EE 312 Macroeconomic theory

Part III

Micro-founded macroeconomics

*The material in this part is mostly based on the lecture slide prepared by Dr. Pichit. I've received his permission to use his slide in my teaching. His permission is gratefully acknowledged here.

Historical development of macroeconomics framework

- 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.

Historical development of macroeconomics framework

- 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.

Historical development of macroeconomics framework

Robert Lucas
Nobel 1995

- 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**

Historical development of macroeconomics framework

Edward Prescott
Nobel 2004

Finn Kydland
Nobel 2004

- 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

- 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**.

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 above decisions determine the outcomes: income, employment, productivity, etc.

Where we are headed from now

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

Readings: Chapters in Williamson (check your outline.)

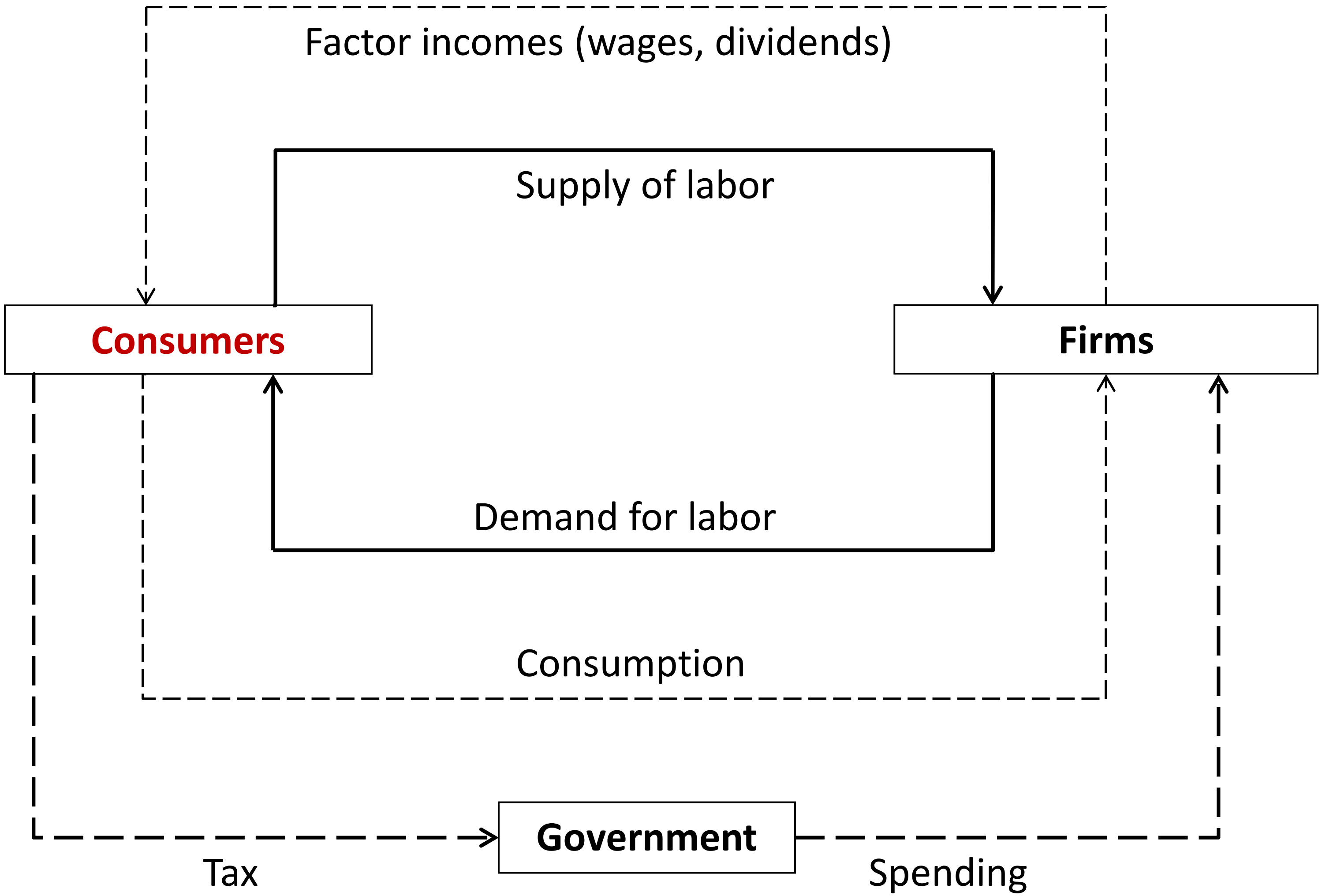
Closed-economy one-period model

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

One-period decisions

- 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.

The Circular Flow



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.

The utility function

- U = U(C, L),
  - where U = the utility function;
  - C = amount of consumption goods;
  - L = amount of leisure
- U(C1,L1) = level of utility derived from the **consumption bundle** of C1 and L1.

Properties of consumer preference

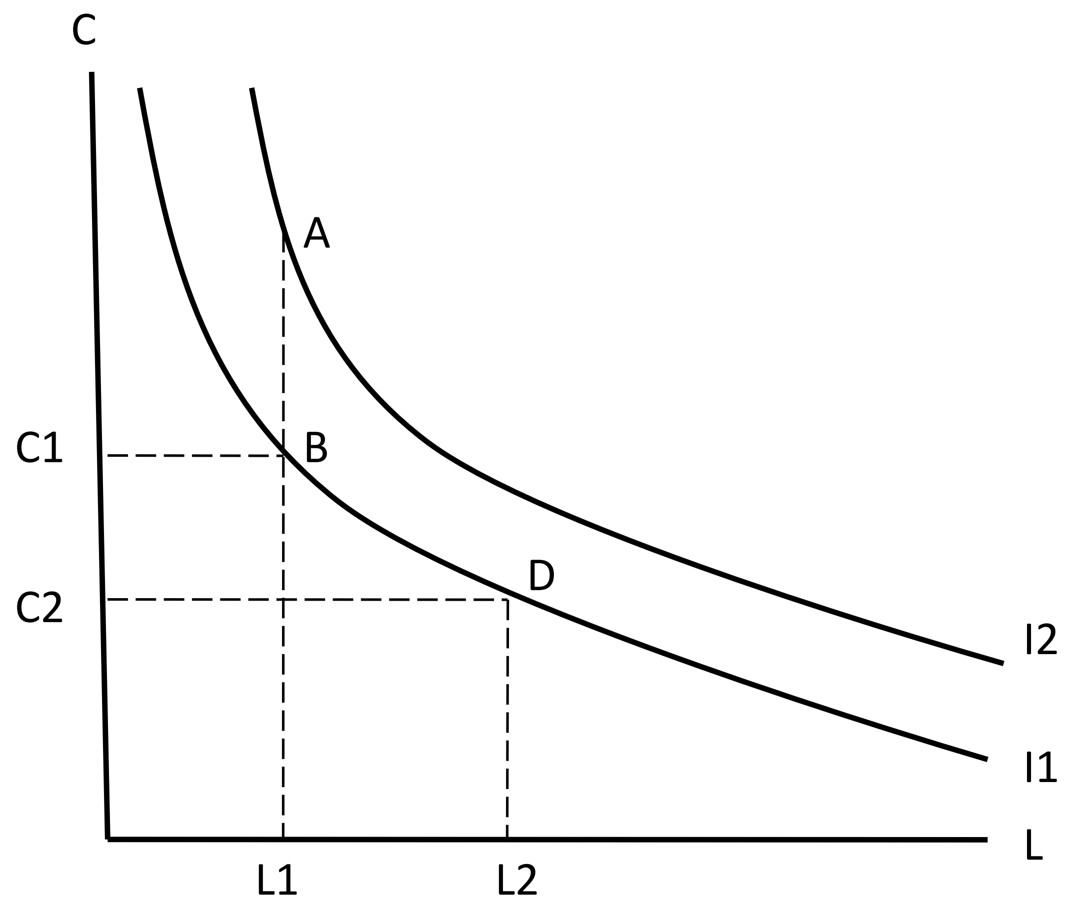
- **More is preferred to less.**
  - If U(C2,L2) > U(C1,L1), then U(C2,L2) is strictly preferred to U(C1,L1).
- **The consumer has preference for diversity in his/her consumption bundle.**
  - U (C2,L1) is preferred to U (C3,0).
- **Consumption goods and leisure are normal goods.**
  - The consumer demands more as income rises.

The indifference curves

- **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.

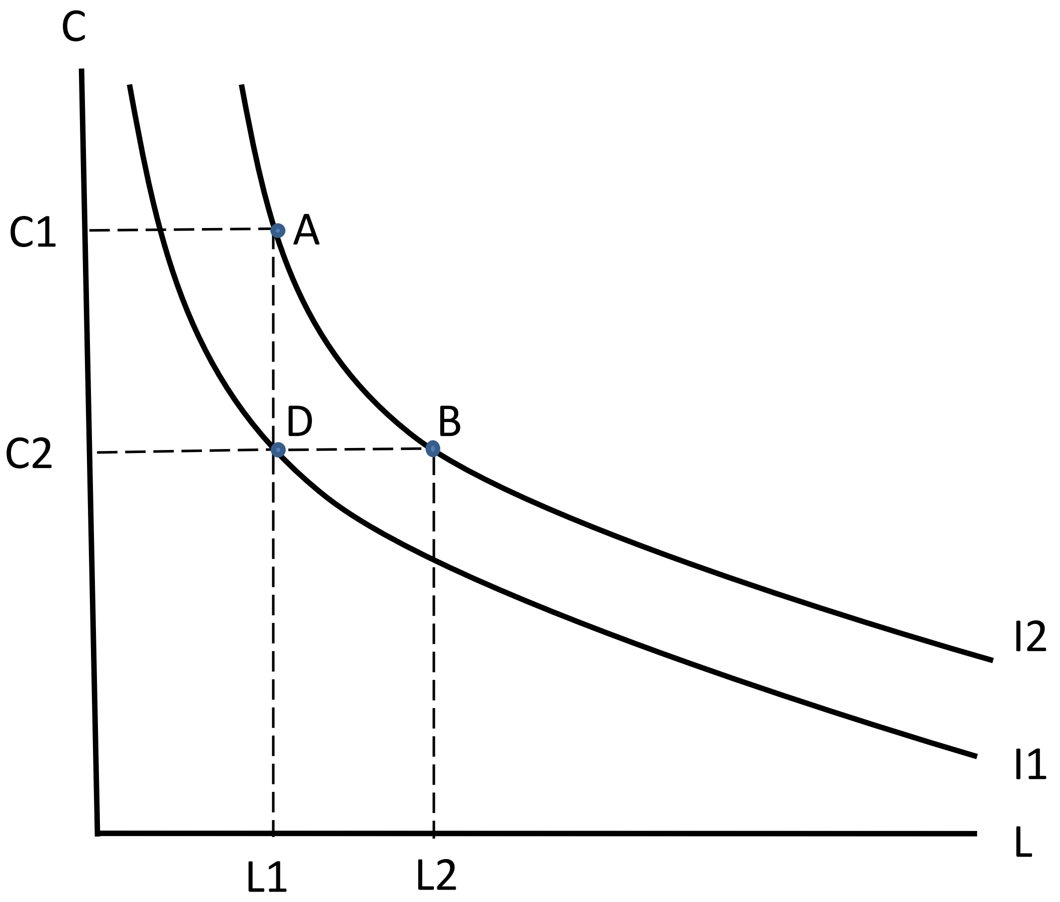
Indifference Curves

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



More is preferred to less.

- If C1 (at A) drops to C2 with the same L1, the consumer is on a lower I1.
- To get the initial I2 (with the same C2, raise L1 toL2 (at B).

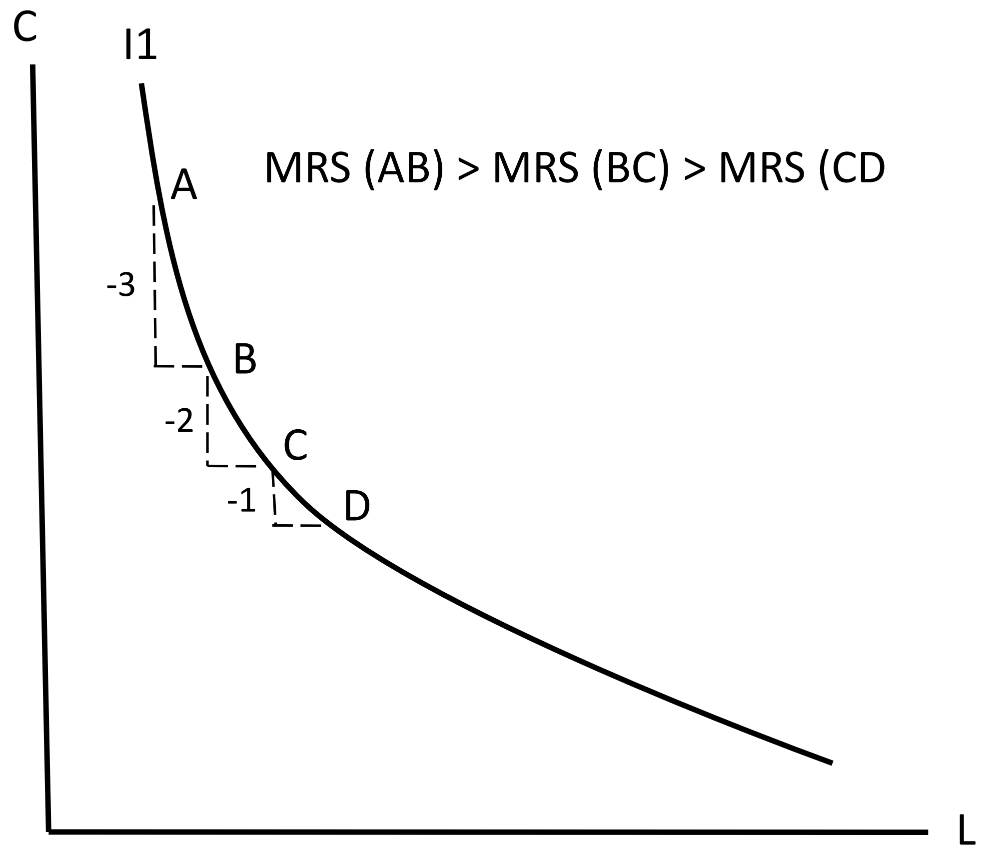


Marginal rate of substitution (MRS)

- **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

- **From A to B**, the agent is willing to sacrifice 3 units of C for one unit of L.
- **From B to C**, 2 units of C is sacrificed for one unit of L.
- **From C to D**, one unit of C is sacrificed for one unit of L.



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.

The consumer's time constraint

- h = hours of time available;
- L = time allotted to leisure;
- N^s = time spent working (labor supply)

$$l + N^s = h$$

Real disposable income

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

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

The consumer's budget constraint

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

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

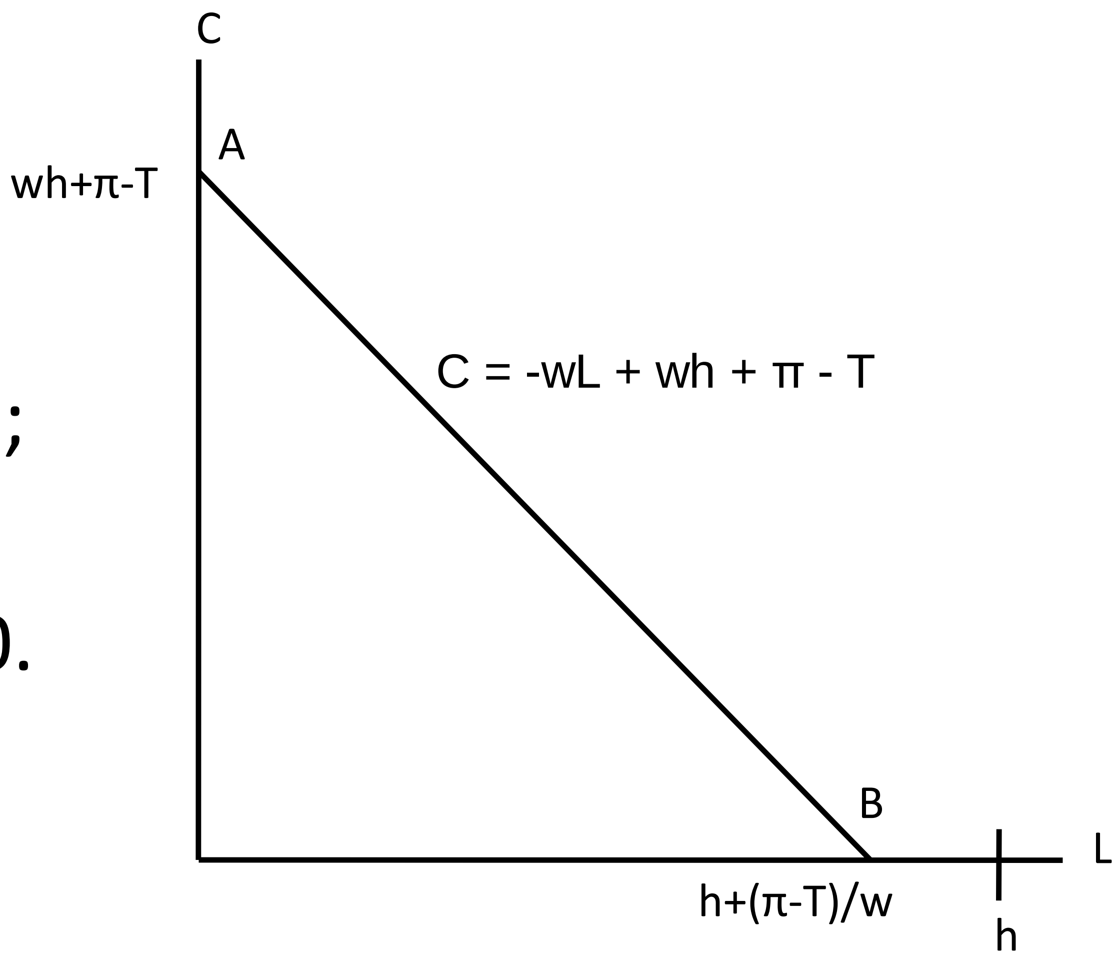
$$C = w(h - l) + \pi - T$$

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

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

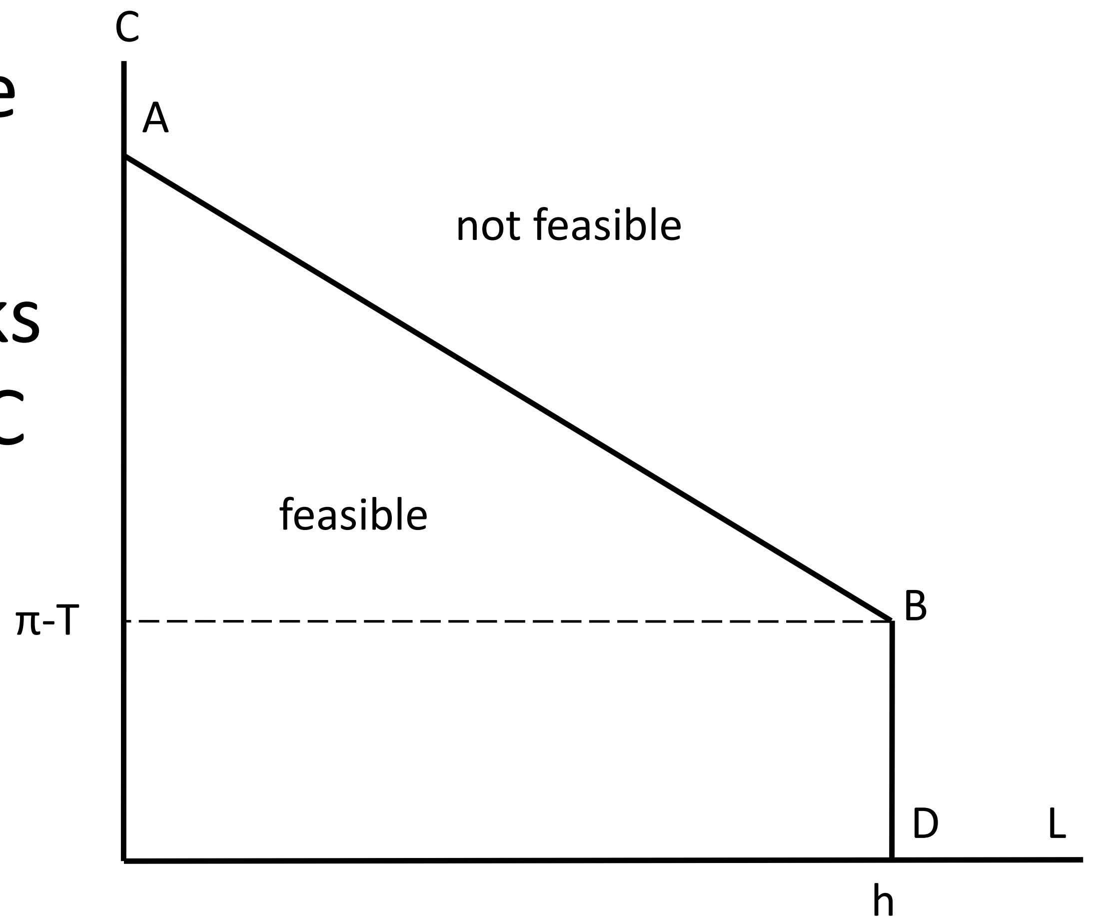
The budget constraint ($T>\pi$)

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



The budget constraint (T<π)

- The budget line is kinked at B.
- Along BD, works = 0; L = h, and C ≤ π – T > 0.



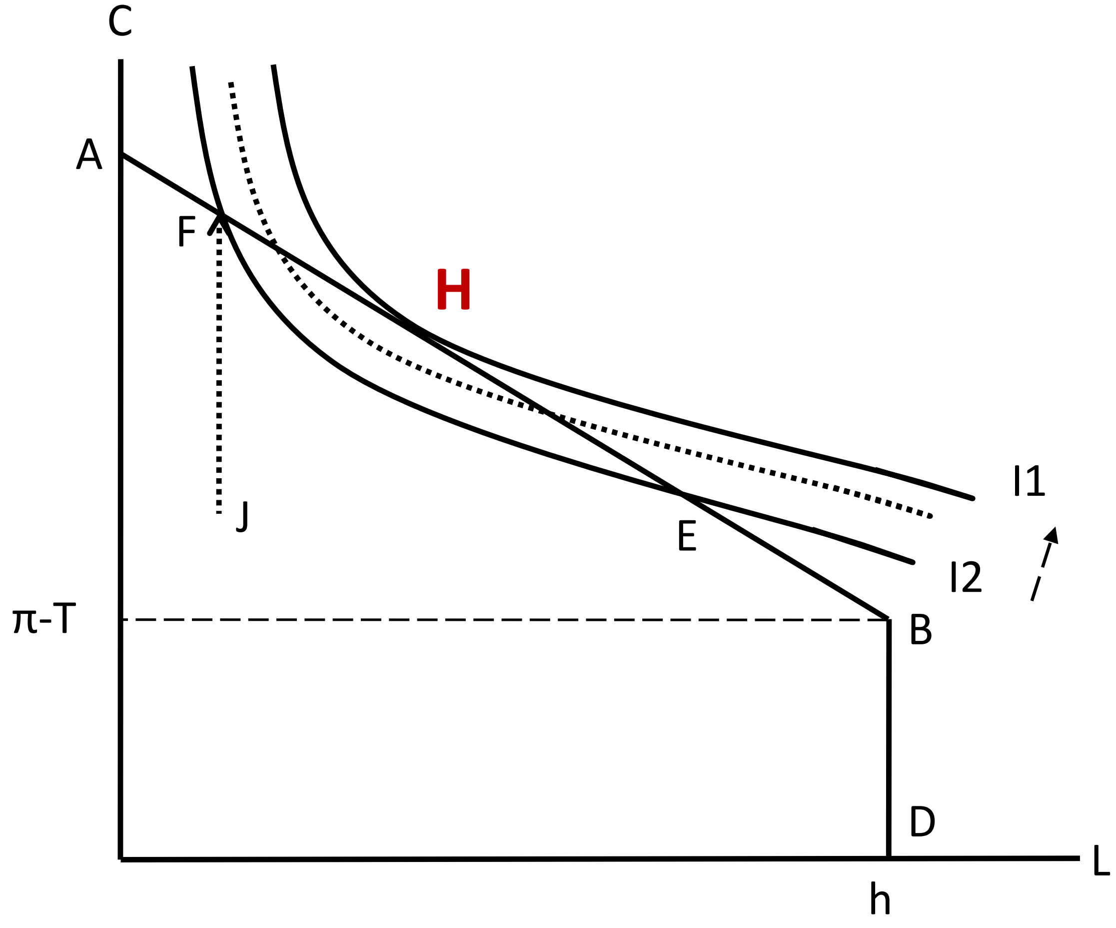
Consumer optimization

- The consumer is rational.
  - Knowledge of his/her own preferences and budget constraint.
  - Combination of consumption goods and leisure (the consumption bundle) which maximizes utility.

- The consumer chooses the consumption bundle that is on his/her highest indifference curve subject to the budget constraint.

The optimal consumption bundle

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



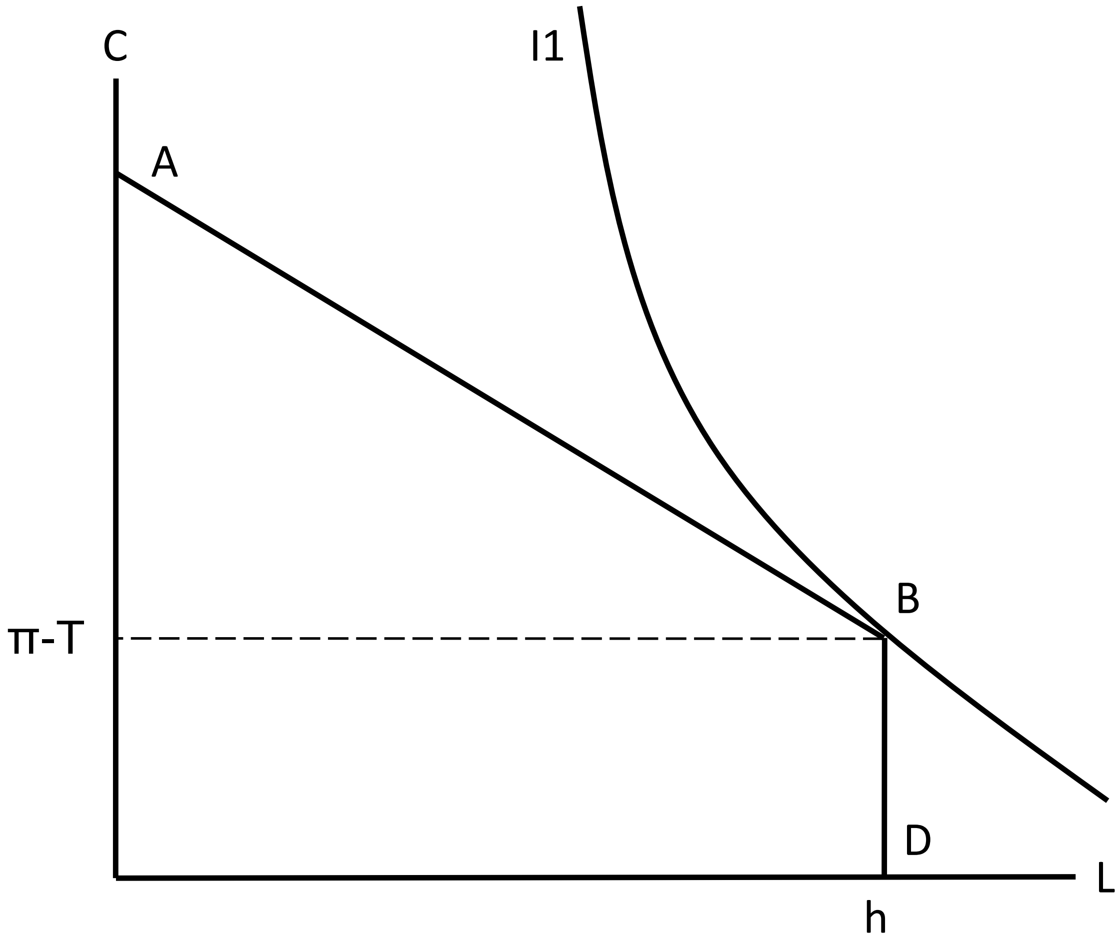
Optimization condition

- 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 chooses not to work at B.



Corner solution: impossible

- The consumer may choose not to work and consume only leisure.

- 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.

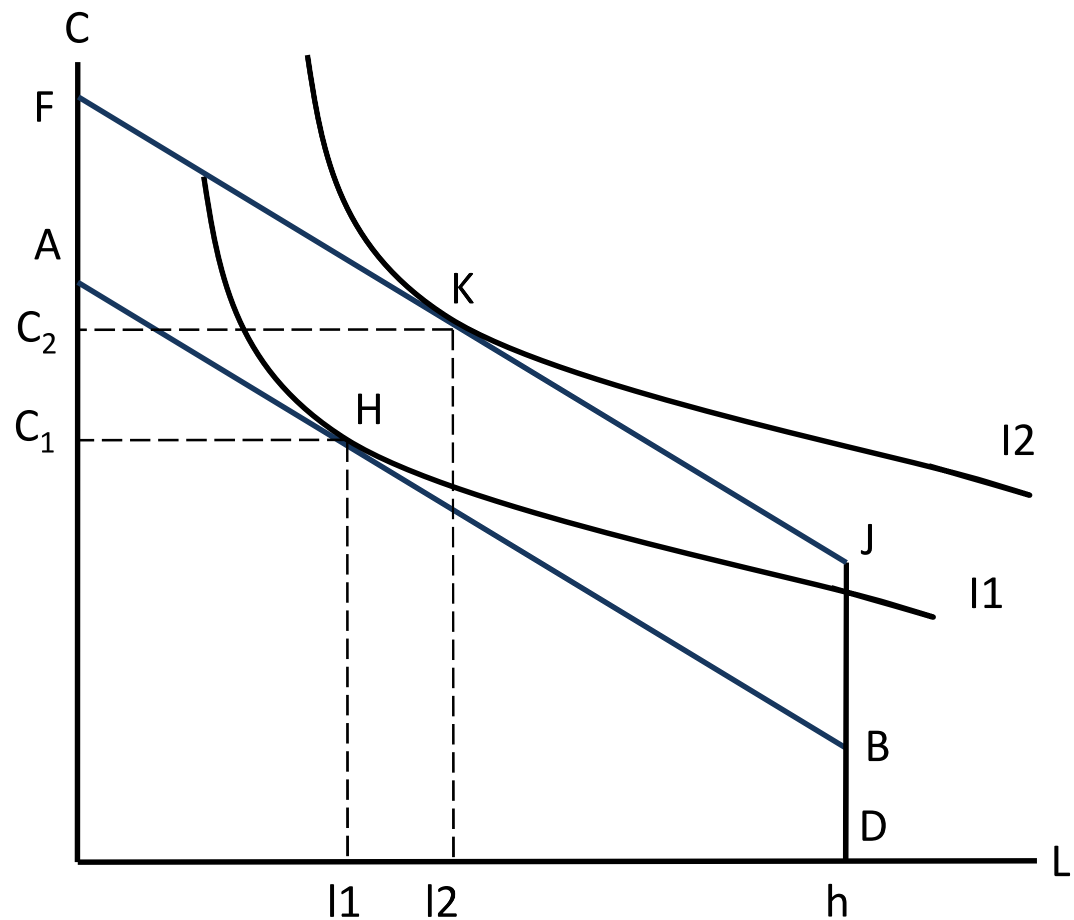
Changes in dividends or taxes

- Assuming consumption goods and leisure are both **normal goods**.

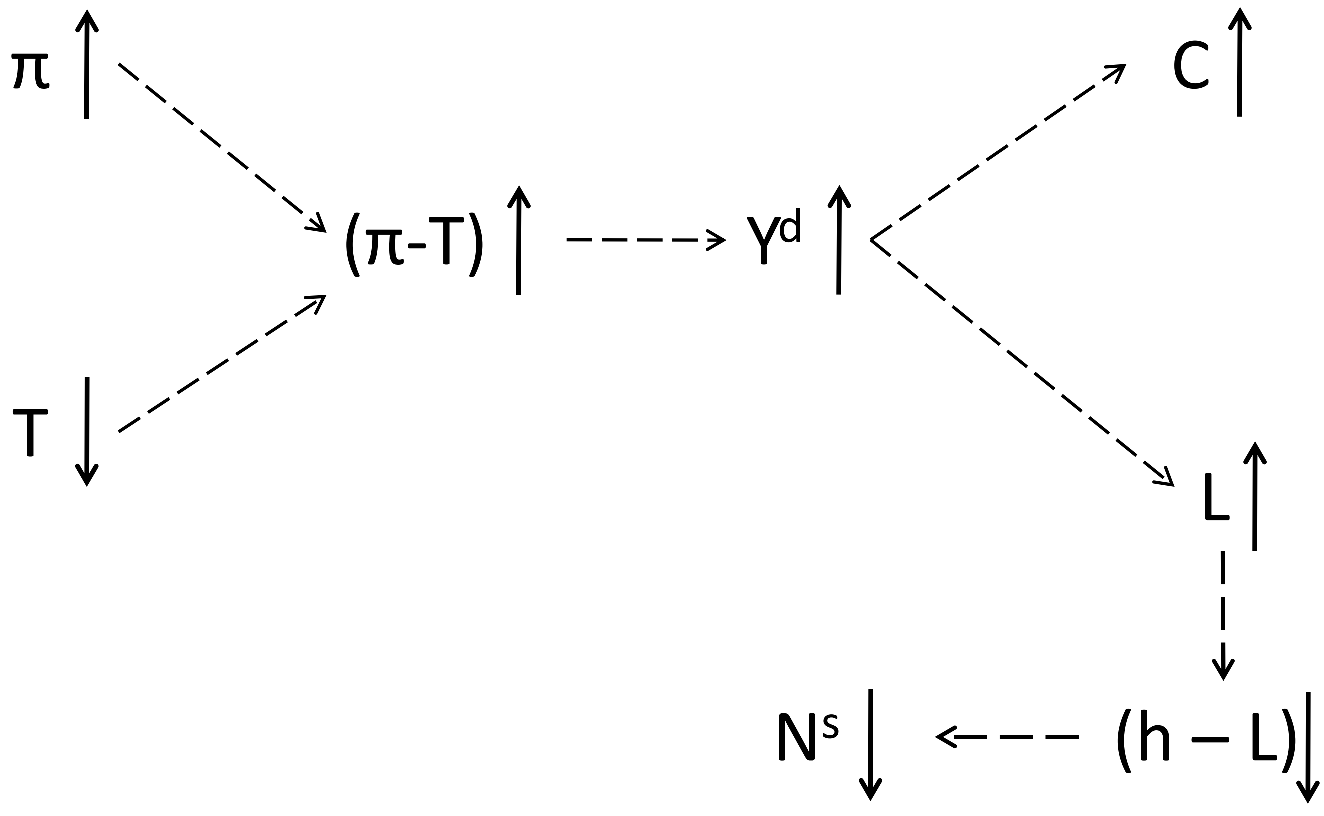
- An increase in dividends or a decrease in taxes (π-T) causes the consumer to increase both consumption goods and leisure (and to reduce the quantity of labor supply).
  - The pure income effect.

An increase in π-T

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



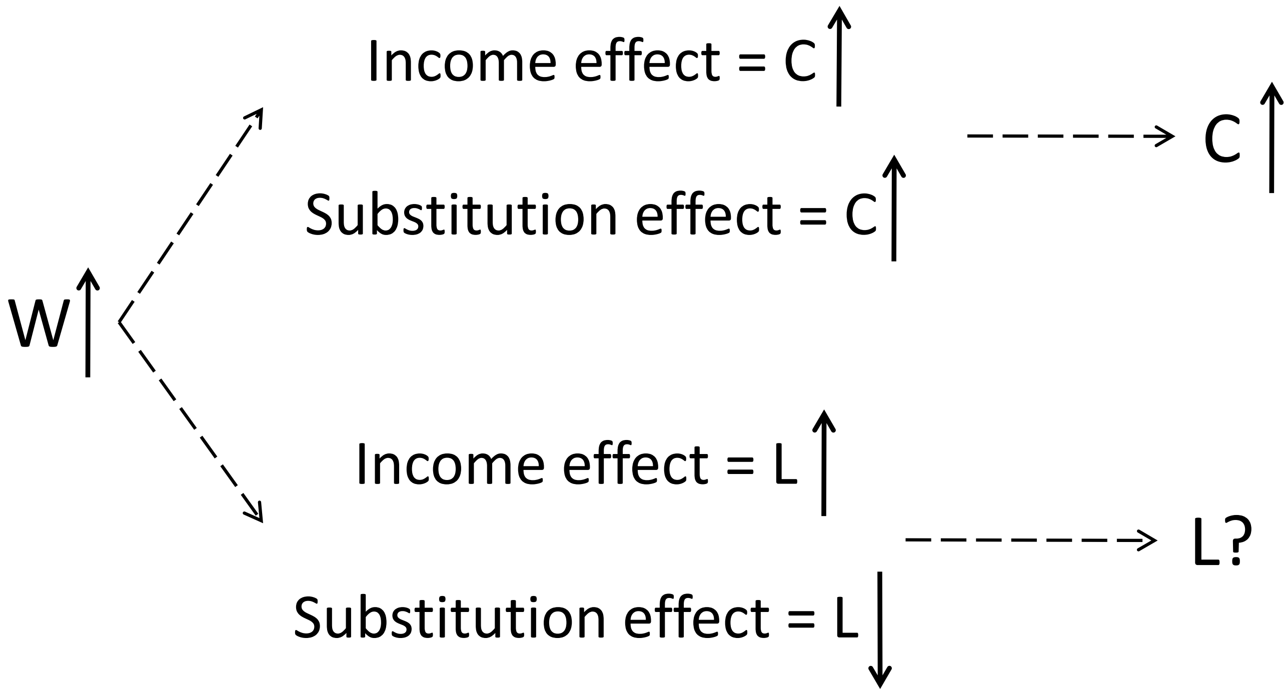
A higher π-T raises C and L



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 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.

A higher wage raises C



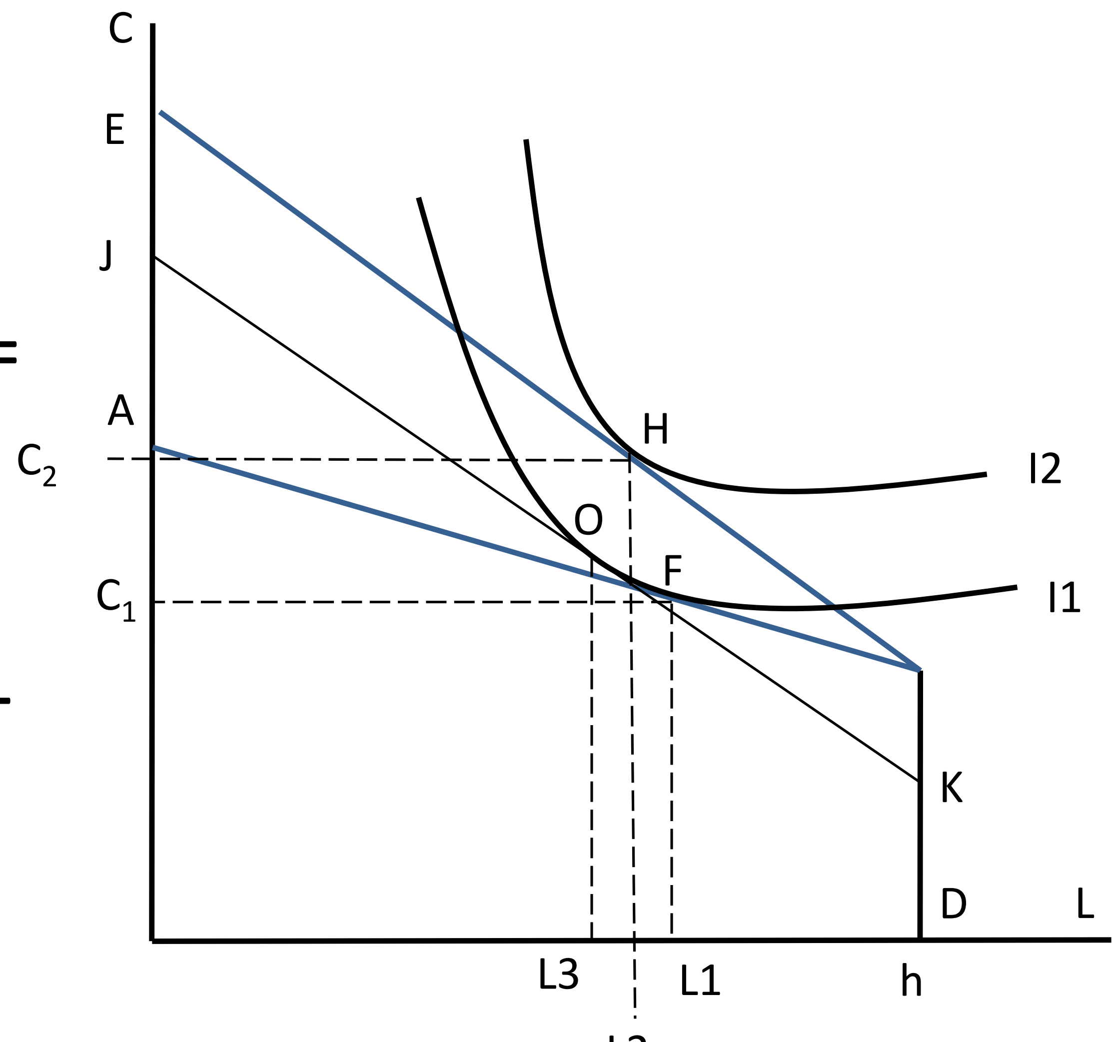
Effects of a higher w on L

w ↑

- Income effect (L↑) < substitution effect (L↓) ---→ L↓ ---→ (h-L)↑ ---→ N^s↑
- Income effect (L↑) > substitution effect (L↓) ---→ L↑ ---→ (h-L)↓ ---→ N^s↓

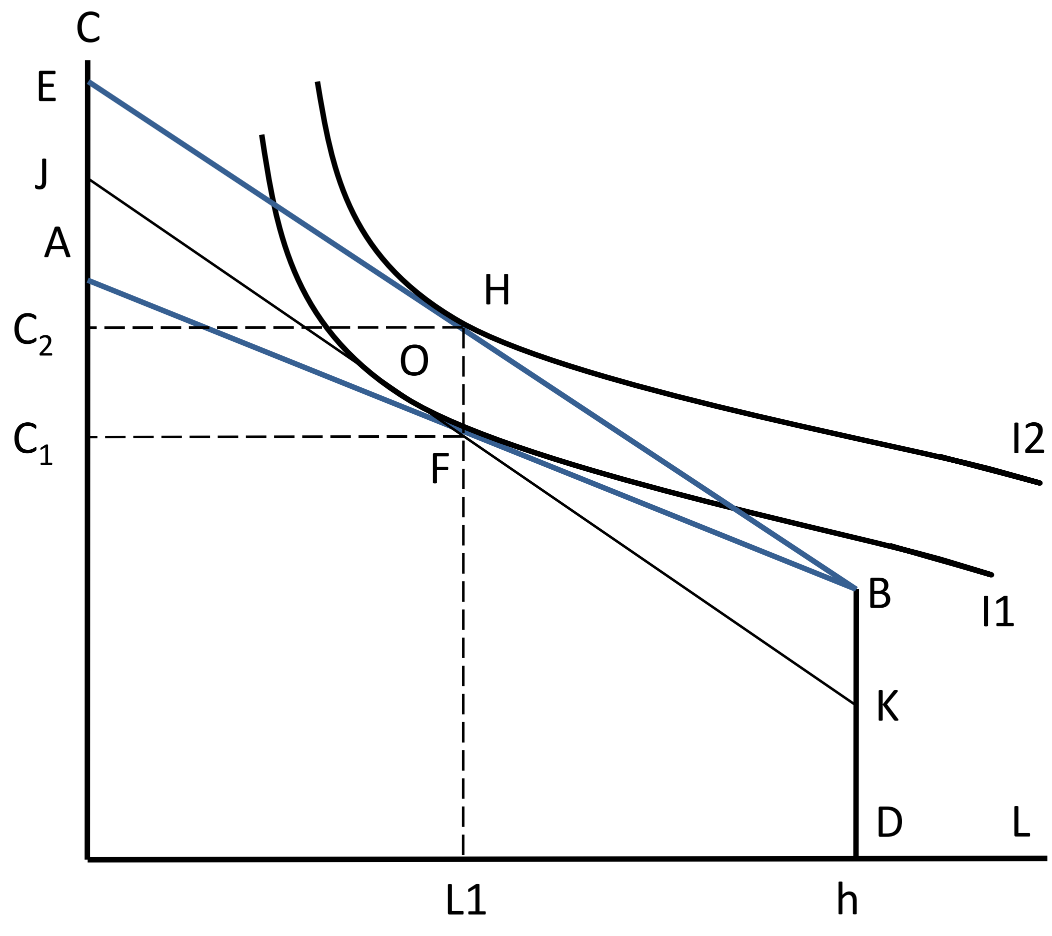
Stronger substitution effect

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



Equal effects (Williamson)

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



The labor supply function

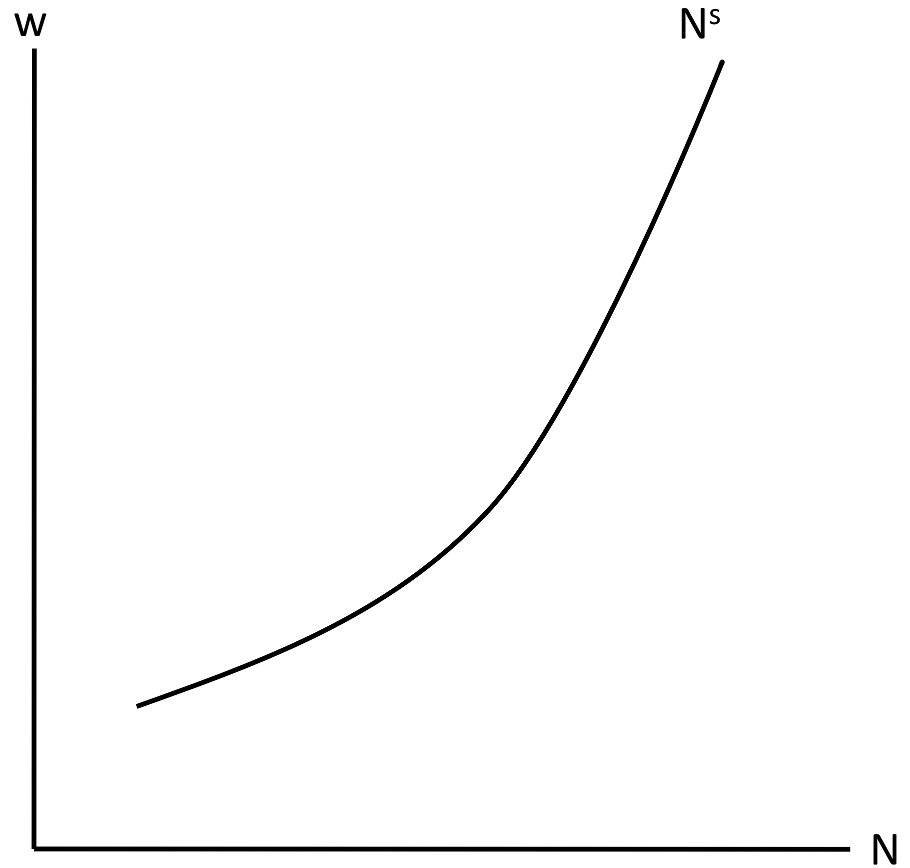
$$N^s(w) = h - l(w)$$

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

- N^s = the labor supply function;
- h = the maximum hours available;
- L(w) = the leisure function, given the real wage.
  - Assuming the **stronger substitution effect**.

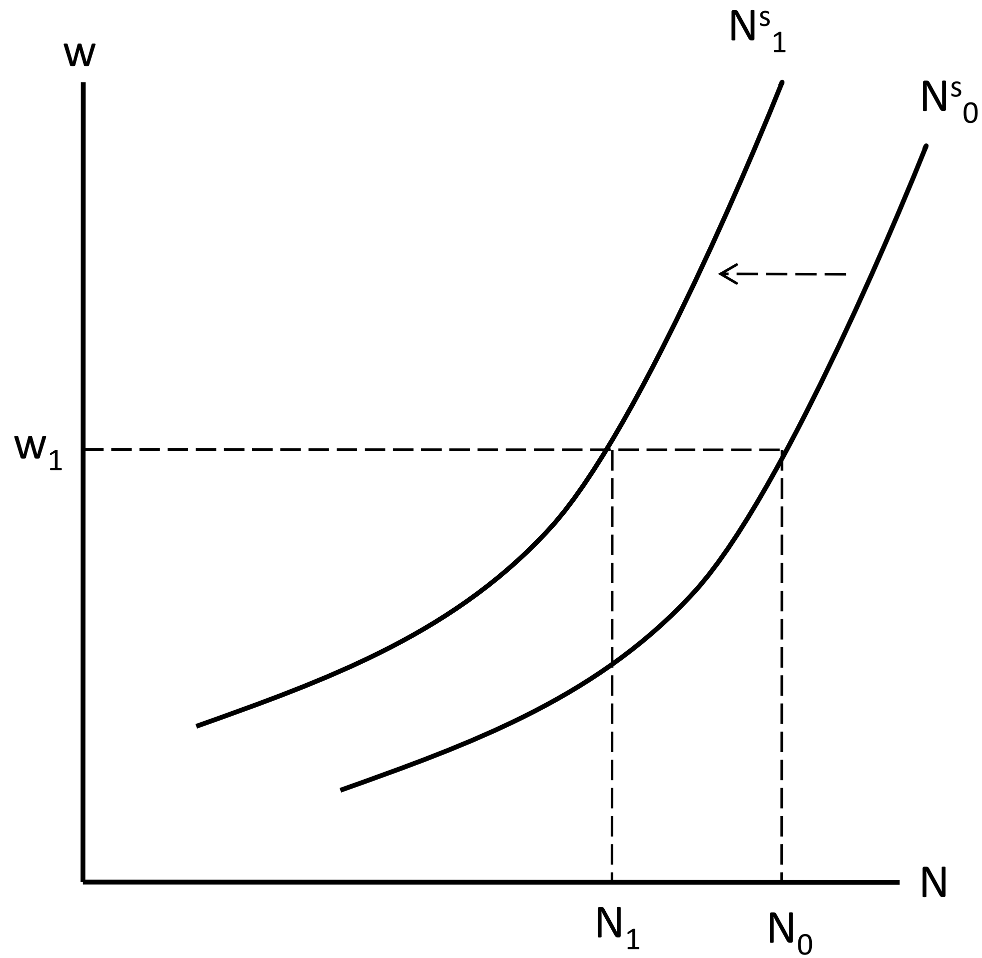
The labor supply curve

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



Effect of an increase in π-T

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



The consumption demand function

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

$$\frac{\partial C^d}{\partial w} > 0$$

- C^d = the consumption demand function;
- Consumption demand function is an increasing function in w, and **hence a decreasing function in 1/w.**

Consumption demand curve

- Conventionally, 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).**

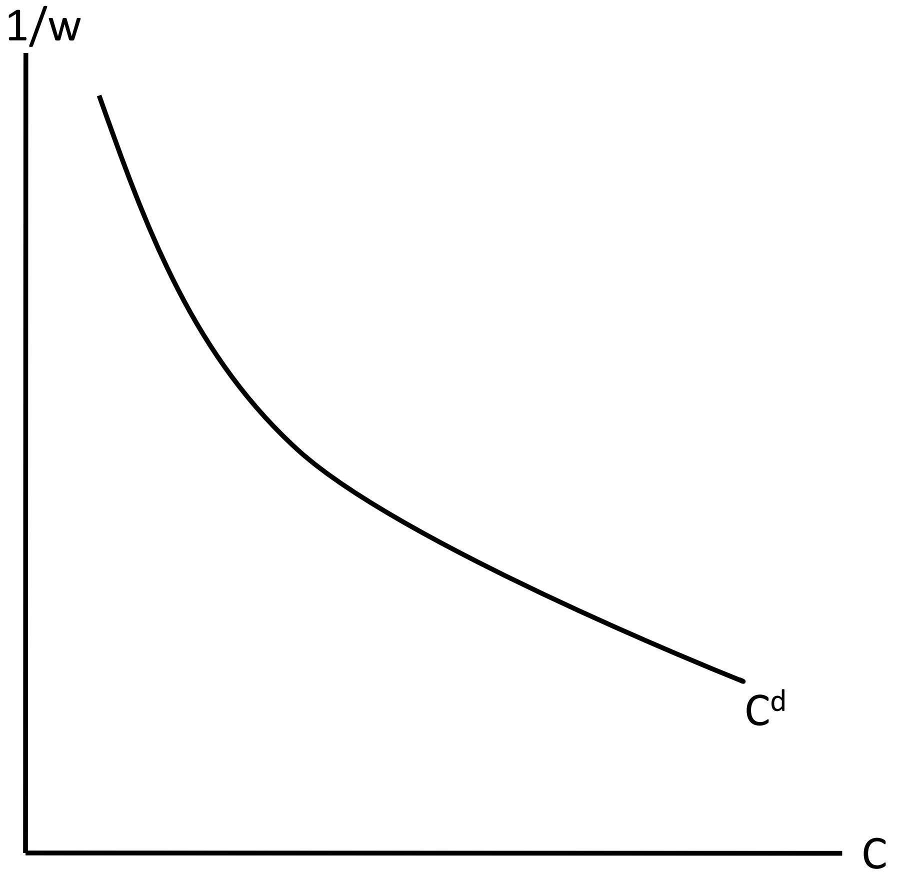
Consumption demand curve

- w = real wage
  - **Interpretation:** 1 hours = w units of consumption acquired
  - Price of a unit of labor (leisure) hour in terms of units of consumption goods acquired (forgone)

- 1/ w = price of consumption goods
  - **Interpretation:** 1 consumption goods = 1/w units of working hours = 1/w units of leisure hours acquired.
  - Price of a unit of consumption goods in terms of units of working hours forgone.

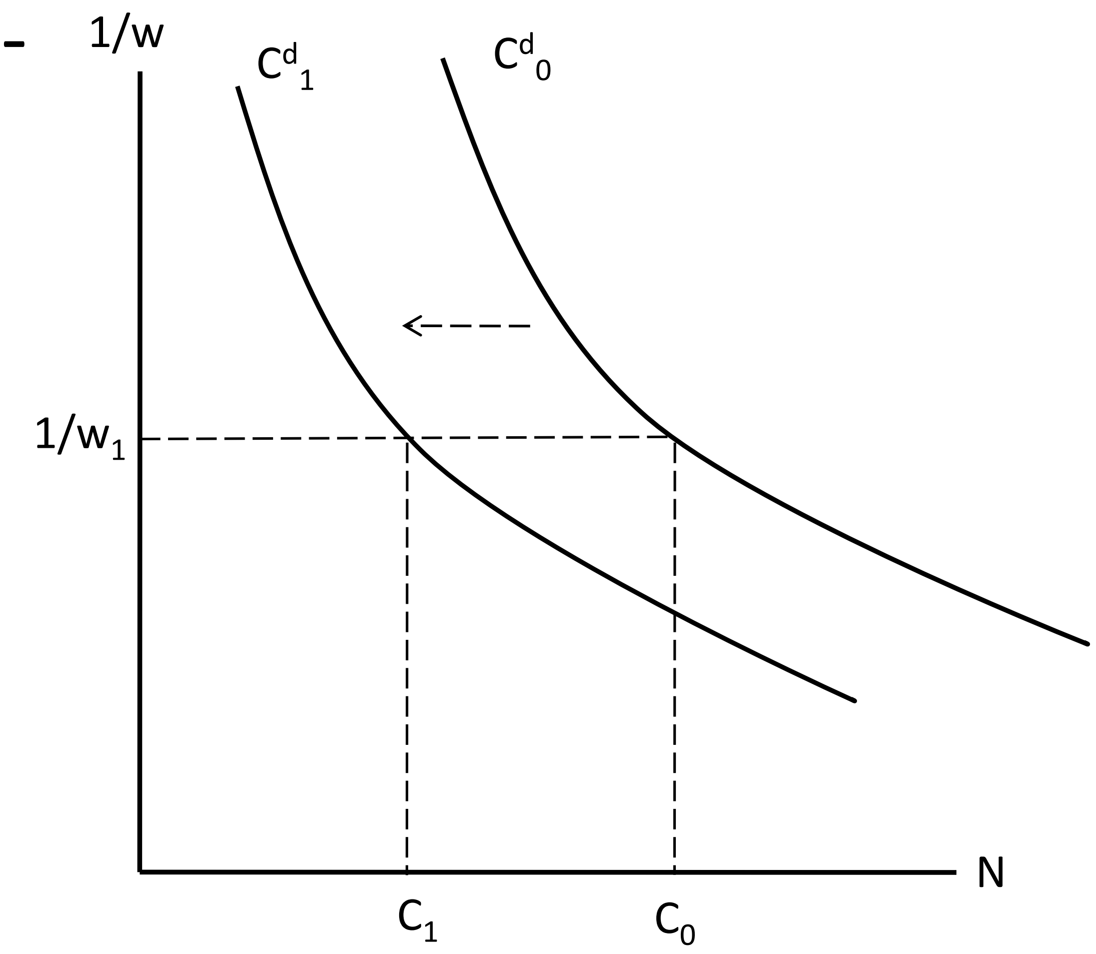
The consumption demand curve

- The consumption demand curve plots the amount of consumption with respect to its price, i.e. 1/w.

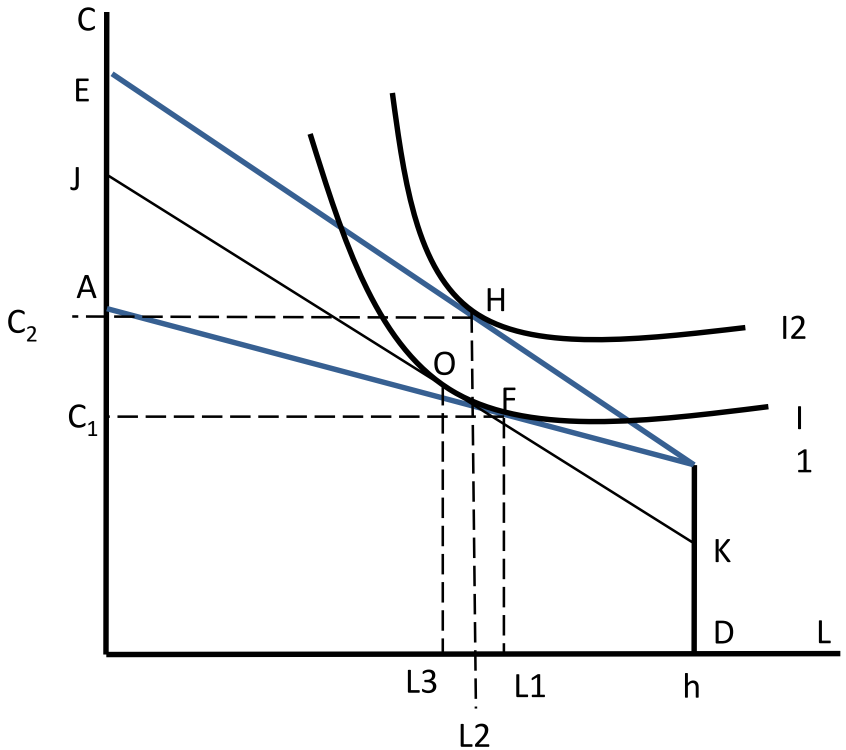


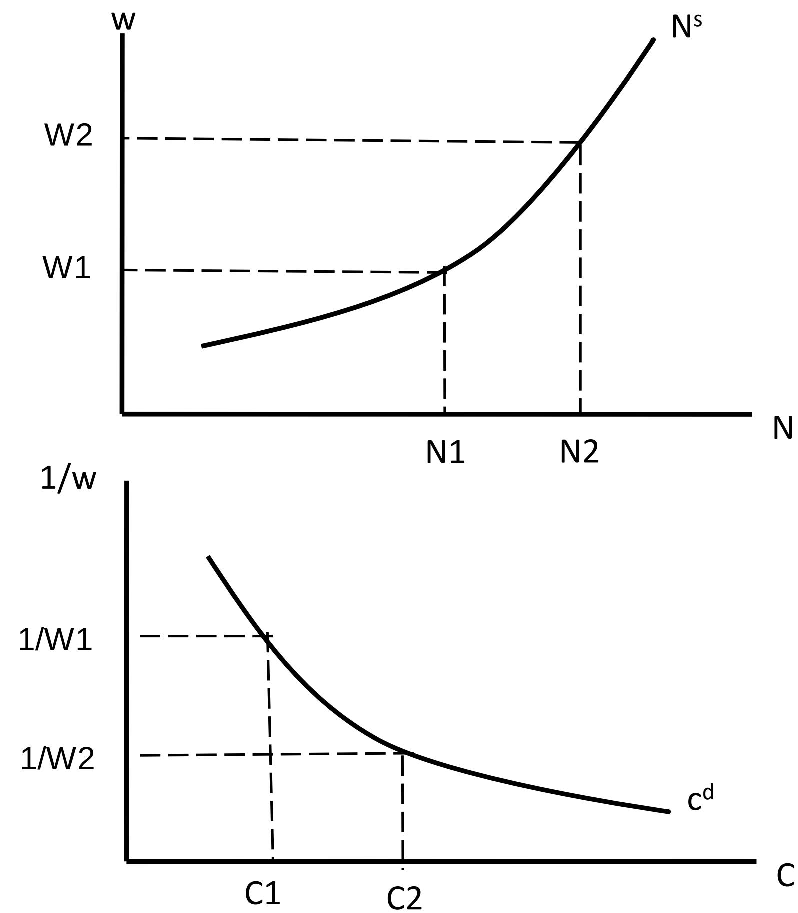
Effect of a decrease in π-T

- A decrease in π-T causes the consumer to decrease consumption goods, due to the negative income effect



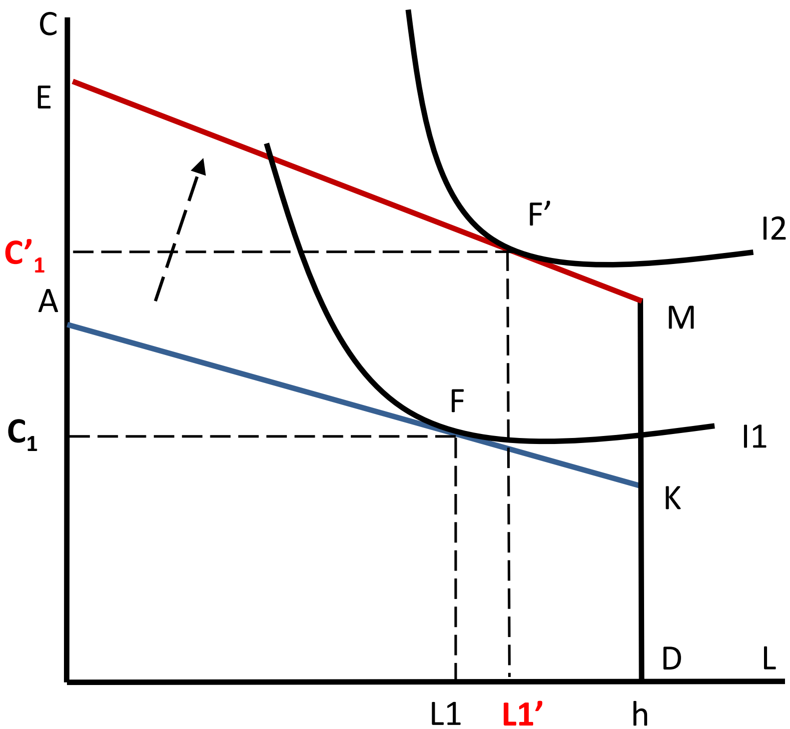
Recap on Household's behavior:
The labor supply and (Private) consumption demand

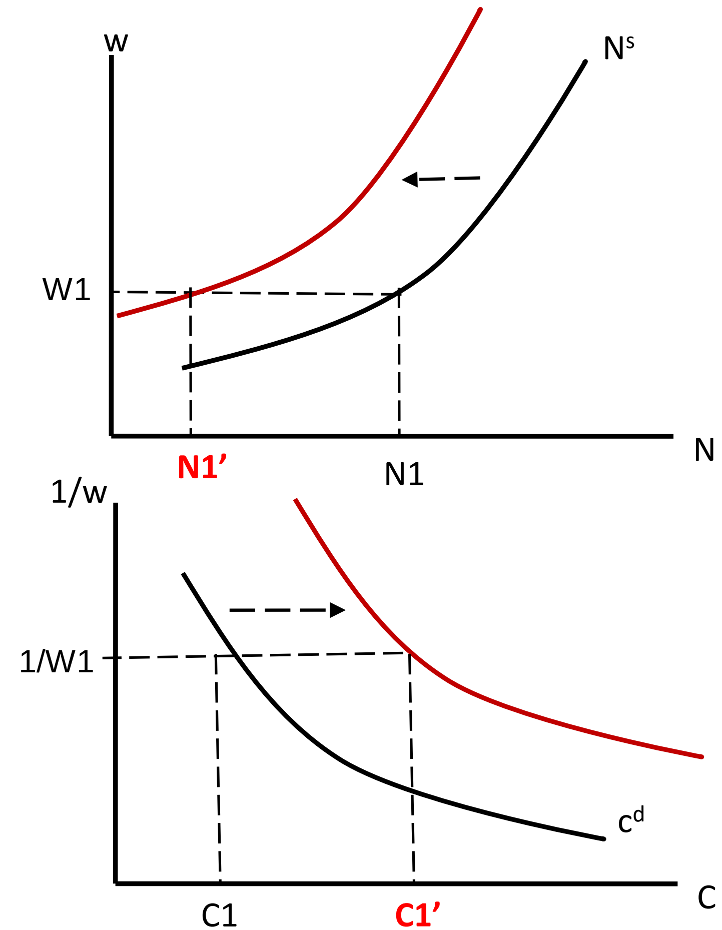




- **Effect of "wage" on leisure, and hence working hour**
  - **Substitution effect = FO.**
  - **Income effect = OH.**
- **FO > OH, C increases and L decreases**
- **So N increases.**

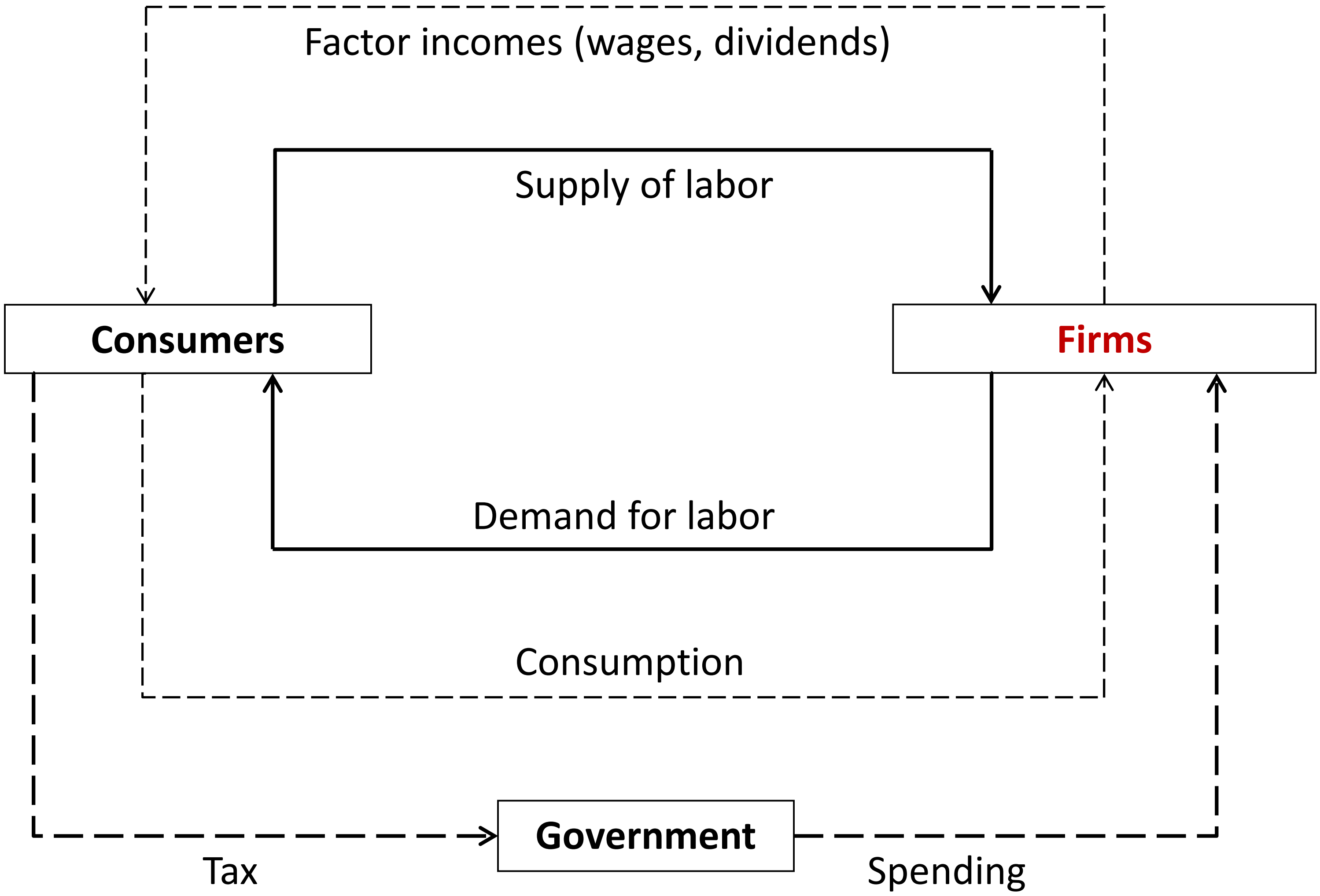
Recap on Household's behavior:
The labor supply and (Private) consumption demand (effect of T)





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

The Circular Flow



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.

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.**

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.
  - Production organization;
  - Managerial input;
  - Social and physical infrastructures.

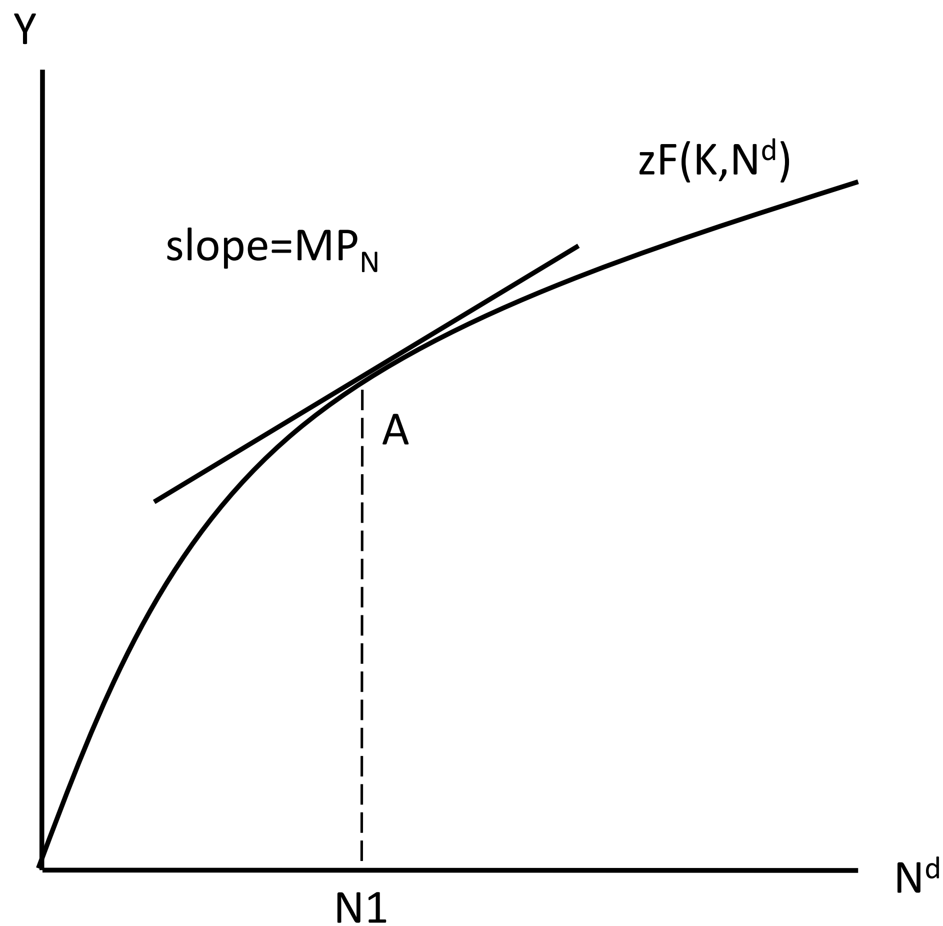
Properties of the production function

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

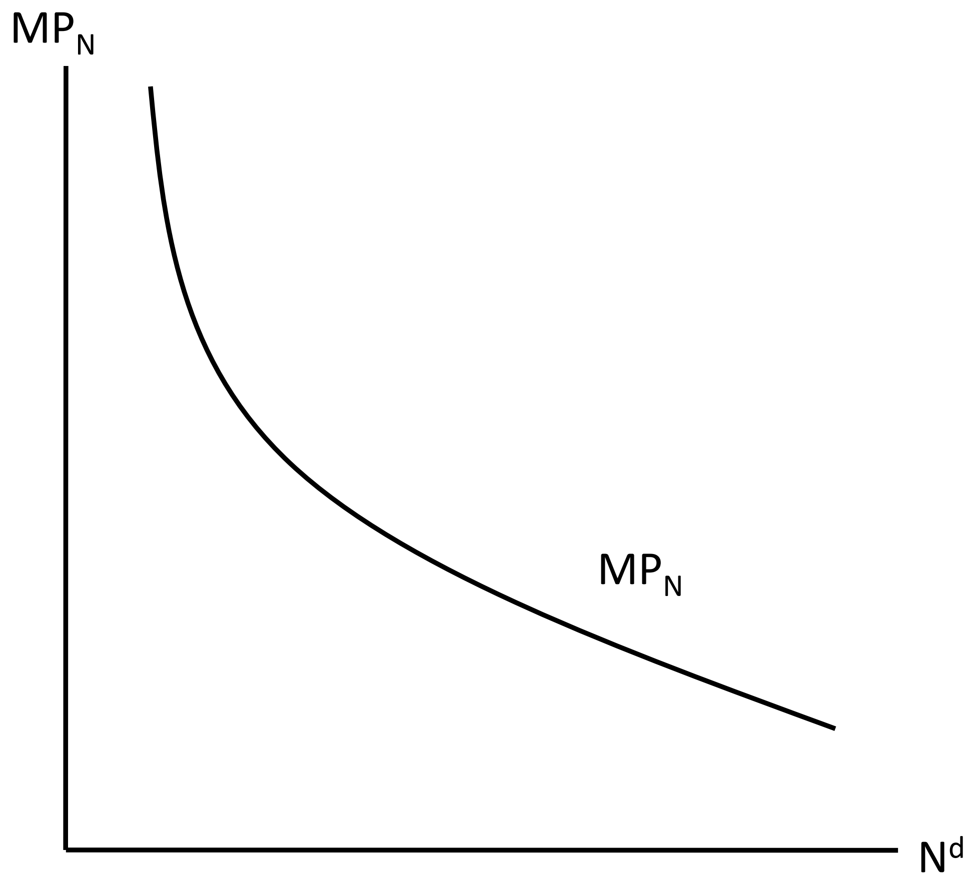
Production function, fixed capital

- The slope at A is MP_N when N = N1.
- MP_N is falling as the labor input increases, given the capital input.



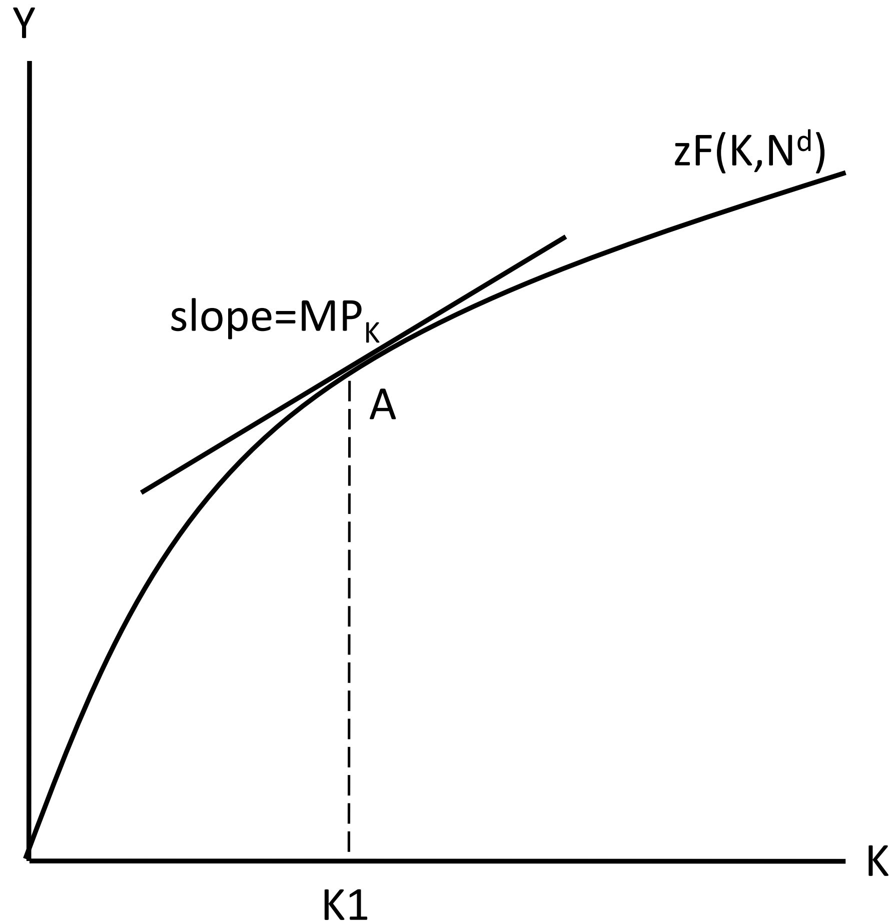
Marginal product of labor

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



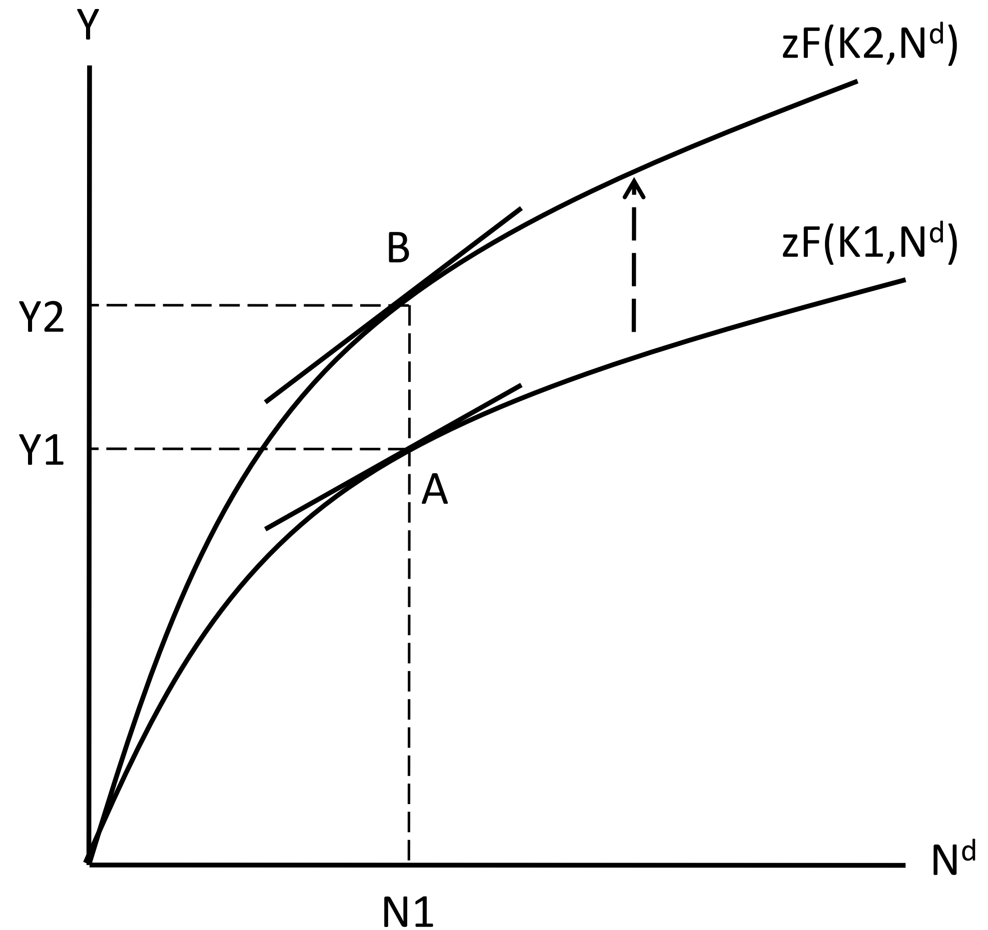
Production function, fixed labor

- The slope at A is MP_K when K = K1.
- MP_K is falling as the capital input increases, given the labor input.



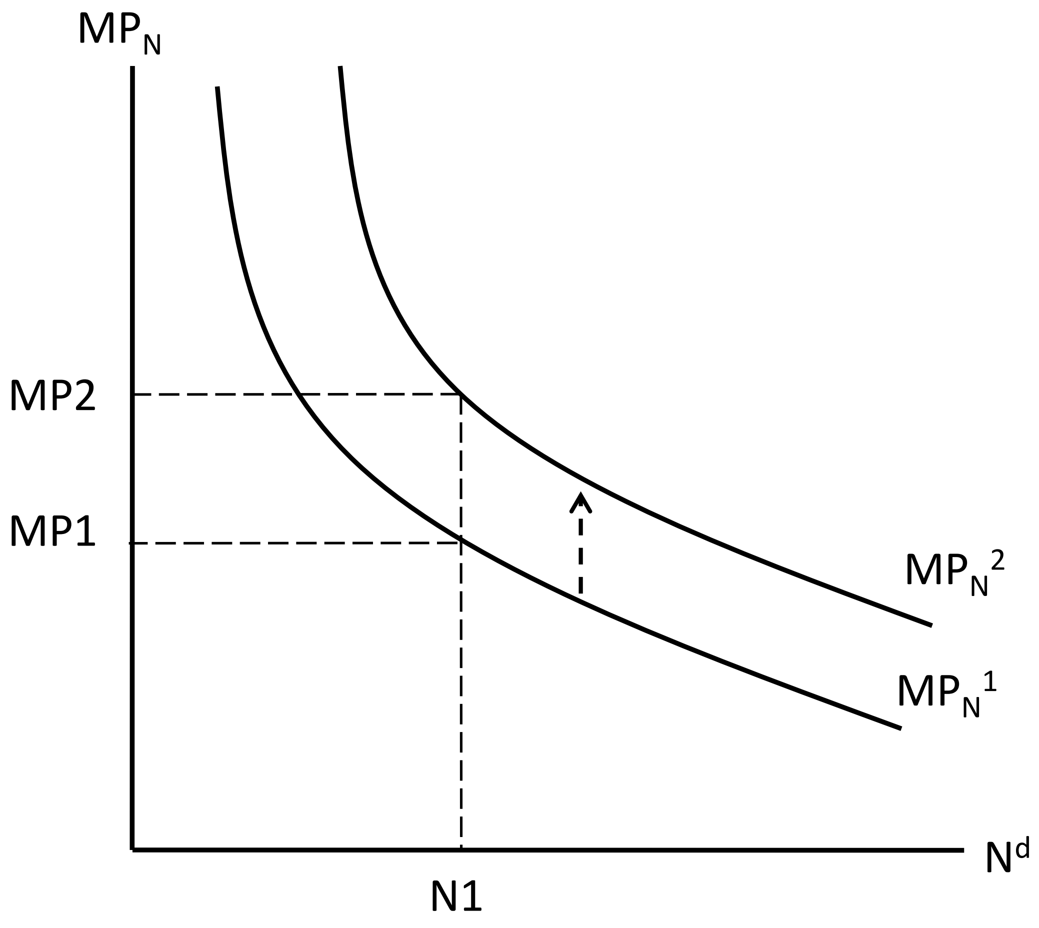
Increases in the capital input (K)

- An increase in K causes MP_N and output (Y) to rise at N1.



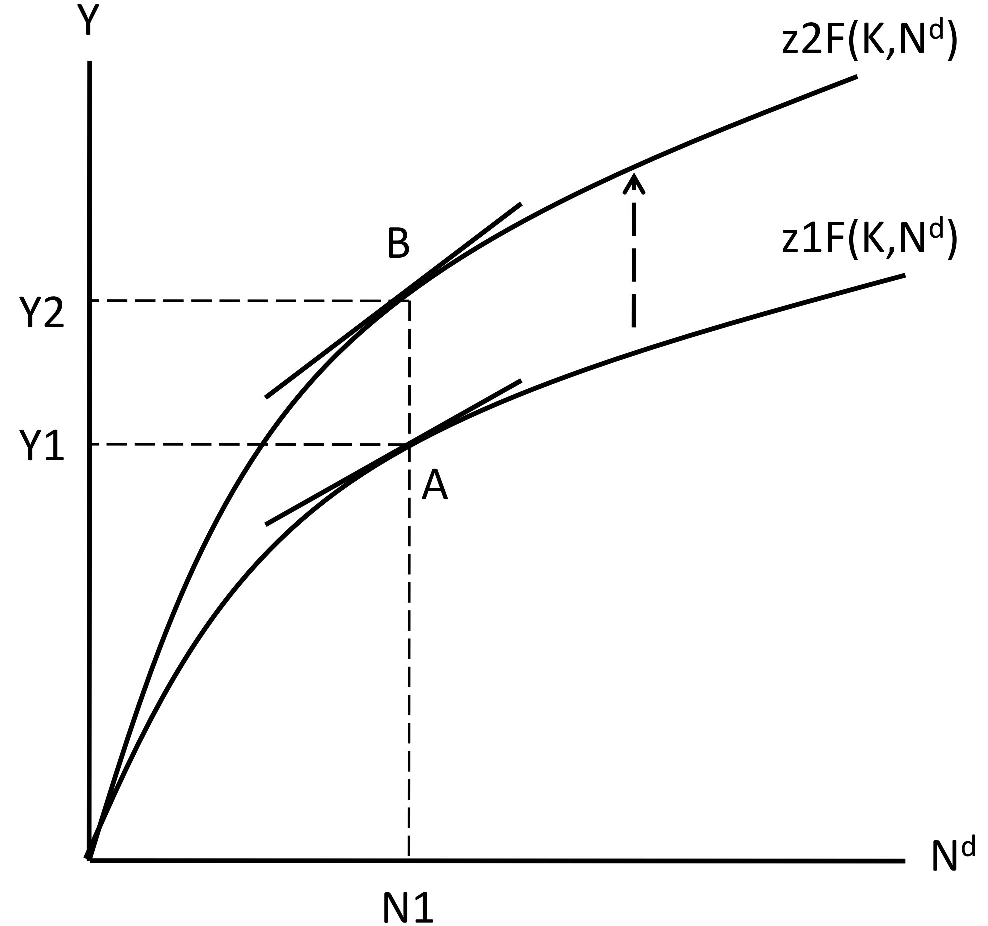
MP_N increases as K increases.

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



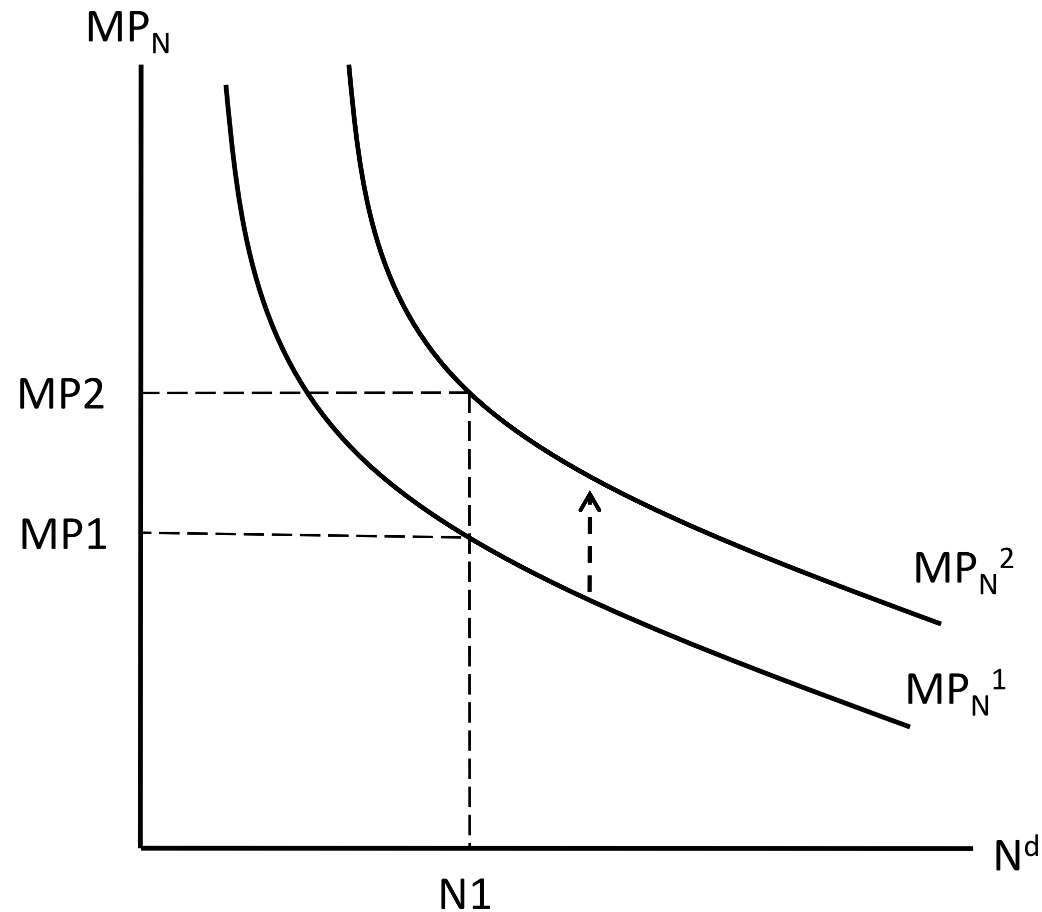
Increases in total factor productivity (z)

- An increase in z causes MP_N and output (Y) to rise at N1.



Effect of rising z on MP_N

- An increase in z causes MP_N at N1 to rise.

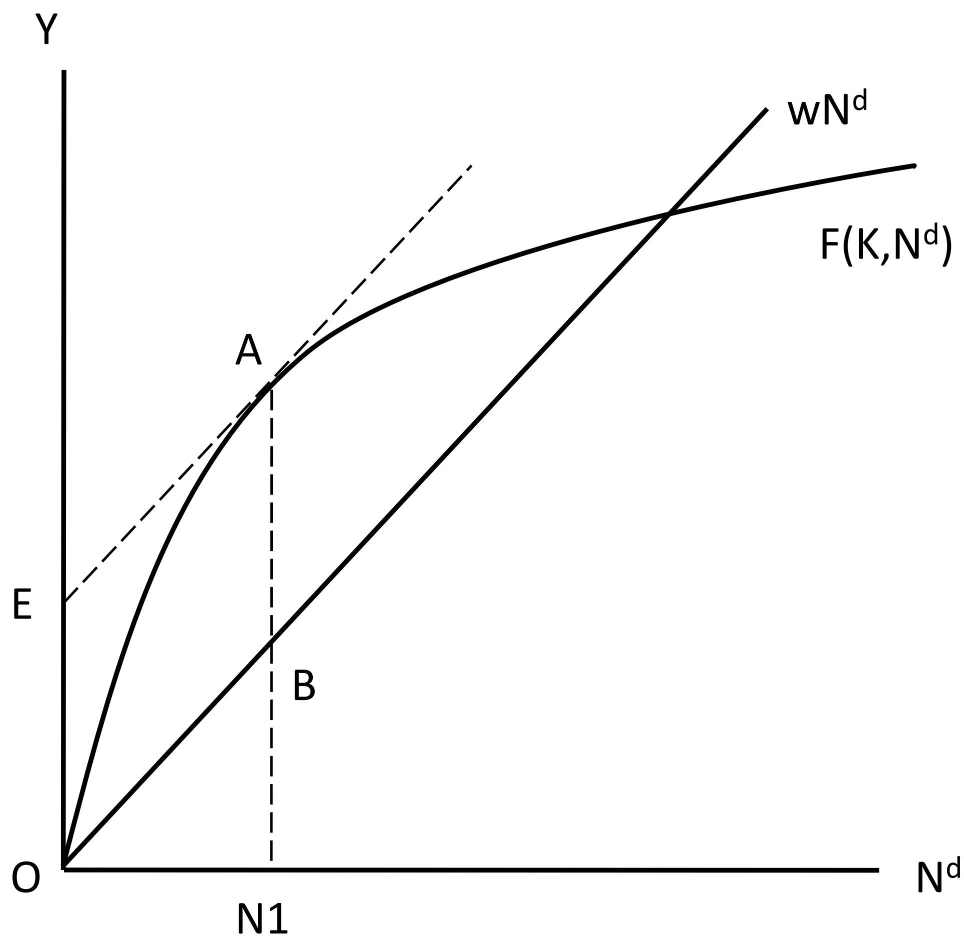


The firm's profit maximization

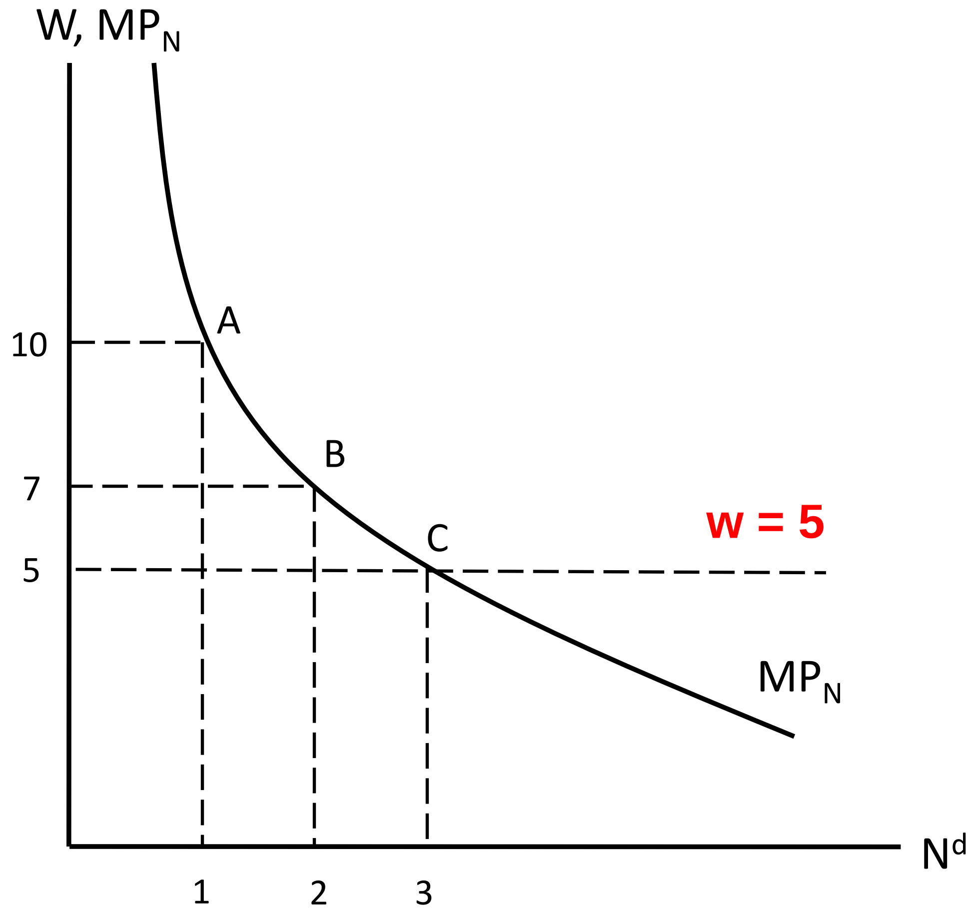
- Y = total revenue = $zF(K, N^d)$;
- wN^d = total variable cost;
- $\pi = zF(K, N^d) - wN^d$
- **Maximized profit** where
  - Slope of Y = slope of $wN^{d;}$
  - MR = MC
  - $MP_N = w$ or the firm's labor demand function.
- The MP_N is the firm's labor demand curve.

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.

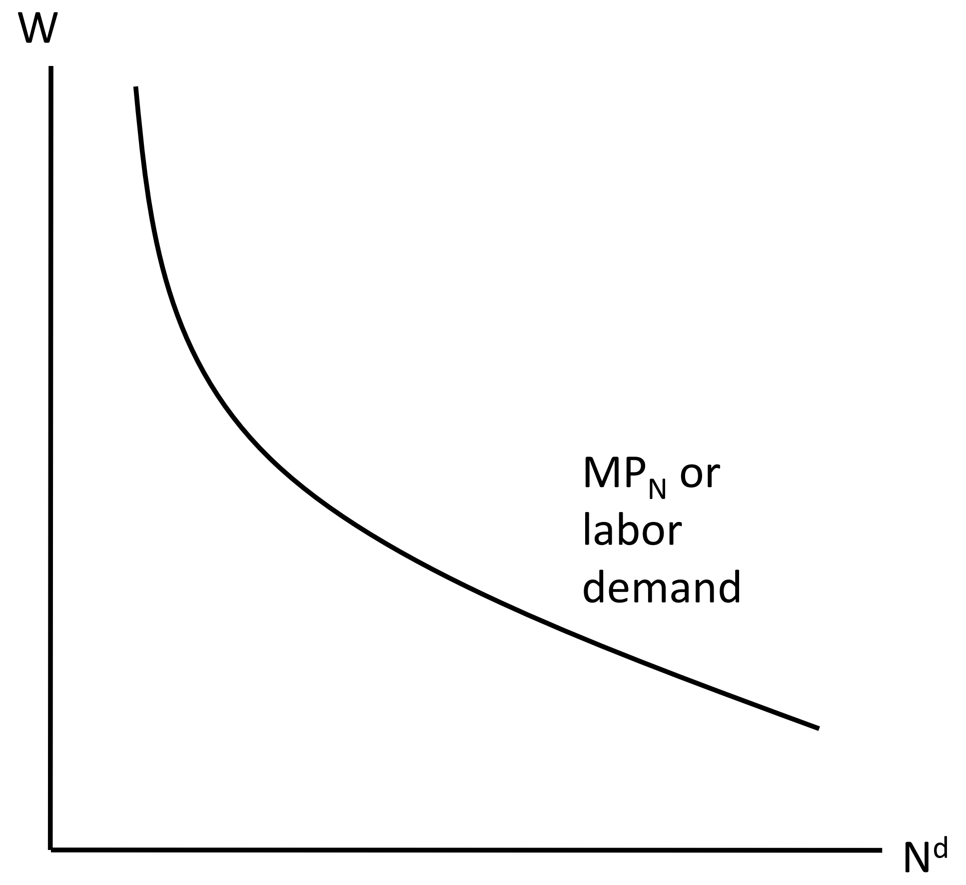


- If $MP_N > w$, hire more workers.
- If $MP_N < w$, hire less workers.
- Profit-max at $MP_N = w$
- If w = 5, the firm hires 3 units of labor.



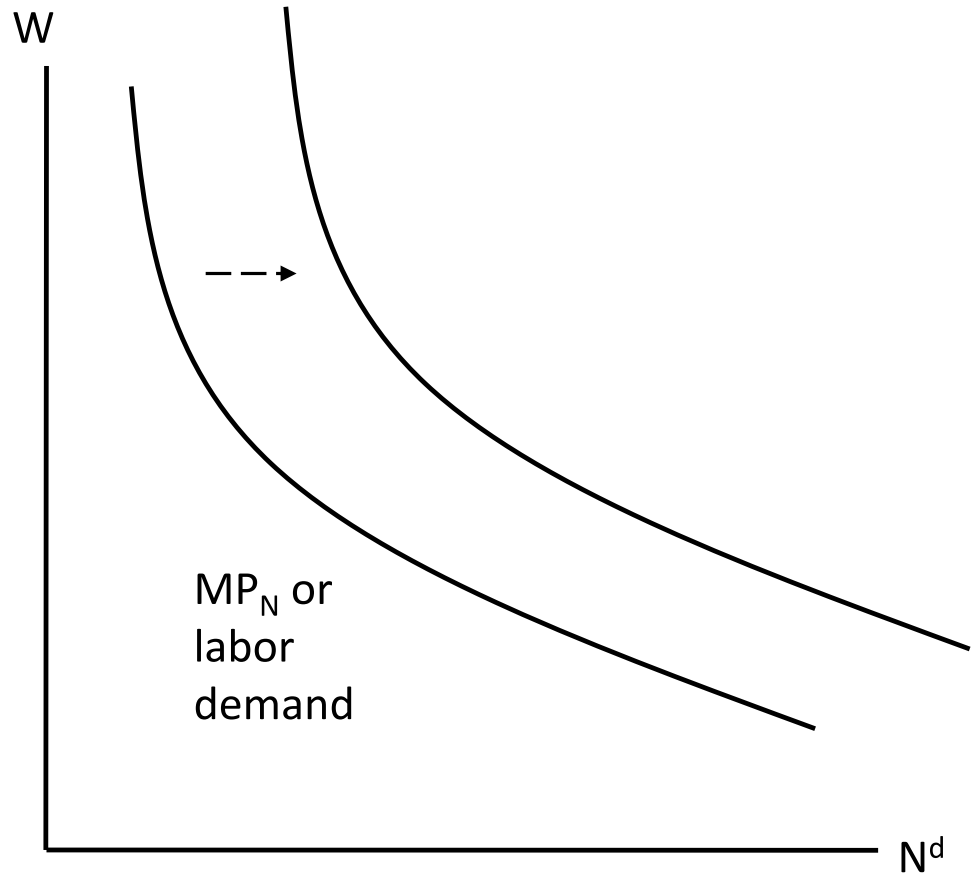
The firm's labor demand curve

- Profit-max: the firm hires labor up to the point where $MP_N = w$.
- As w changes, the firm moves along MP_N curve.



Effect of an improvement in Z and K

- Labor demand curve shifted right, due to an increase in MP_N



Firm's output supply function

$$Y^s(w) = ZF\left(K, N^d(w)\right)$$

$$\frac{\partial Y^s}{\partial w} < 0$$

- $Y^s(w)$ the amount of output supplied at a given w.

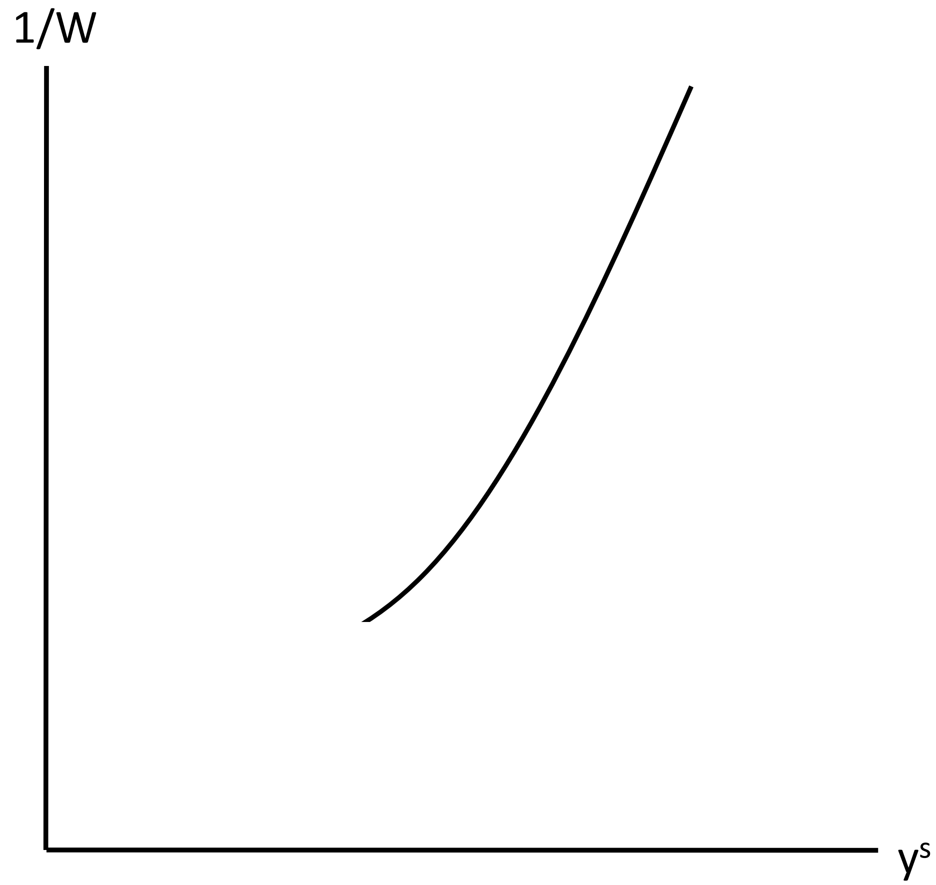
Output supply curve

- We plot Y^s with respect to the price of consumption goods, i.e. 1/w.

- This yields us the conventional shape of output supply when the amount of output supplied is an increasing in its own price.

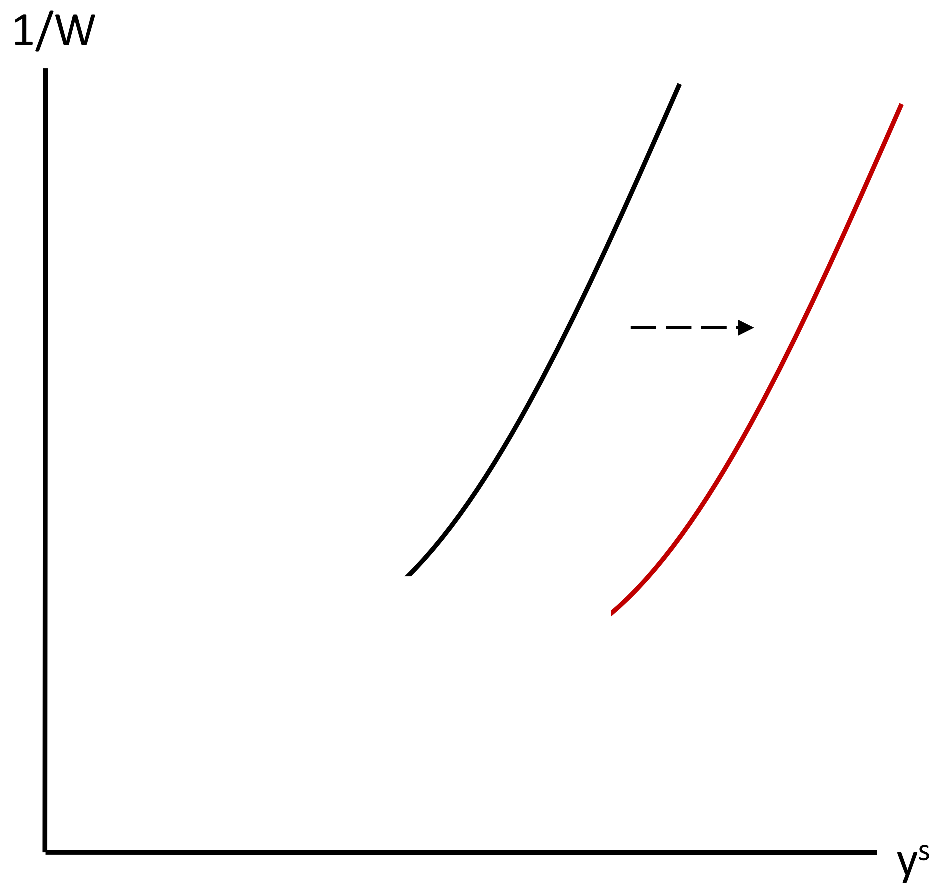
Output supply curve

- Output supply curve is an upward sloping in 1/w (price of consumption goods)



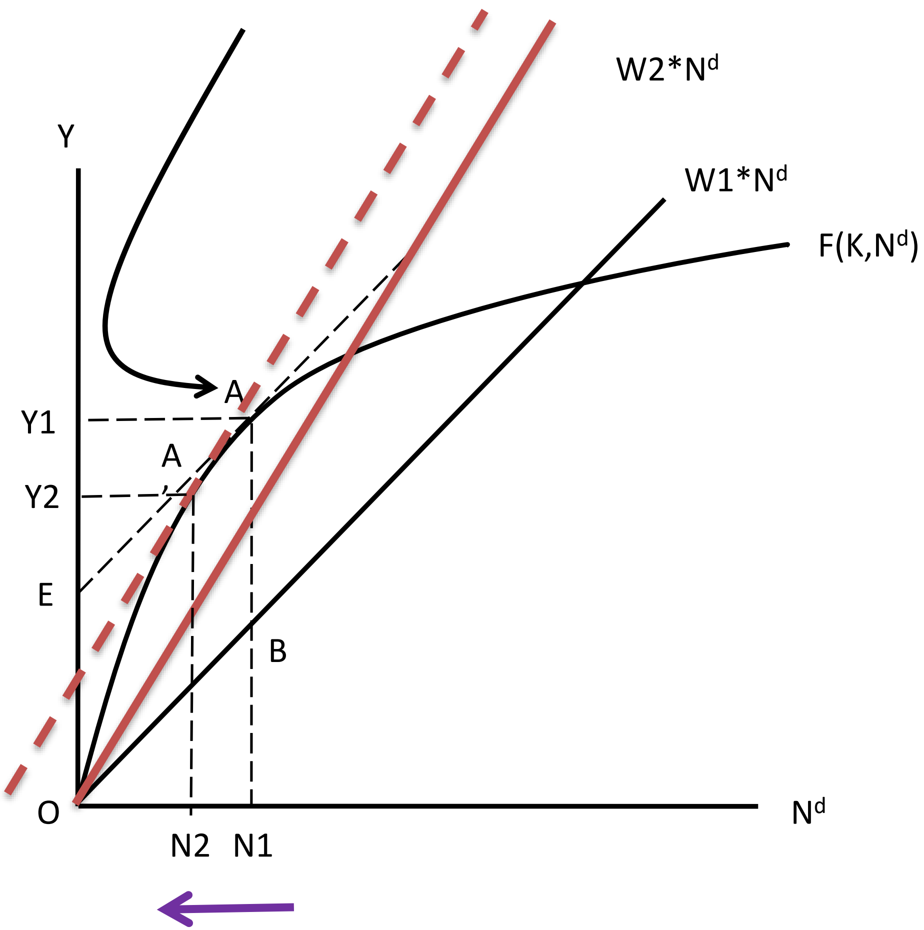
Effect of an improvement in z and K

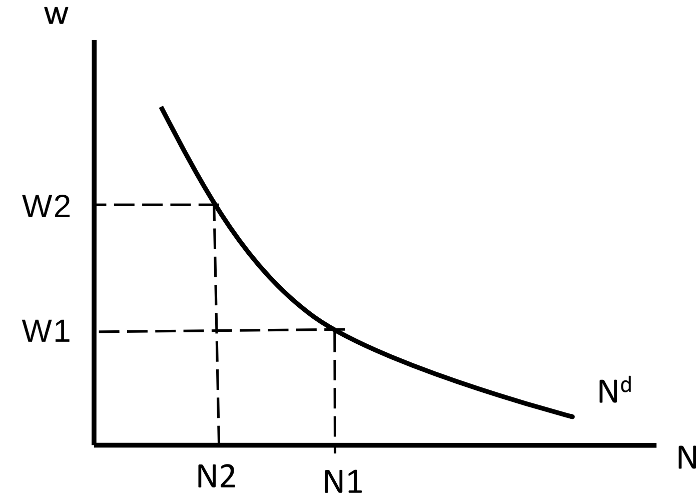
- Output supply curve shifted right, due to an improvement in production capacity.

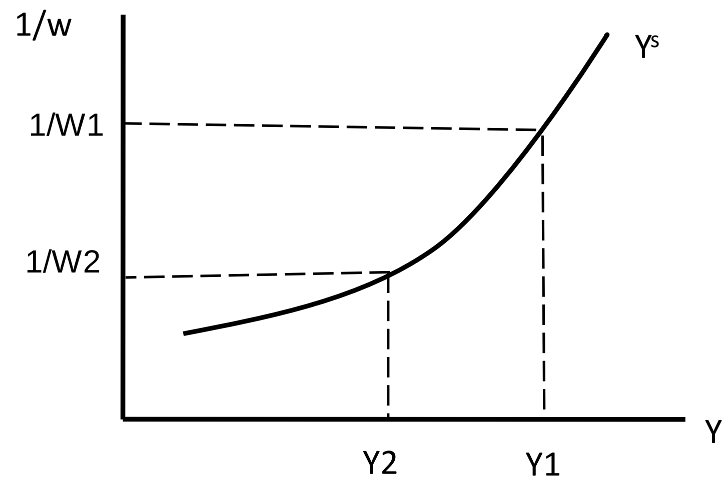


Recap on Firms' behavior:
The labor demand and output supply

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 → N2

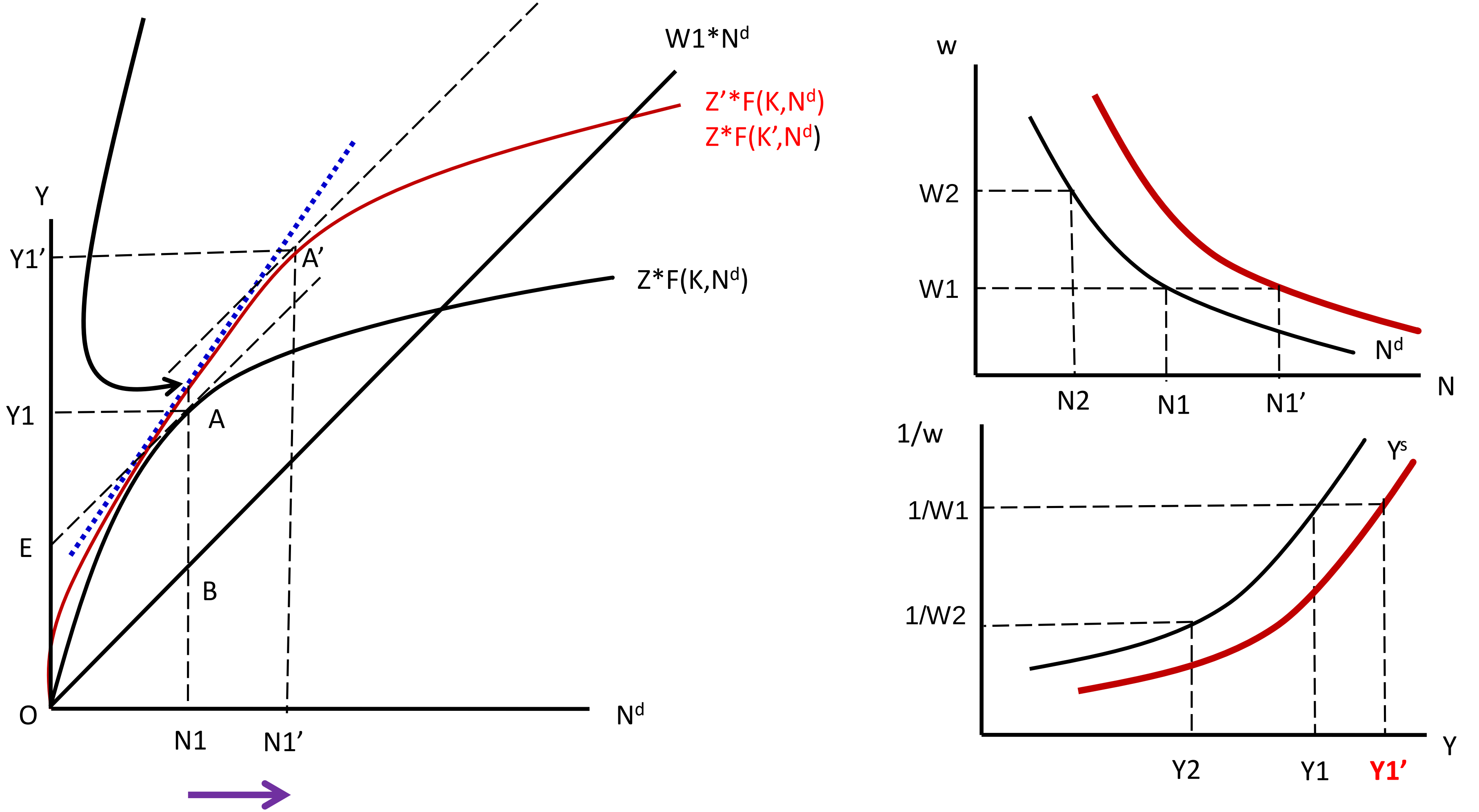






Recap on Firms' behavior:
The labor demand and output supply (effect of z and K)

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 stepper.

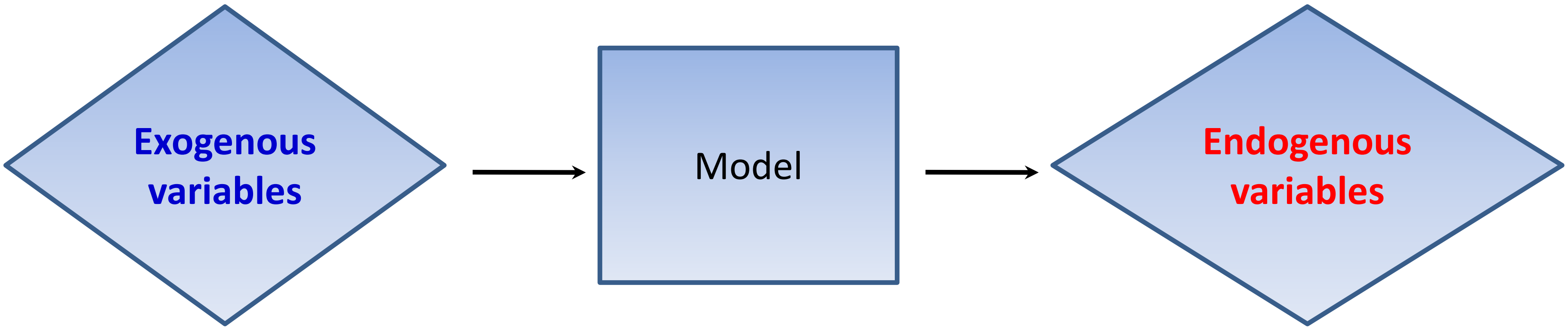


Government sector

- 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.

Closed-economy one-period model

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

Competitive equilibrium: definition

- The values of endogenous variables (C, Y, N^d, N^s, w, T) at which, given z, K and G (exogenous):
  - **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 goods market** clears: Y^d ($= C^d+G$) $= Y^s$
  - **The government budget constraint**: $G = T$.

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 example
  - If labor market is cleared, then the goods market is cleared as well.

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

Two approaches for equilibriums analysis

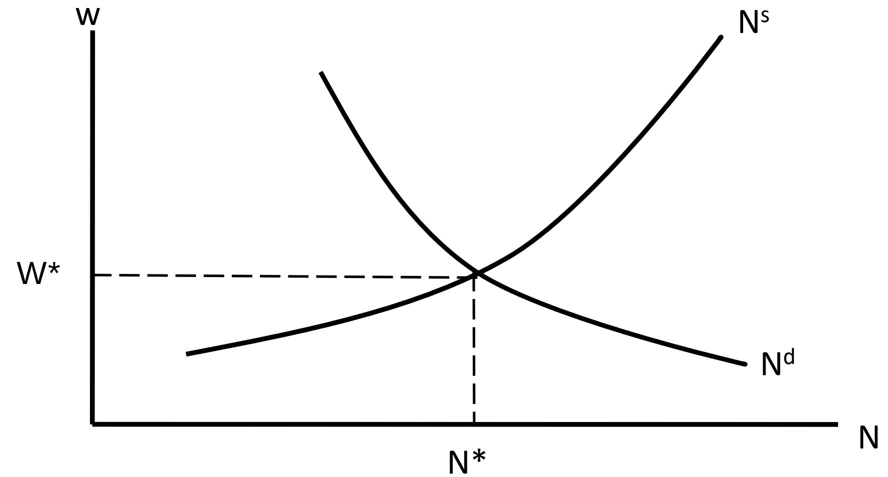
- **Demand and supply approach**
- Edgeworth box approach

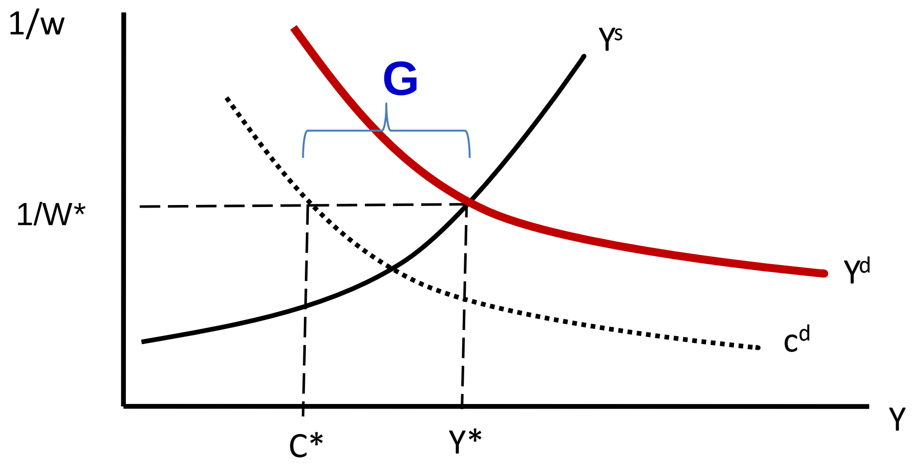
Graphical illustration of General equilibrium: demand and supply diagram

- Given the **optimizing behavior of agents**, the economy is under the equilibrium when **all markets clear!**
  - Labor market in equilibrium: Nd = Ns
  - Goods market in equilibrium:

    YD = YS → C^d + G = Ys
    - G is treated as an exogenous!
- Equilibrium allocation and price: (N*, C*, Y*, W*)

Labor market

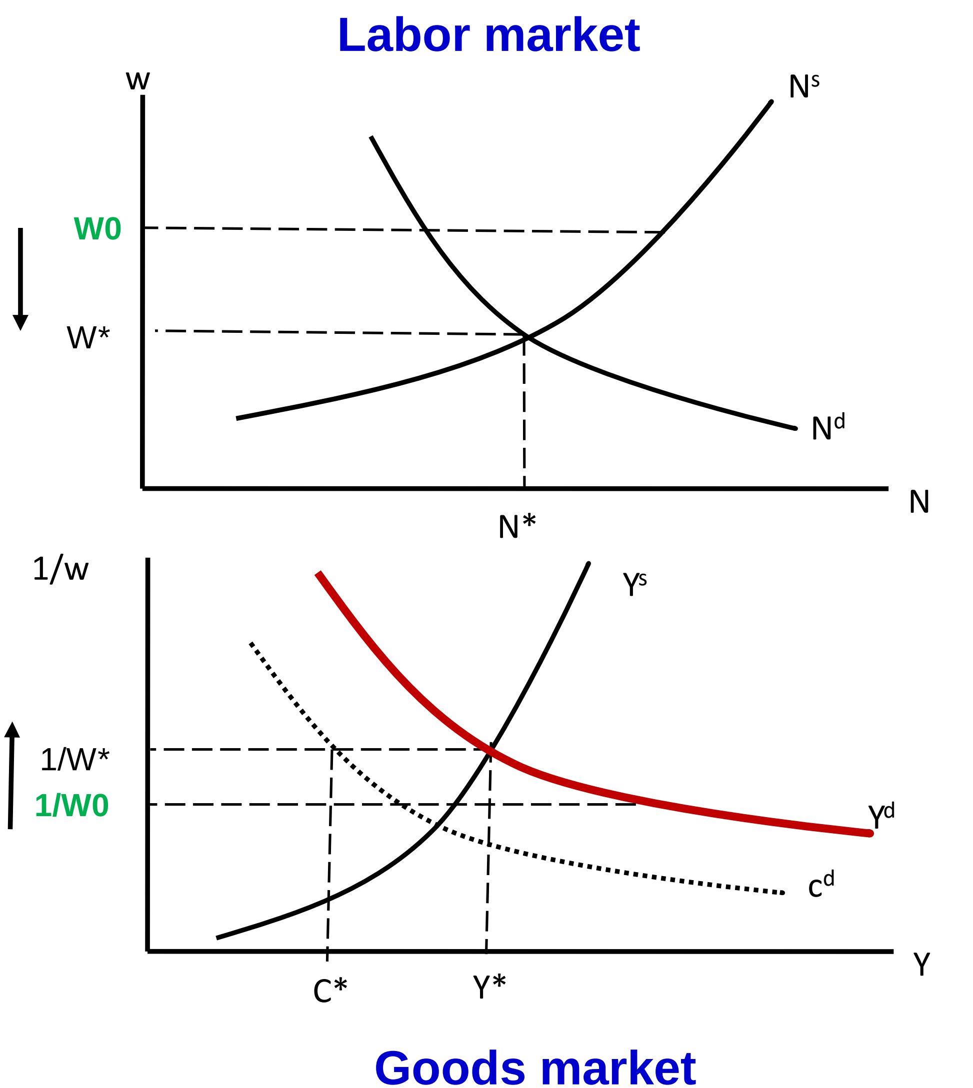




Goods market

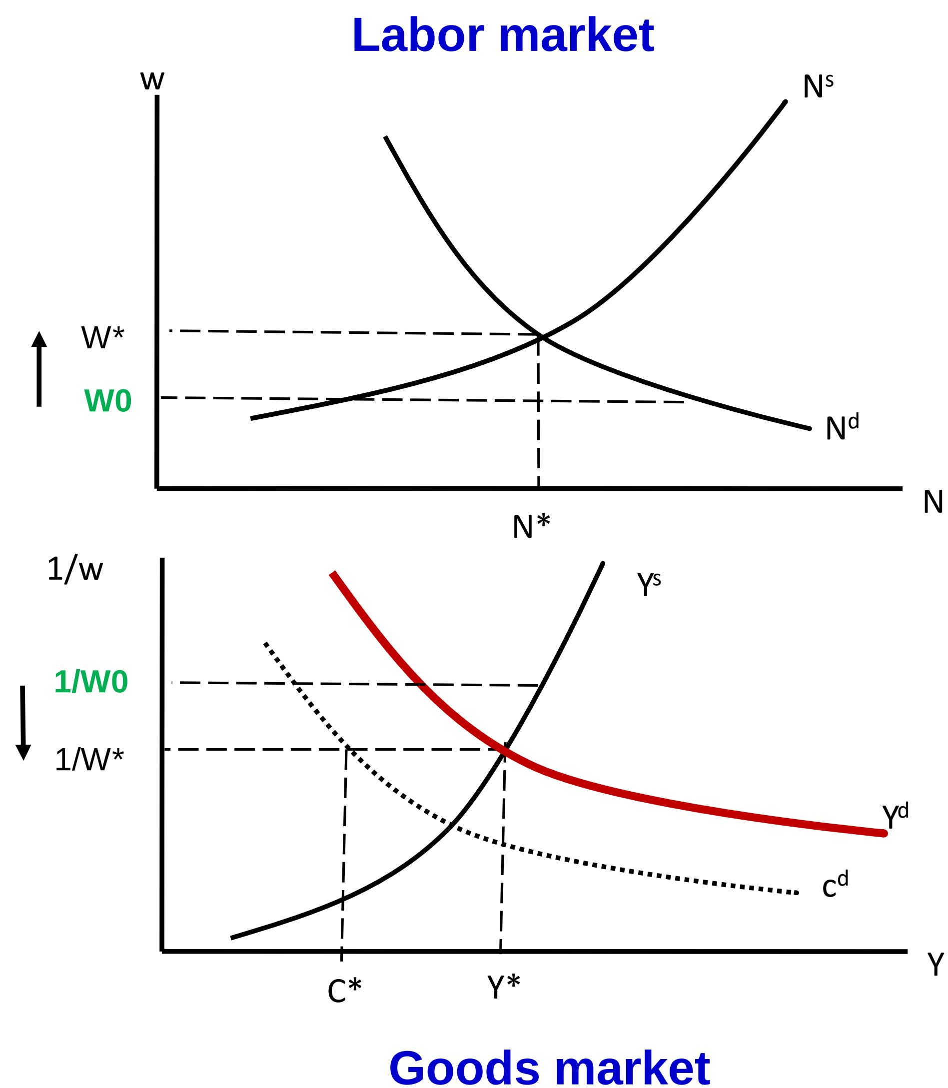
Graphical illustration of General equilibrium: demand and supply diagram

- Equilibrium adjustments
- Notice that W0, we have
  - ES in labor market
  - ED ins goods market
- Wage should be falling, resulting in
  - Drop in labor supplied, and Increased in labor demanded
- Consumption price should increase, resulting in
  - Drop in private consumption and aggregated quantity demanded.



Graphical illustration of General equilibrium: demand and supply diagram

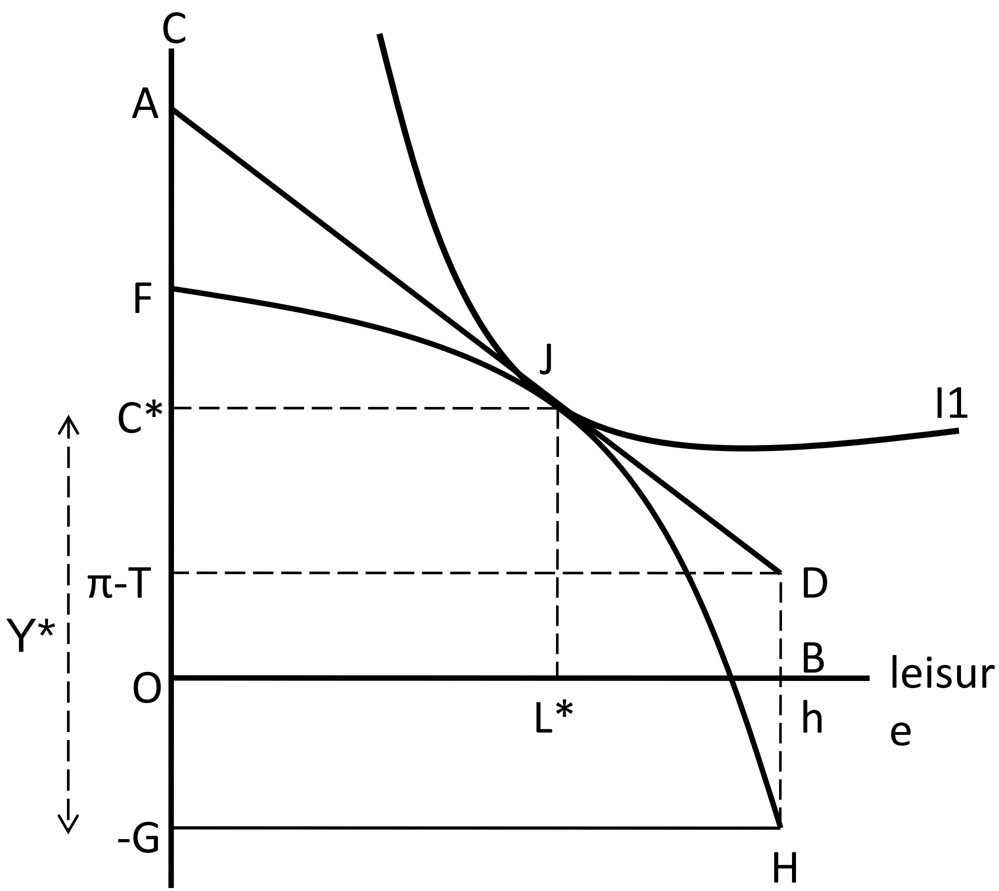
- Equilibrium adjustments
- Notice that W0, we have
  - ED in labor market
  - ES ins goods market
- Wage should be rising, resulting in
  - An increase in labor supplied, and a decrease in labor demanded
- Consumption price should decrease, resulting in
  - An increase in private consumption and hence the aggregated quantity demanded.



Two approaches for equilibriums analysis

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

Edgeworth box approach



- Diagram commonly used in General equilibrium study
- Incorporate all relevant information for the graphical illustration of general equilibrium
  - **Optimizing:** 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 wage line
- Market clearing allocation and associated equilibrium prices

Production possibility frontier

- 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
  - Resource constraints

The production function

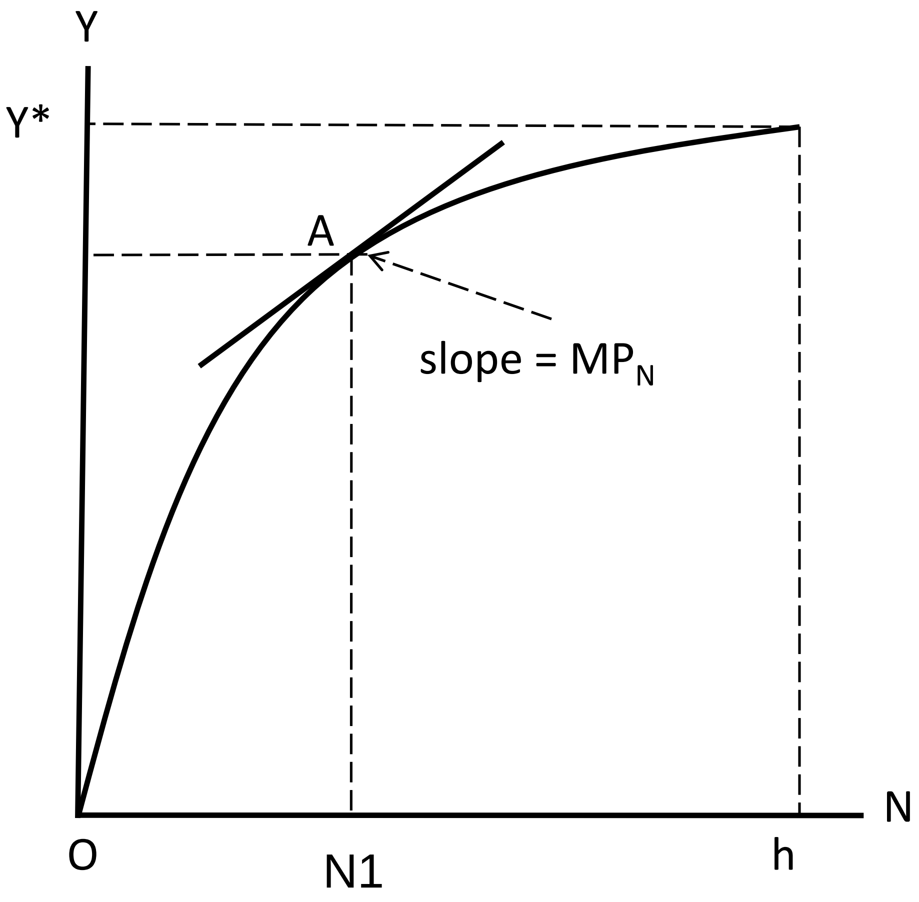
- In equilibrium, $N^d = N^s = N$; and $N = h - L$, therefore:

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

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

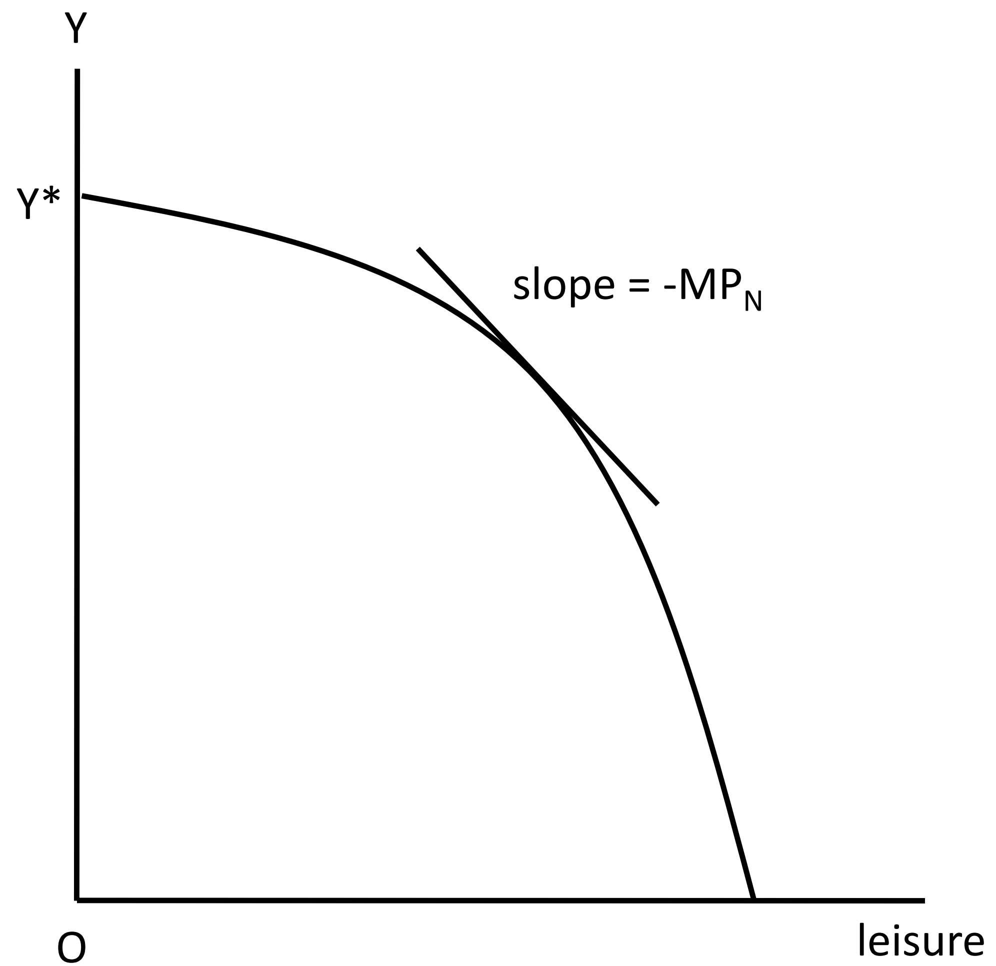
The production function

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



Output as a function of leisure

- $Y = zF(K, h\text{-}L)$.
- 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

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

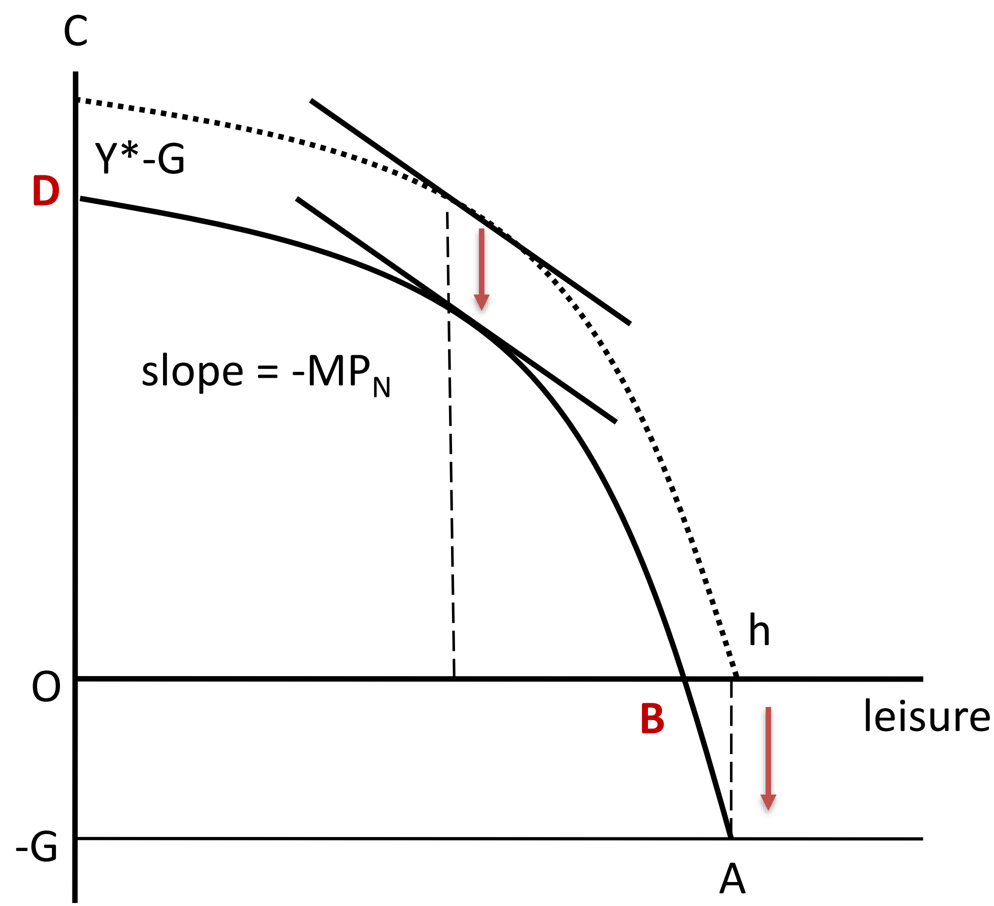
$$as\ C = Y - G$$

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

- 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.

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

The producer's max. profit

- The Edgeworth box diagram can also illustrate the profit-maximizing allocation.

- To understand this, let's introduce the concept of Iso-profit curve and corresponding wage line.

Isoprofit curve

- 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.

$$
\begin{aligned}
\pi &= Y - WN \\
&= (C + G) - W(h - L) \\
&= C + WL - Wh + G
\end{aligned}
$$

Isoprofit curve

Given the profit function,

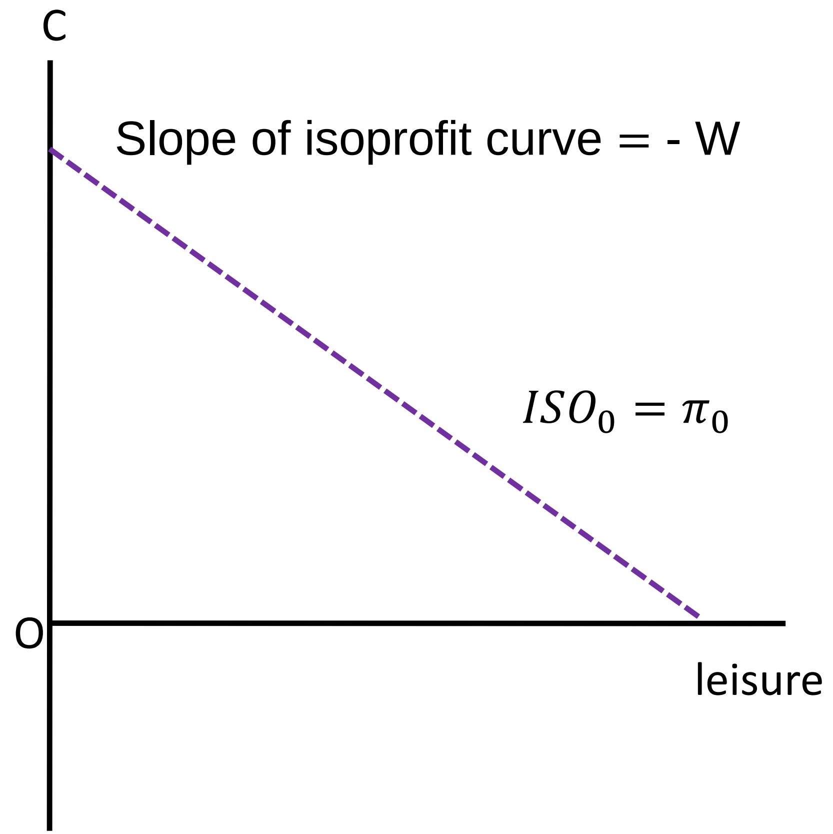
$\pi = C + WL - Wh + G$

For $\pi = \pi_0$,

$C = -WL + Wh - G + \pi_0$

Slope of Isoprofit curve

$= \frac{dC}{dL} =$ - W



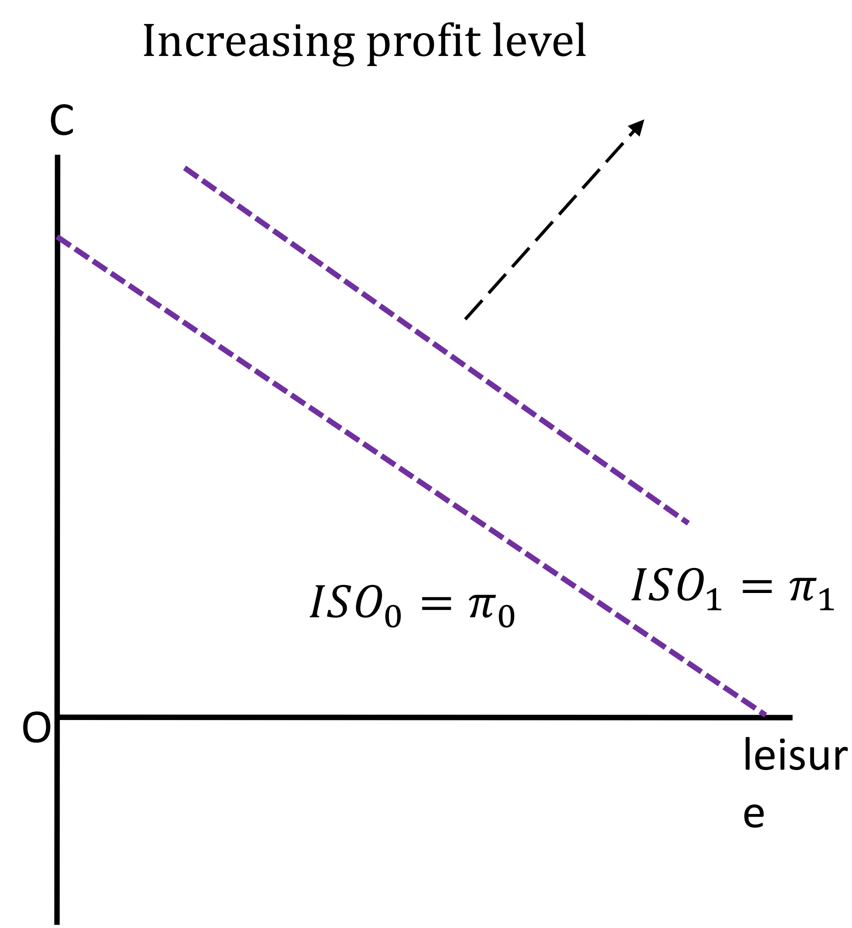
Isoprofit curve is **steeper** when real wage increases.

Isoprofit curve

With higher level of profit,
the ISOprofit curve shifts out

For $\pi = \pi_0$,
$C = -WL + Wh - G + \pi_0$

For $\pi = \pi_1 > \pi_0$,
$C = -WL + Wh - G + \pi_1$



ISO profit curve is increasing in both C and L.

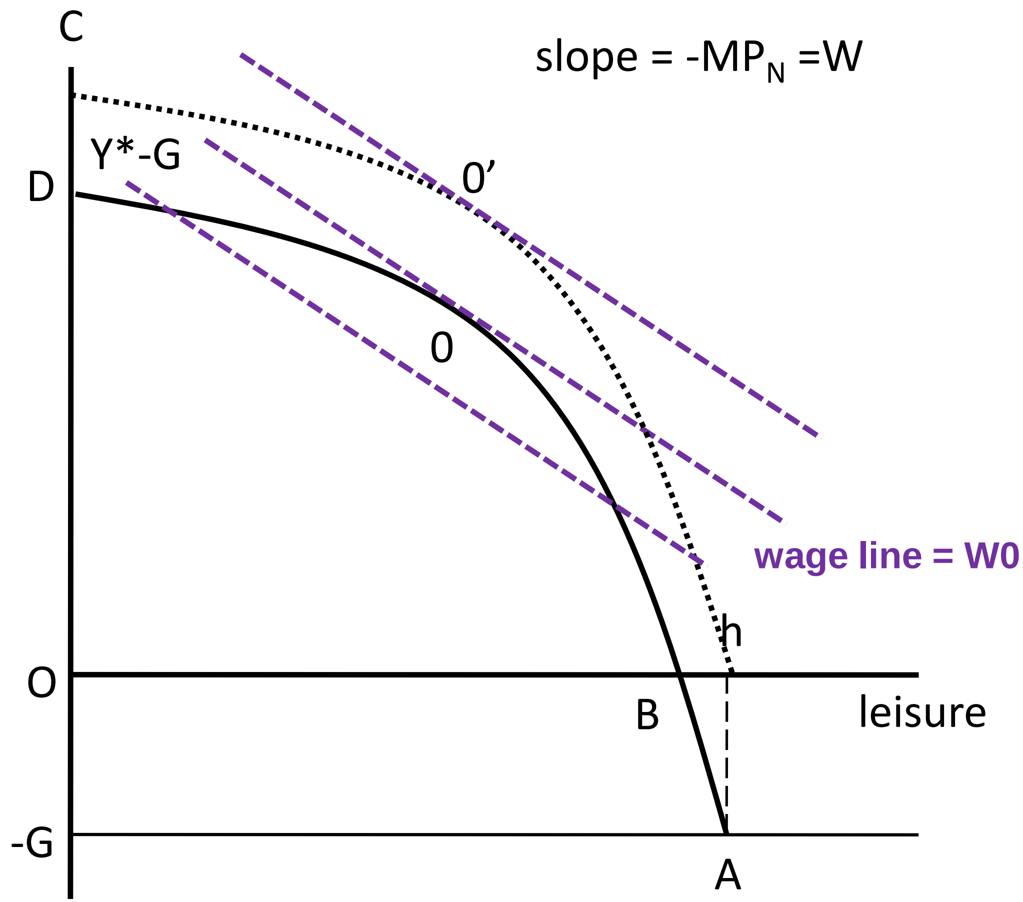
Isoprofit curve and Wage line

- 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).

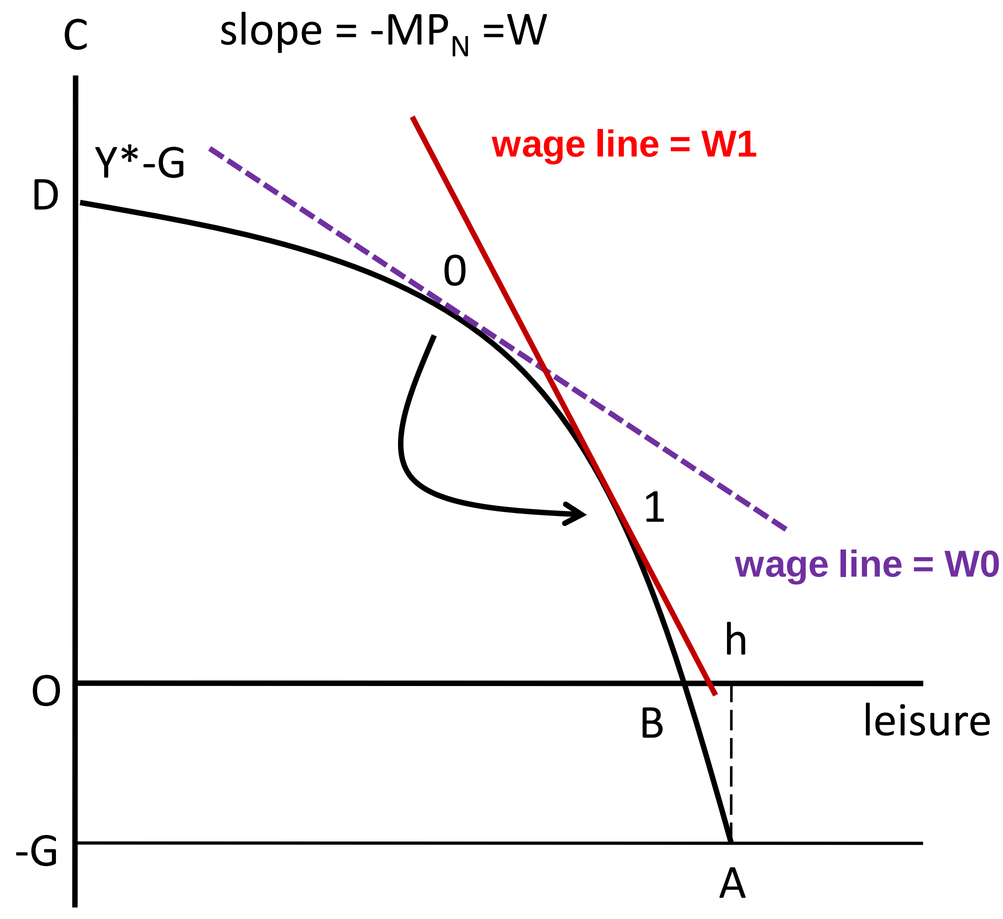
The producer's max. profit

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



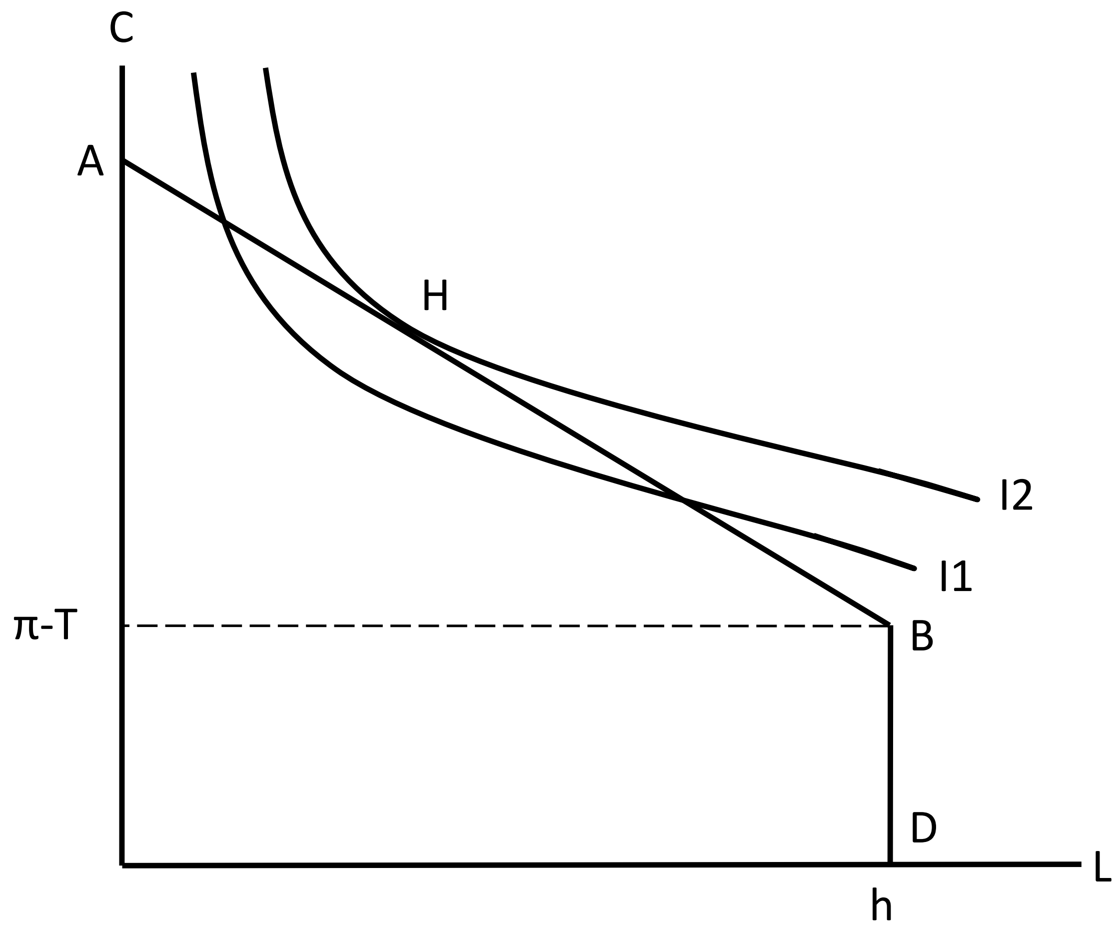
The producer's max. profit

- 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 = 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 max. utility

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



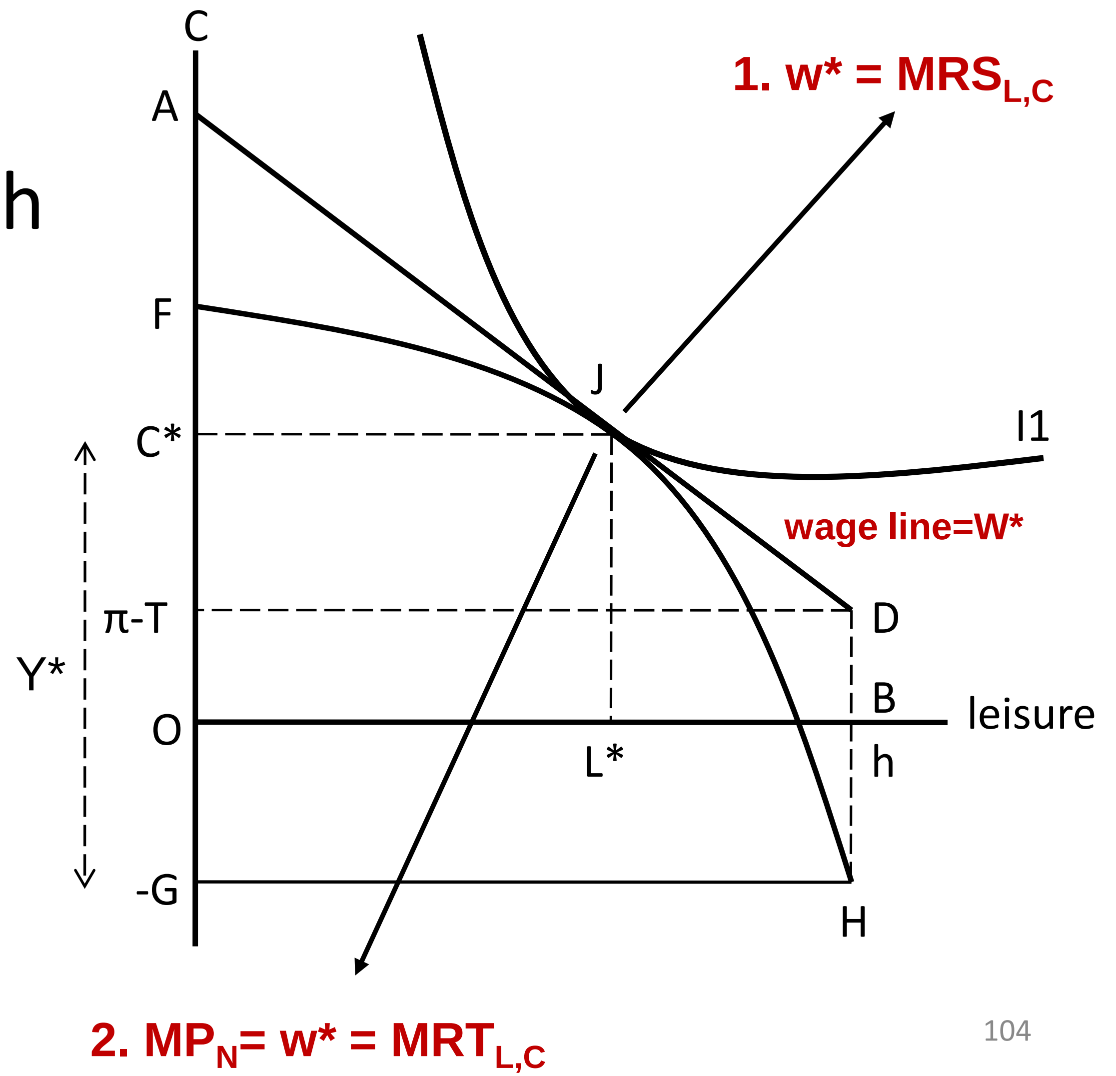
PPF and the consumer: combing the two problems in one figure!

- 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?**

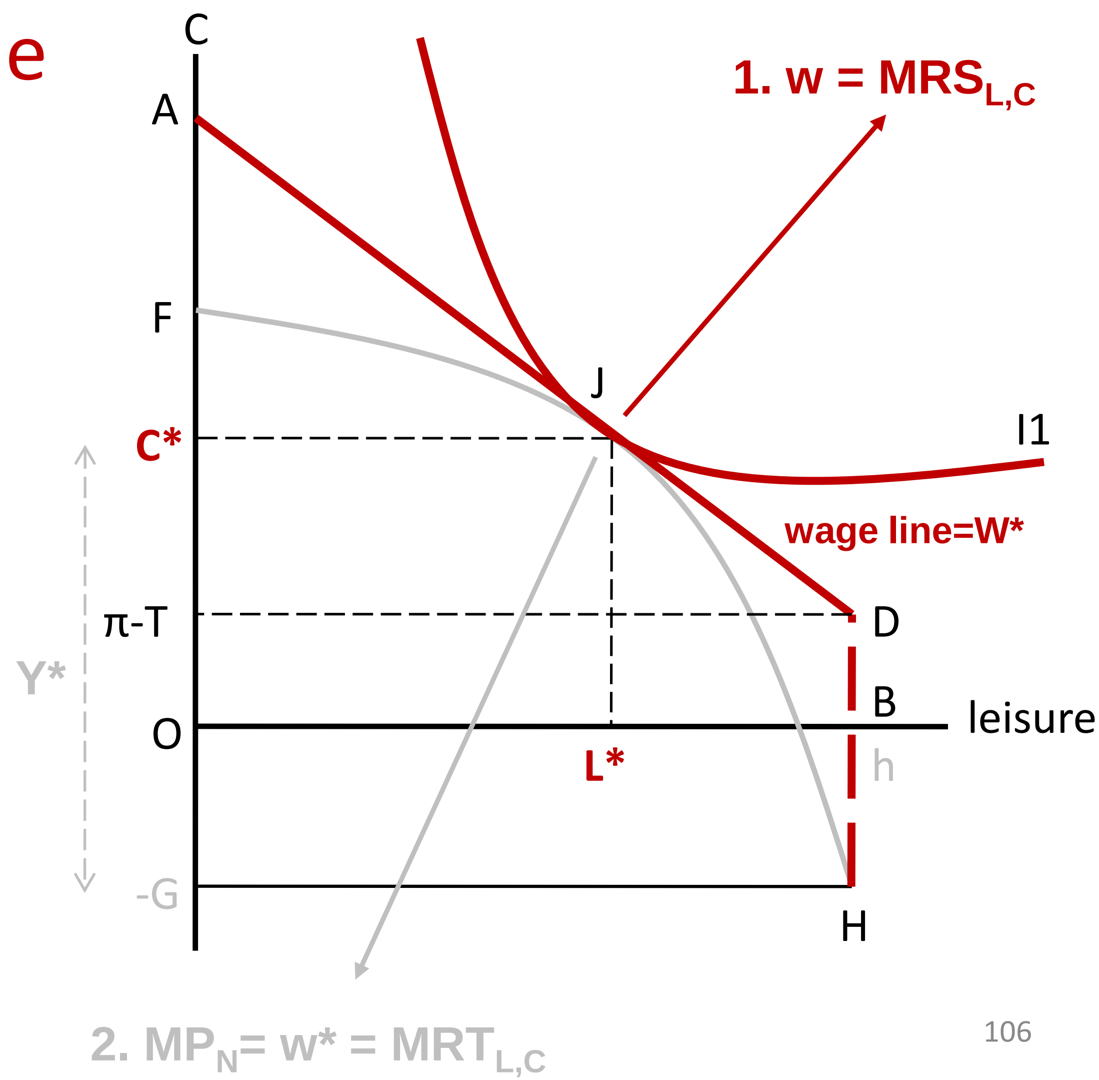


To understand why, recall the definition and properties of competitive equilibrium

- 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.



The consumer's optimization

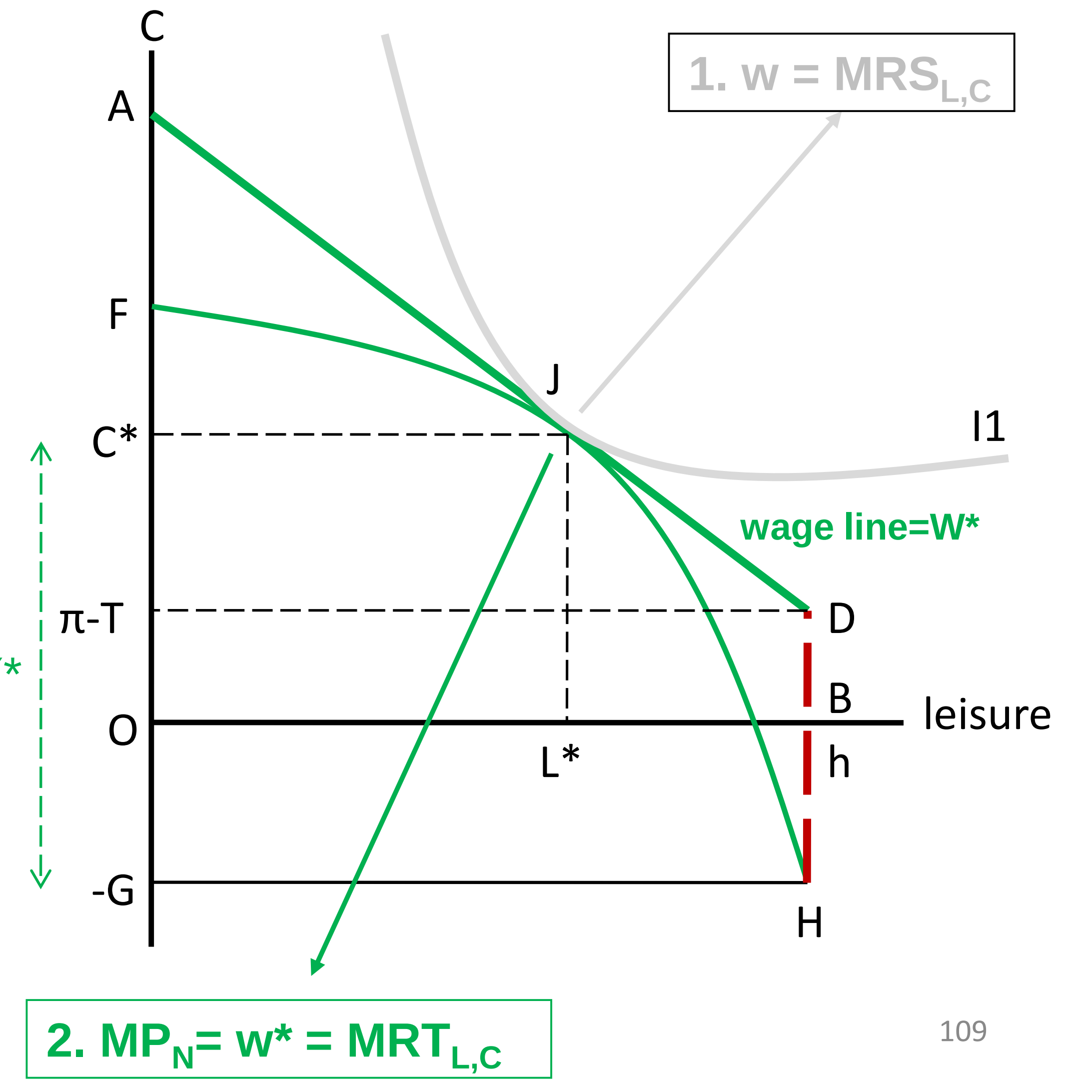
- **The consumer maximizes utility at J** subject to the budget constraint:
  - ADB is the budget constraint; the slope = $-w^*$.
  - DB = the consumer's dividend income minus taxes = π^*- T = π^*- G = the firm's max. profit minus G.
  - OC* = consumption goods obtained by the consumer = quantity of 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

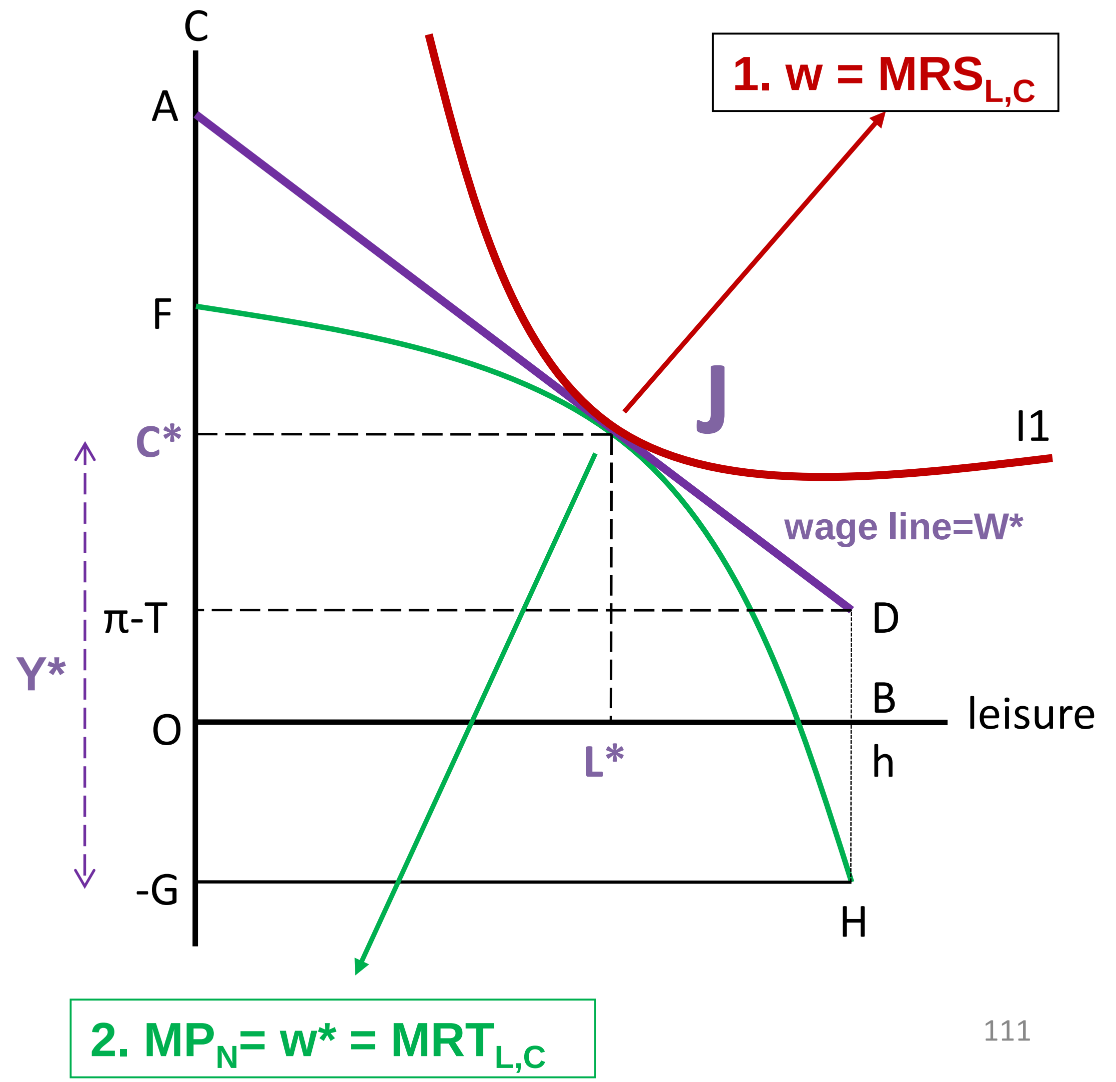


The firm's optimization

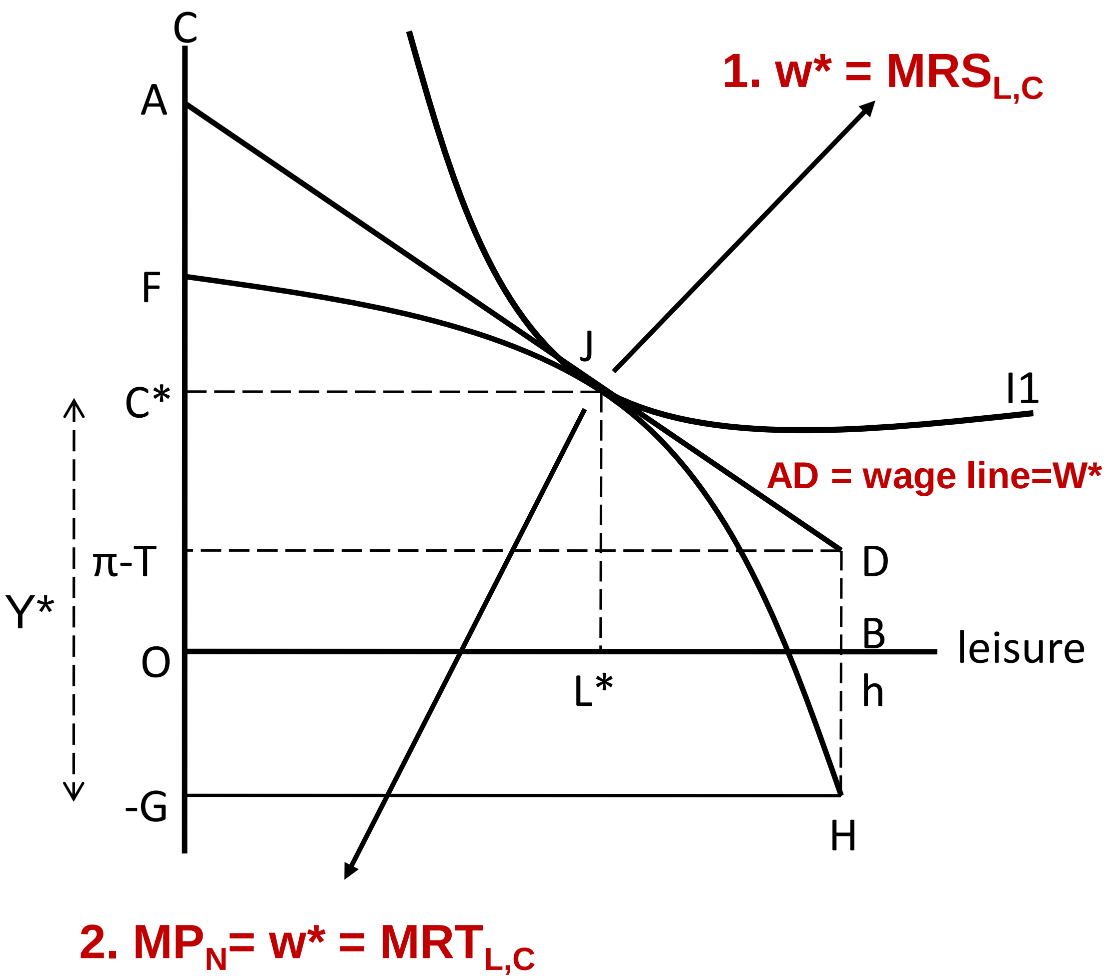
- **The firm maximizes profits at J,** given technology:
  - **MP_N= w* = $MRT_{L,C}$ = slope of the budget line AD**.
  - The firm pays the real wage = w* = the real wage received by the consumer.
  - The firm demands labor equal to h-L* and produces Y*= zF(K, h-L*).
  - Max. profit: π* = zF(K, h-L*)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

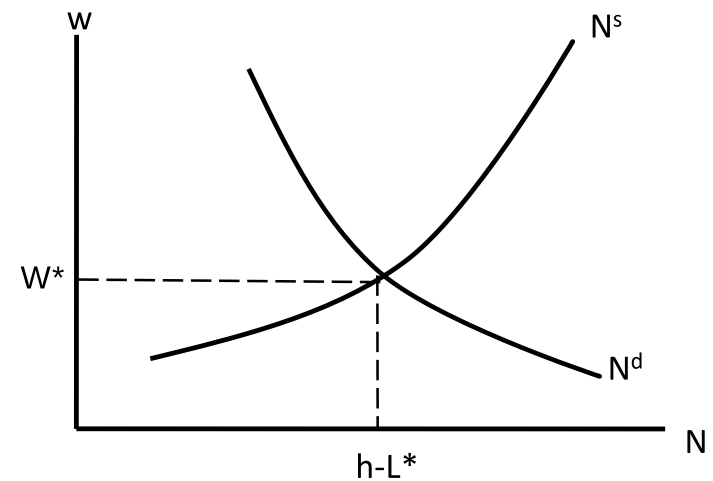
3. Demand = Supply in both markets!

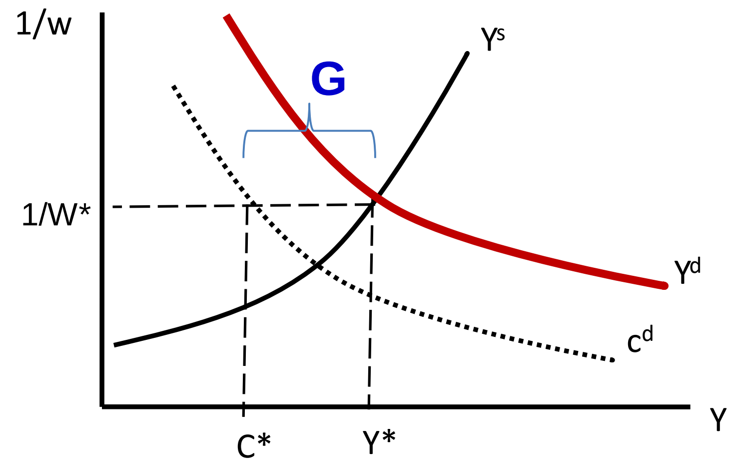
- At point-J, firm maximizes profit.
- At point-J, household maximizes utility.
- At point-J, we know that total output is equal to total private consumption demand plus government spending; goods market is cleared.
- At point-J, labor demand is equal to labor supply.
- Point-J is the general equilibrium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



Competitive equilibrium: Linking the two alternative representations







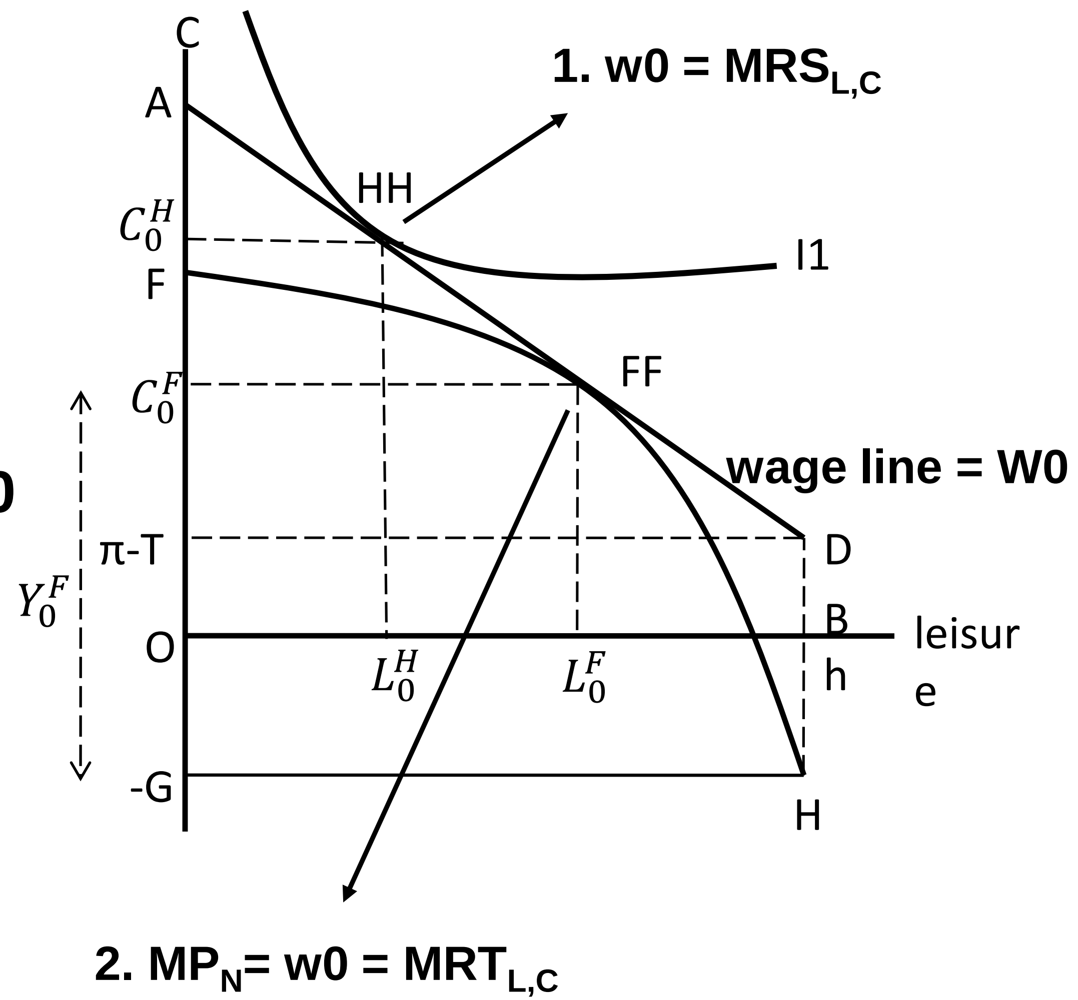
Equilibrium in production and consumption

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

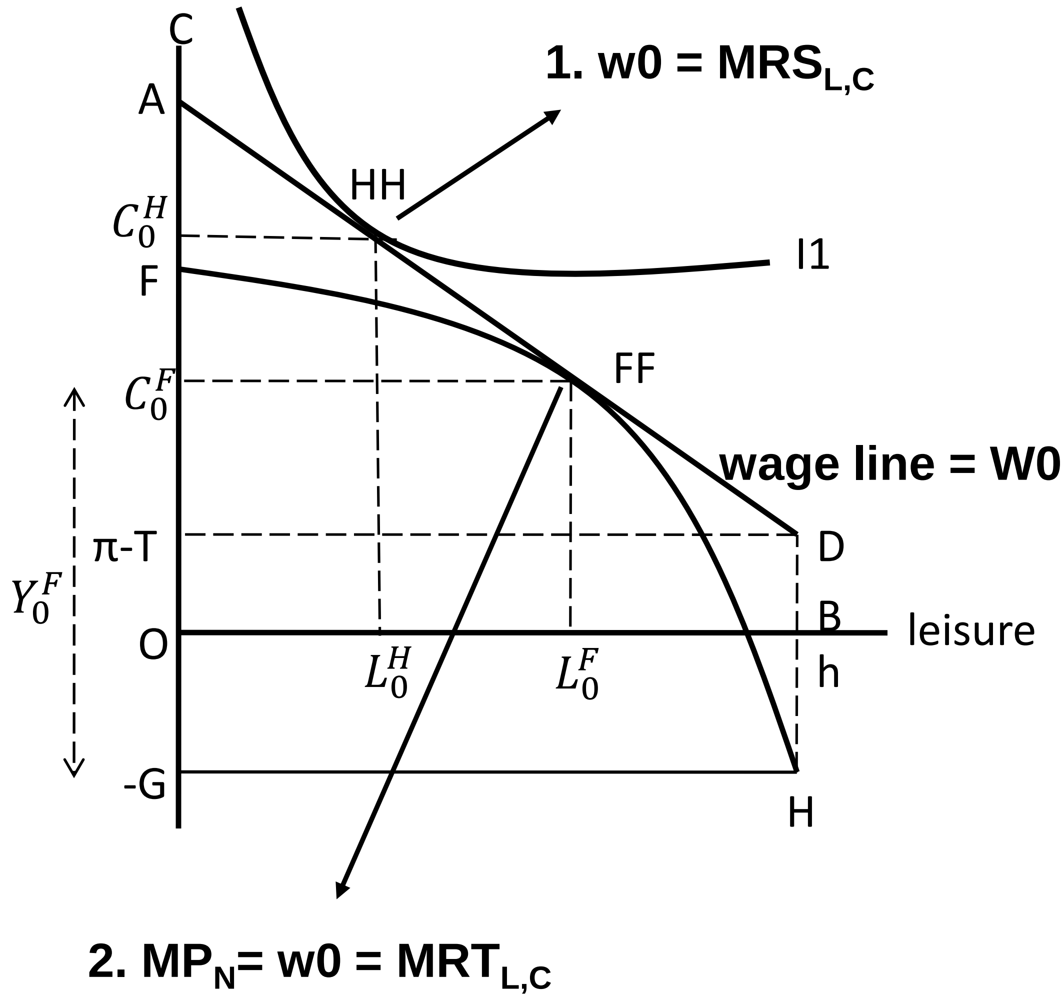
- A competitive equilibrium is achieved when both the consumer and the firm optimize, given z, G and K.
- **Interpretably, the real wage** (w*) is the price signal for both parties to ***adjust*** and achieve a simultaneous equilibrium.

The representation of disequilibrium

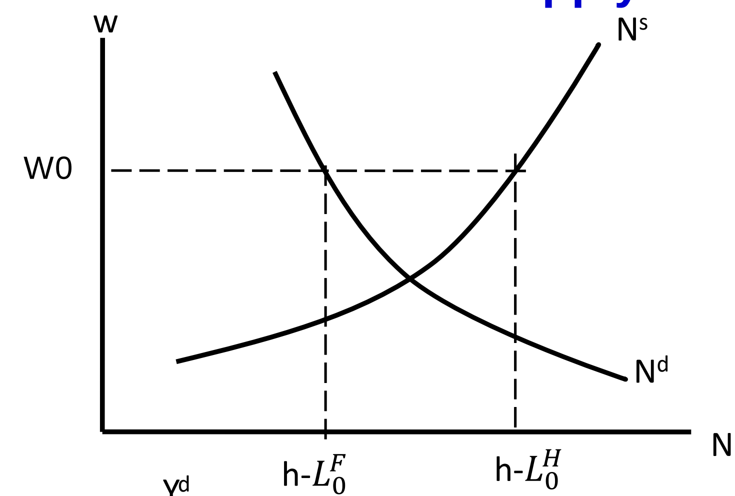
- Given W0, consumer maximizes utility at point-HH; **w0 = MRS$_{L,C}$**
- Given W0, firm maximizes profit at point-FF; **MP$_N$= w0 = MRT$_{L,C}$**
- BUT, W0 is not the market-clearing wage; we are not under the general equilibrium!

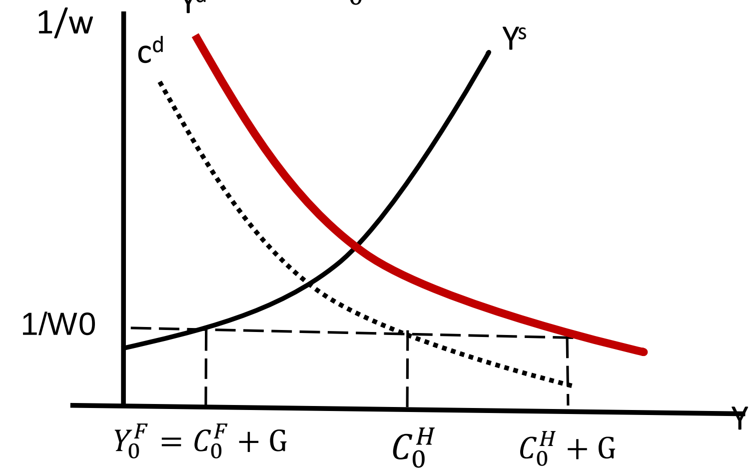


The representation of disequilibrium: excess conditions



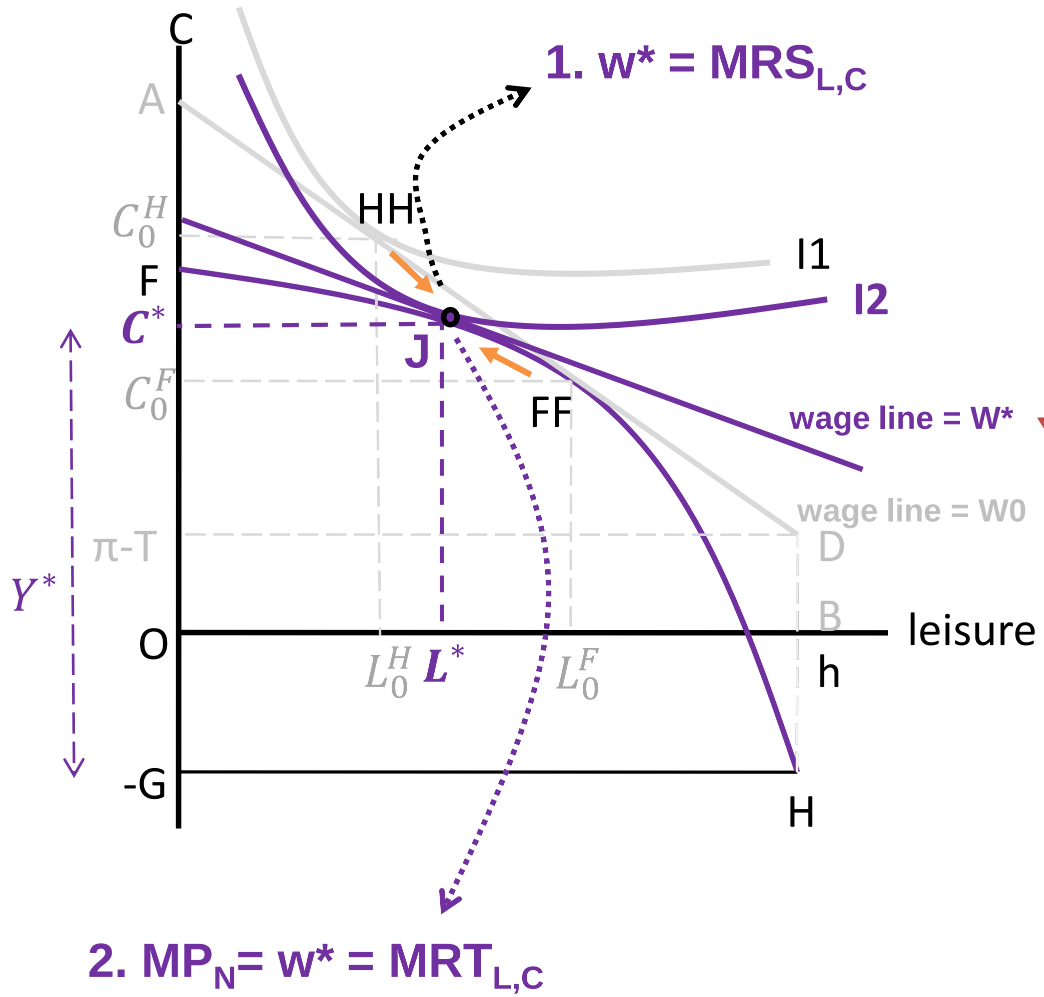
Excess labor supply

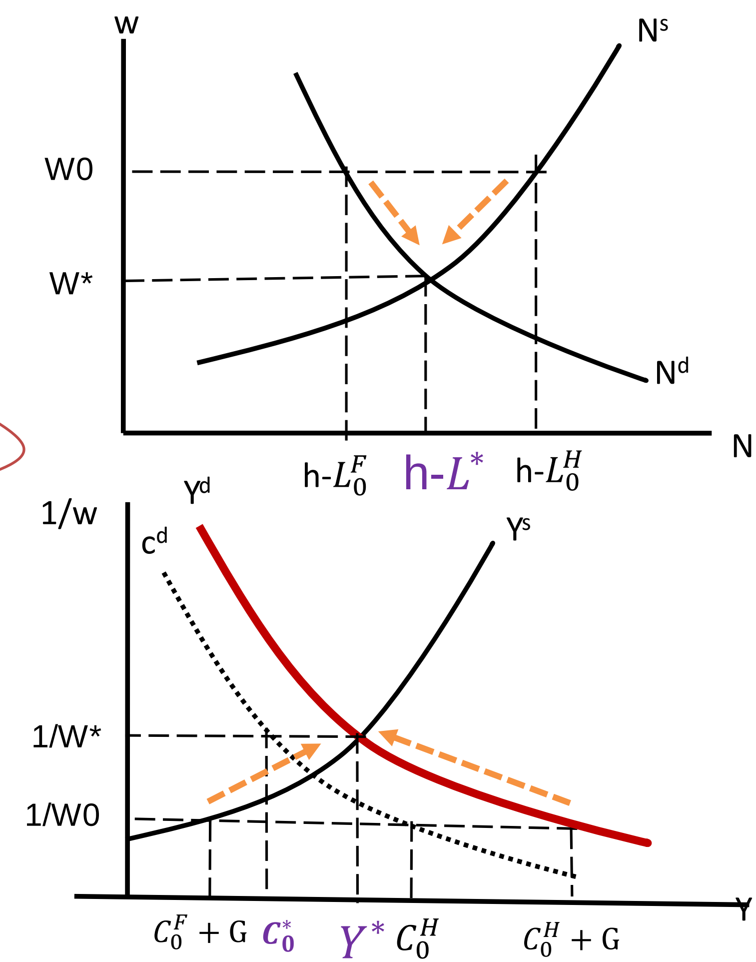




Excess demand for goods

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





Closed-economy one-period model

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

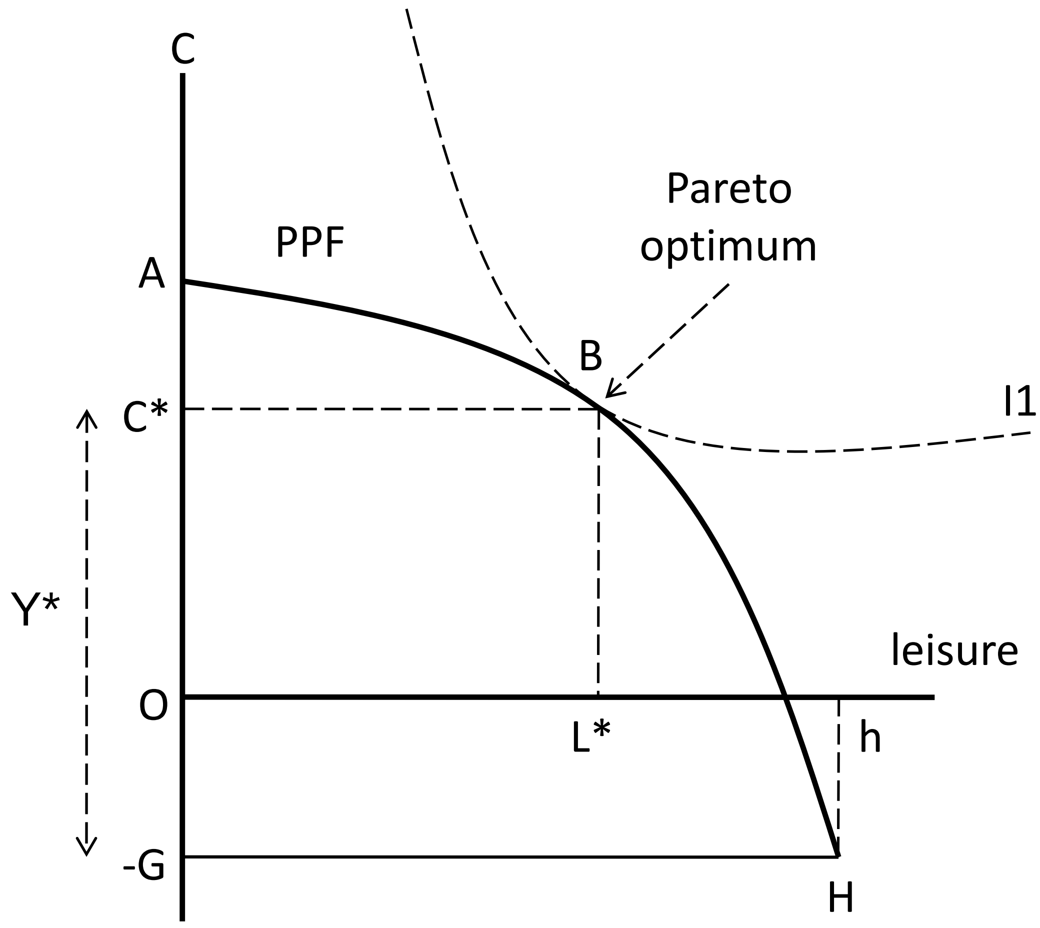
Pareto optimality

- 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.

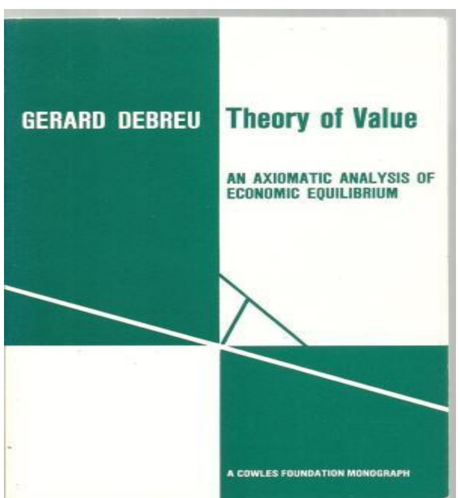
$$MRS_{l,C} = w = MRT_{l,C} = MP_N$$

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:
  - $W(1\text{-}t) = MRS_{l,C} < W = MP_N = MRT_{l,C}$

- **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.***

Closed-economy one-period model

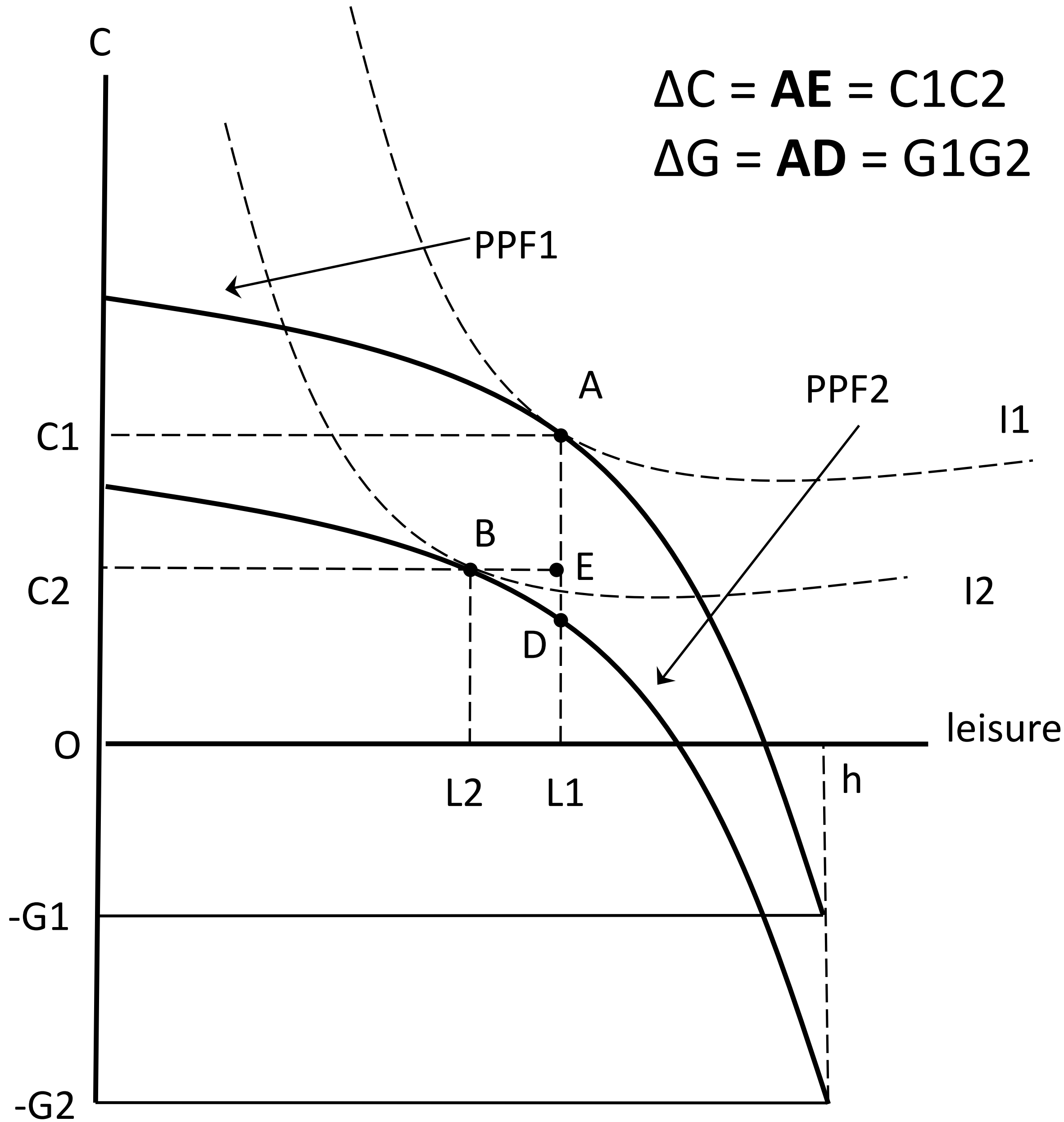
- ~~Structure of the model~~
  - ~~Representative consumer~~
  - ~~Representative firm~~
  - ~~Government~~
- ~~Competitive equilibrium~~
- ~~Economic efficiency and Pareto optimality~~
- Applications of the one-period model

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

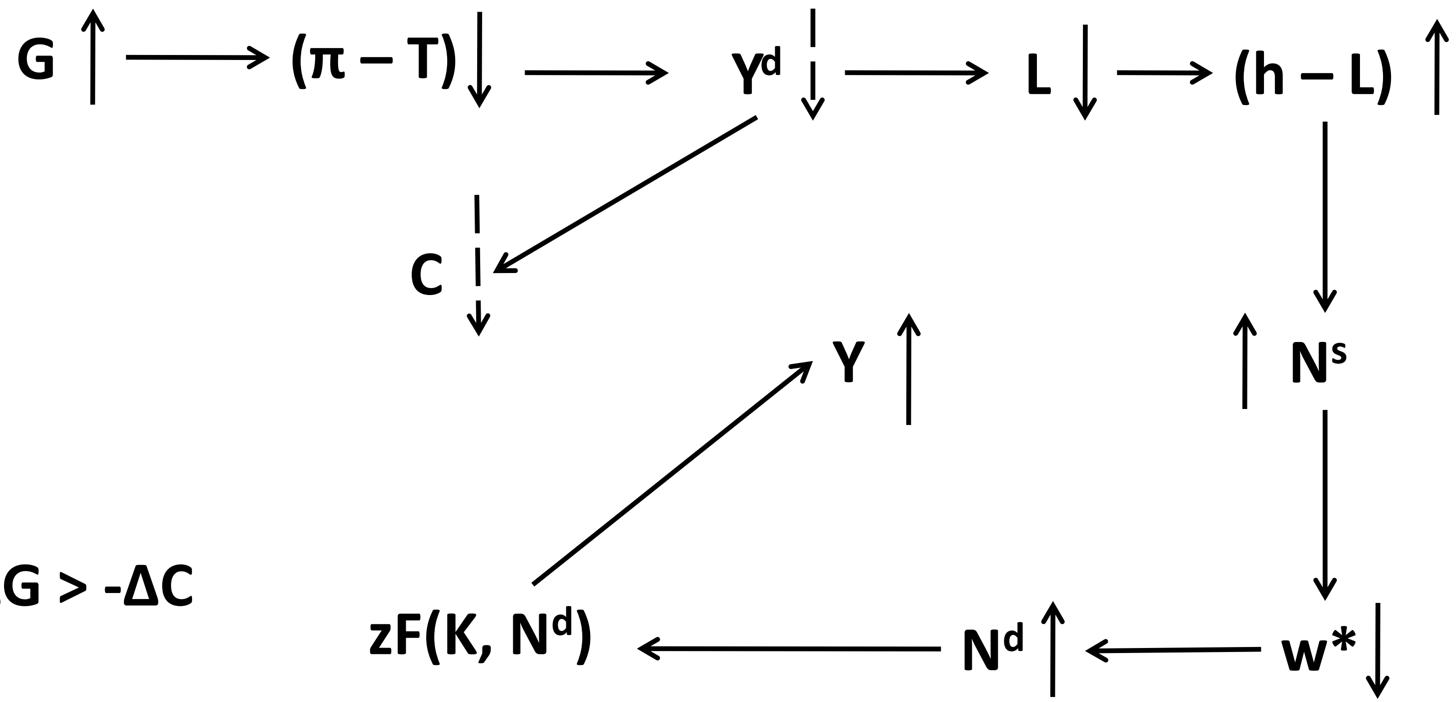
- A pure neg. income effect (as G=T increases).
- Dividend income (π-T) and disposable income fall.
- Both C and L decrease (normal goods).
- Employment (N = h-L) increases.
  - Output Y = zF(K,N) rises.
- But what happens to *private* consumption?


C
ΔC = **AE** = C1C2
ΔG = **AD** = G1G2
PPF1
A
PPF2
I1
C1
B
E
C2
I2
D
O
leisure
L2
L1
h
-G1
-G2

- ΔG = 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.

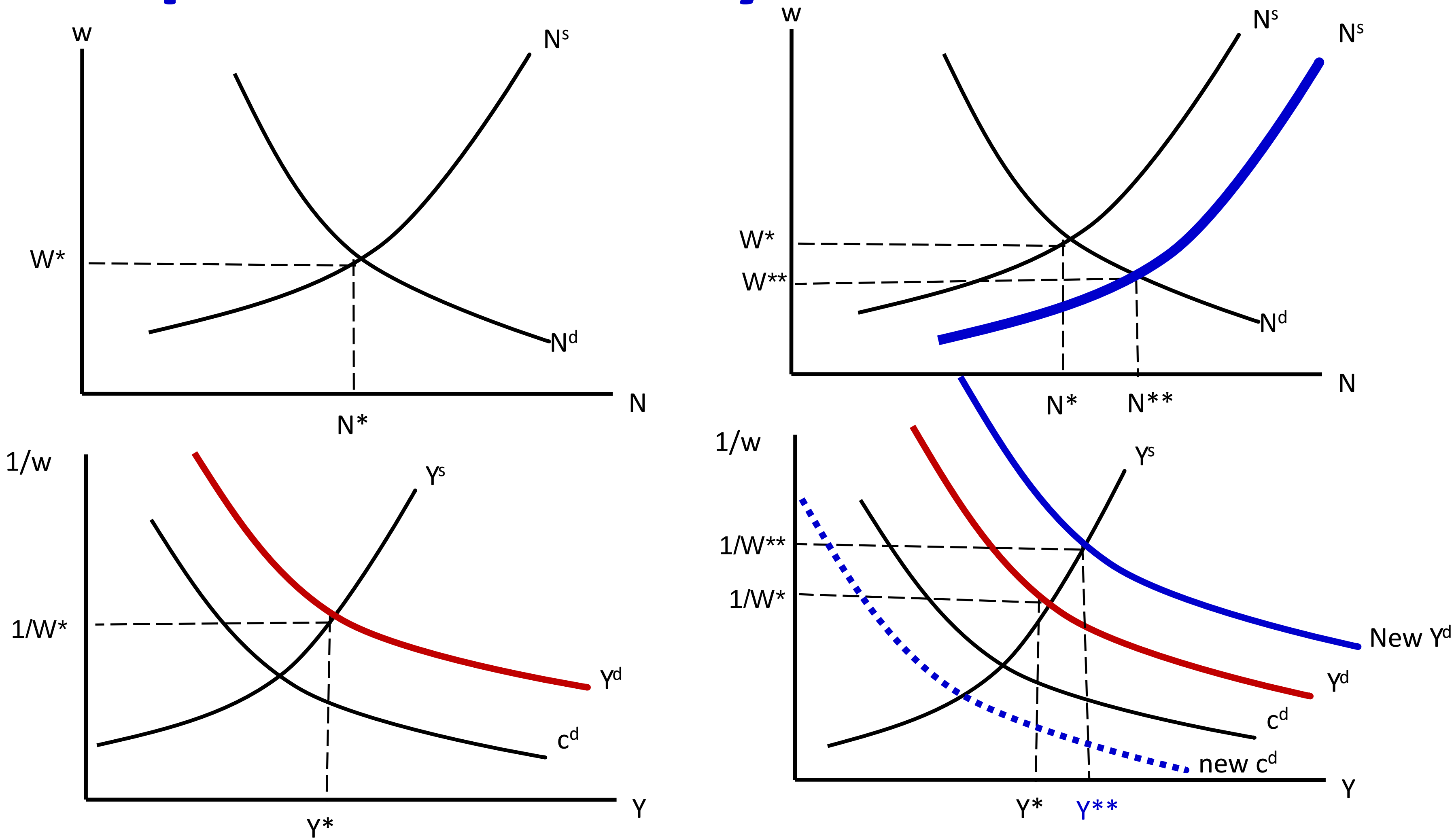
- What happens to **the real wage**?
  - The slope of PPF2 at B is less steep than PPF1 at A.
  - So **the real wage fall.**
  - The consumer supplies more labor (N=h-L increases).
  - Given K, more labor input causes MP_N to fall.
  - The firm optimizes by paying lower $w = MP_N$.
  - The lower real 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



$\Delta G > -\Delta C$

Equilibrium analysis: Effect of G



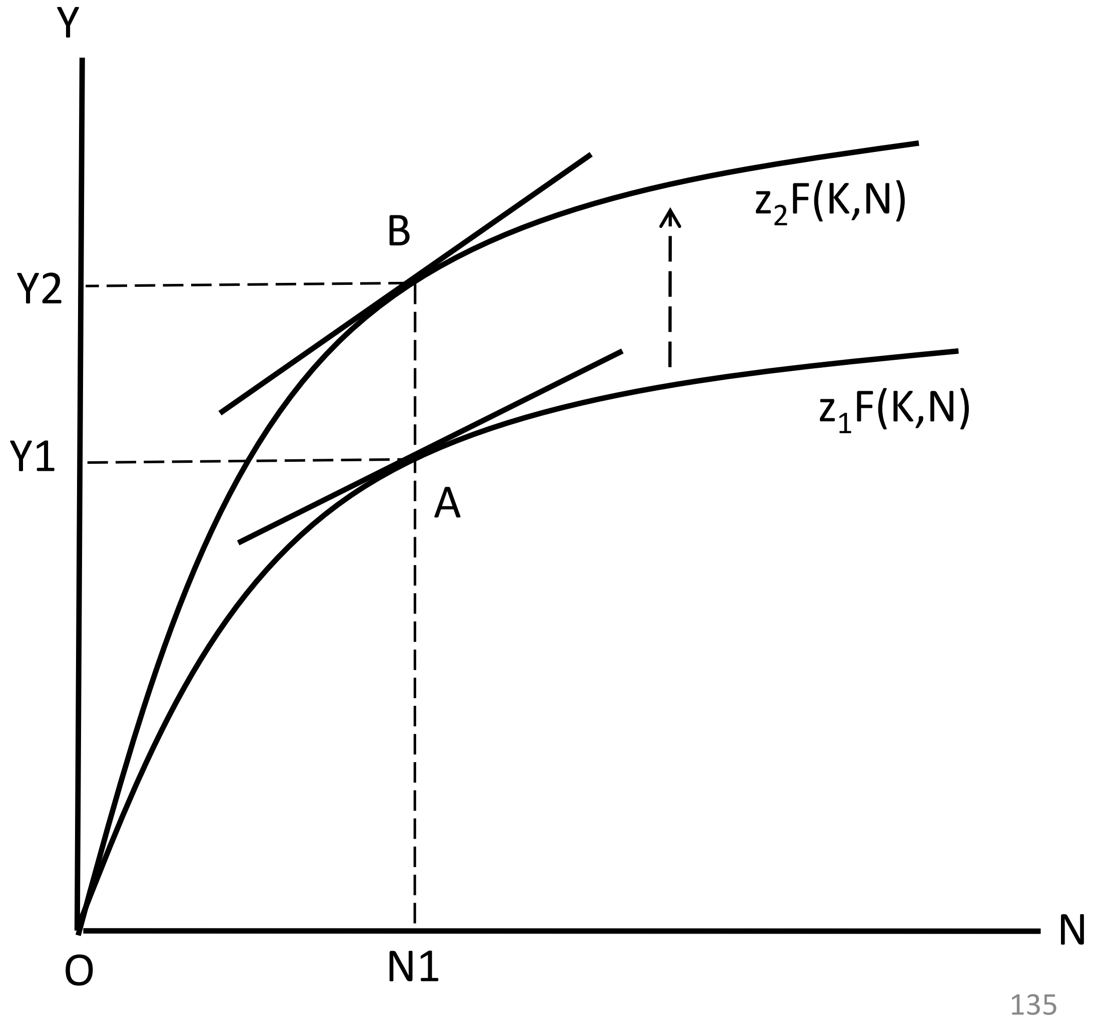
An increase in G is financed by the lump-sum tax. As net disposable income decreases, optimizing-based household will lower consumption and leisure. Graphically, labor supply will shift to the blue one while consumption demand will drop to the dotted blue.

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.

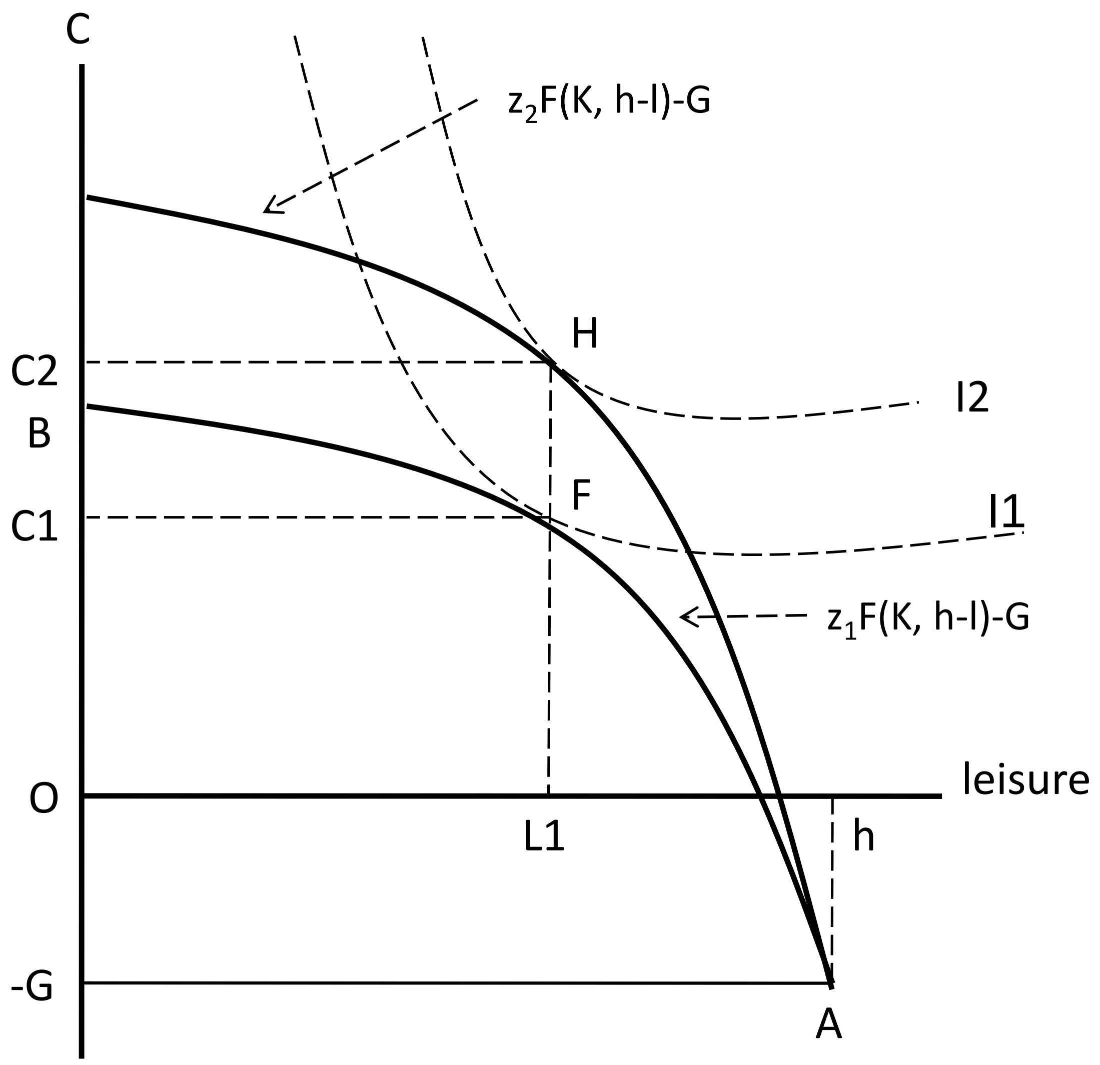
Effect of z on Production function

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



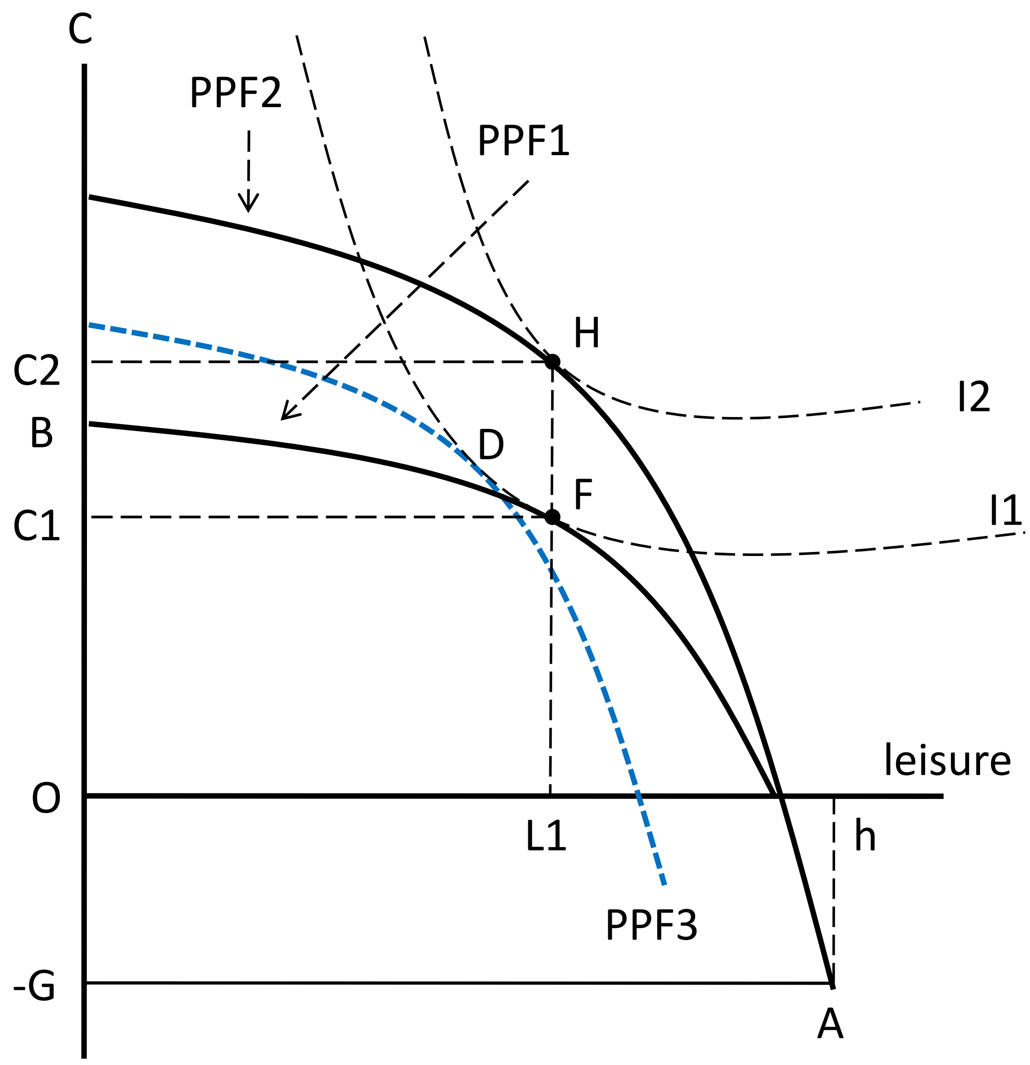
Effects of rising z on PPF

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

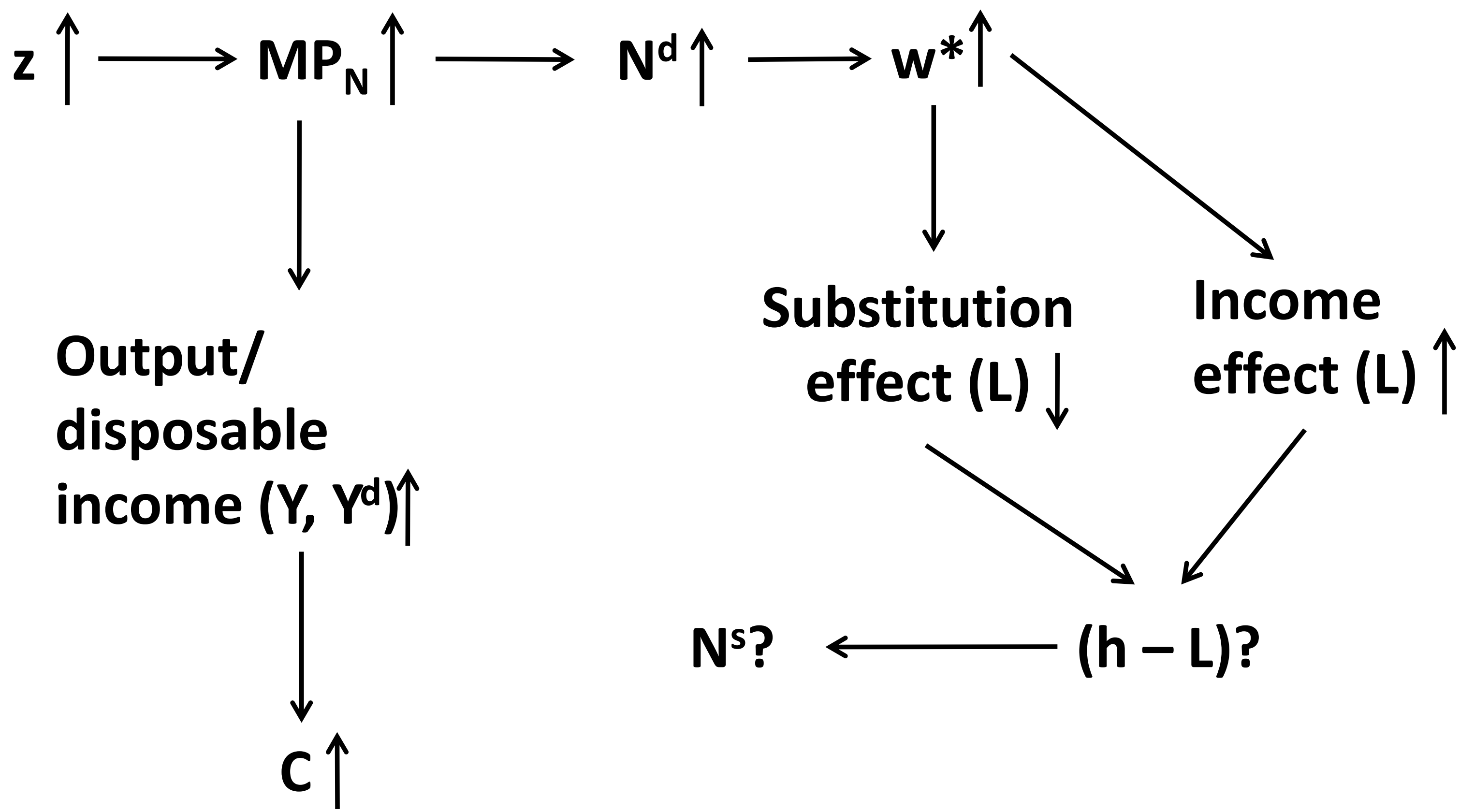


Income and substitution effects

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

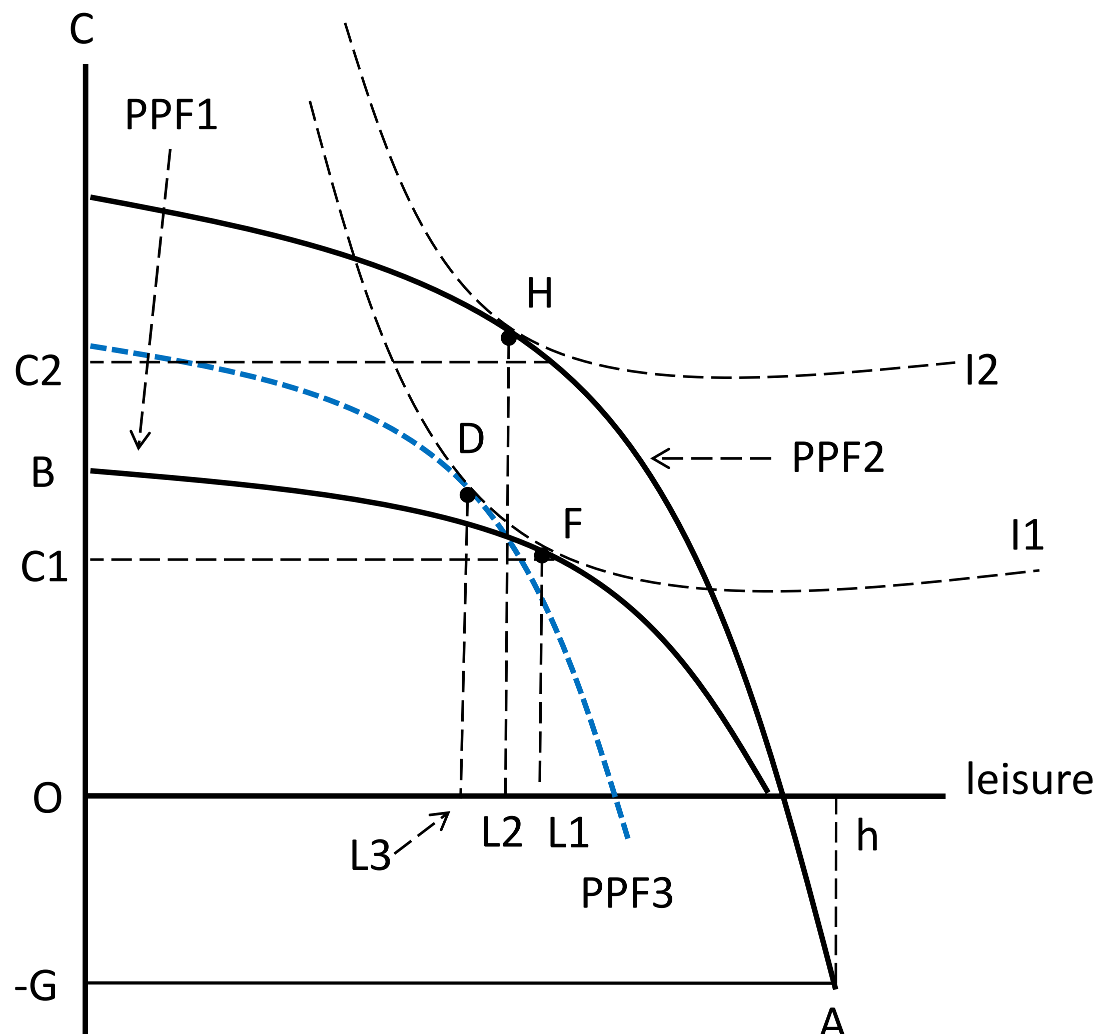


A higher z or K raises w, Y, C

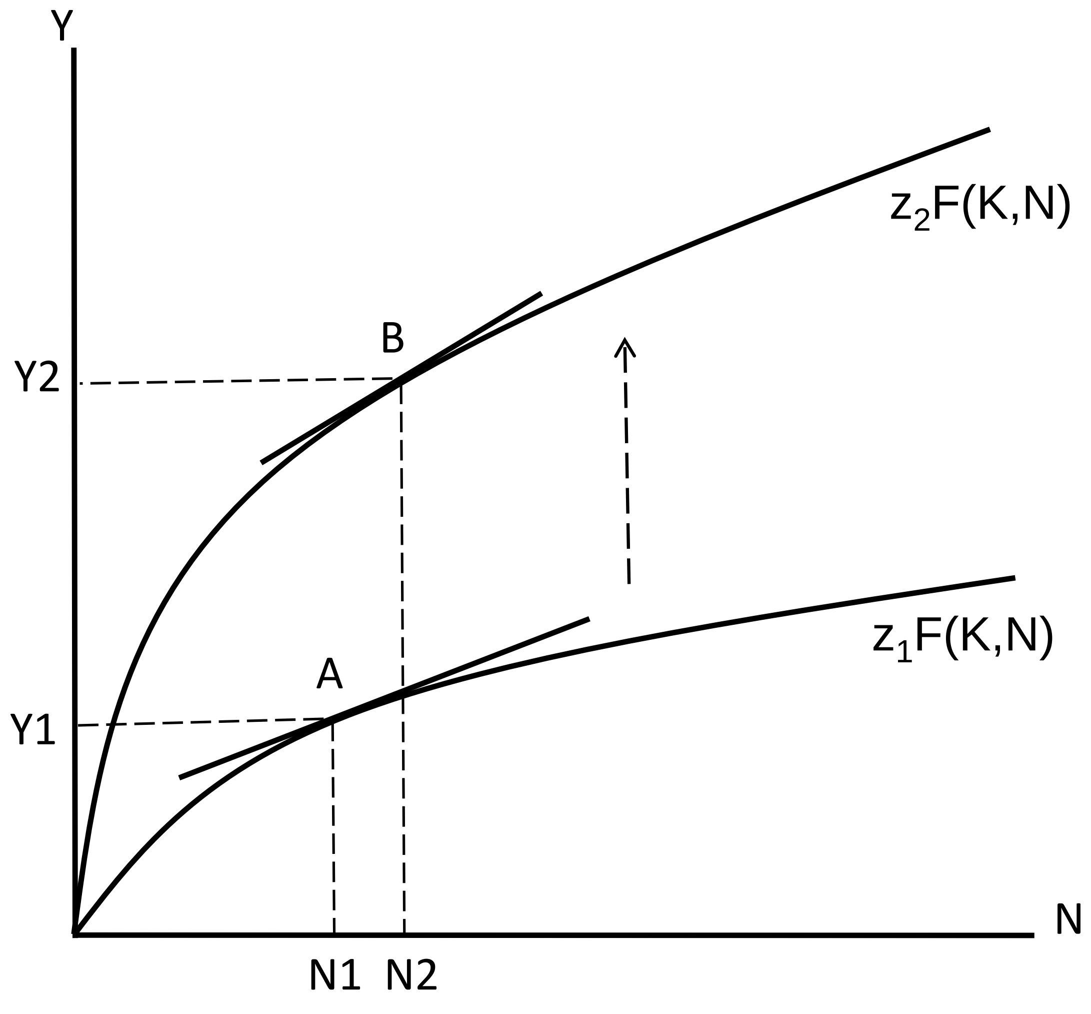


Stronger substitution effect

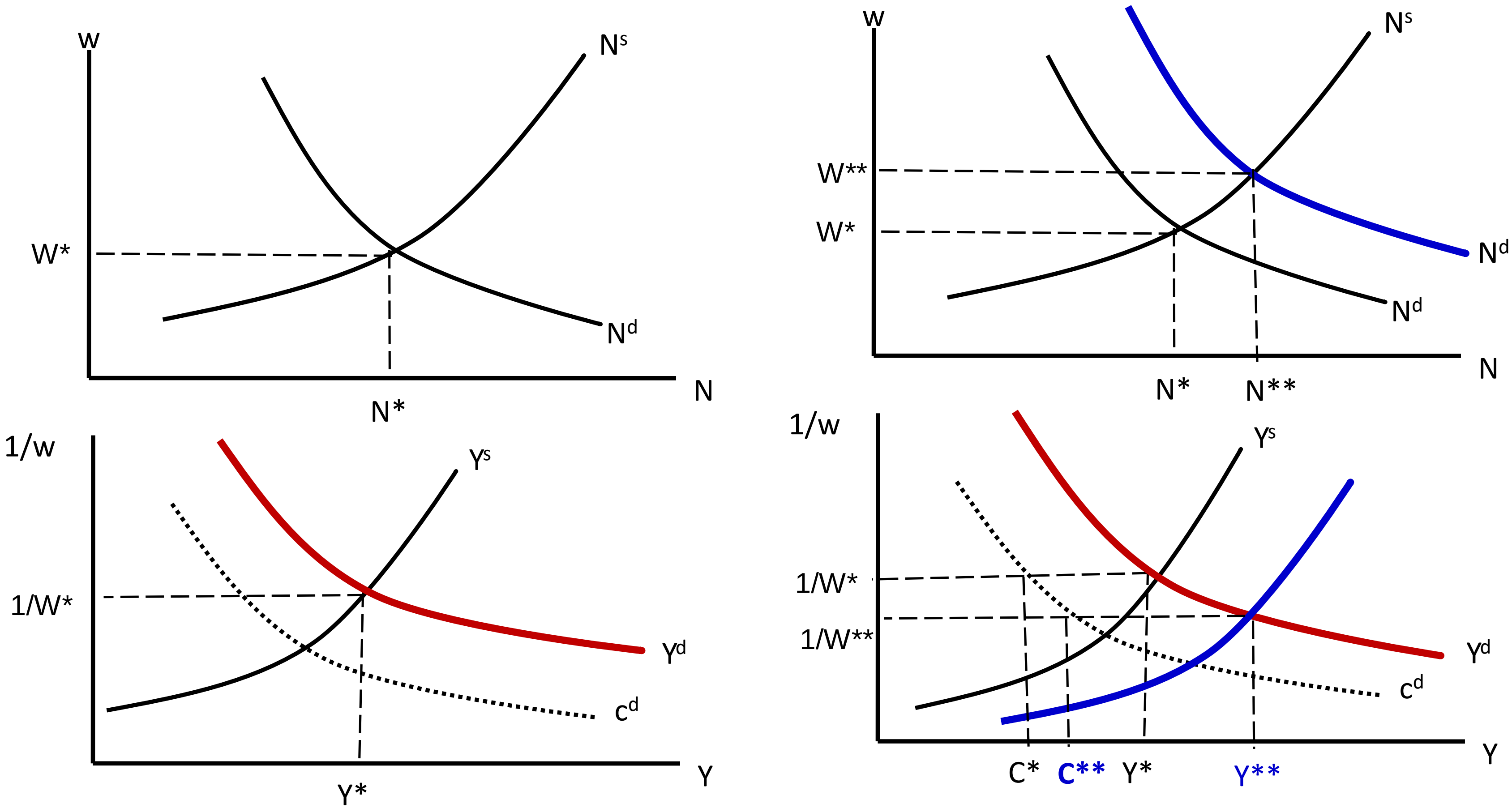
- FD = substitution effect (rising C, falling L).
- DH = income effect (rising C and L).
- Lower L and larger N.



Strong substitution effect on 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.

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

	Cyclicality	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	TFP	Government
Y	+	+
C	+	-
N	+	+
W	+	-
Y/L	+	+/-

The role of TFP shocks

Edward Prescott
Nobel 2004

Finn Kydland
Nobel 2004

- 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**.