher z or K raises w , Y , C



Strong substitution effect on N



Applications of the model

- Which type of shocks is more likely to explain the business cycles?
- Use the predictions to identify the source of business cycles
- Suppose the model is correct, does the shock generate the pattern of **co-movement** that matches with stylized-facts?

Business cycles stylized-facts

Table 3.2 Summary of Business Cycle Facts

	Cyclical	Lead/Lag	Variation Relative to GDP
Consumption	Procyclical	Coincident	Smaller
Investment	Procyclical	Coincident	Larger
Price Level	Countercyclical	Coincident	Smaller
Money Supply	Procyclical	Leading	Smaller
Employment	Procyclical	Lagging	Smaller
Real Wage	Procyclical	?	?
Average Labor Productivity	Procyclical	Coincident	Smaller

Model predictions

Model variable	Technology	Government
Y	+	+
C	+	-
N	+	+
W	+	-
Y/L	+	+/-

The role of technology shocks



Edward Prescott
Nobel 2004



Finn Kydland
Nobel 2004

- In lights of the finding we knew, if one believe that the model explains how agents make decision and interact, technology shock is more likely to explain the observed pattern of business cycles
- 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 **technology level**.