

EF3441: Intermediate Macroeconomics

Prepared by Dr. Tam
Lecture 4

The Main Goal of this Lecture

- ▶ Understand government budget constraint
- ▶ Understand the competitive equilibrium concepts by understanding the equilibrium price (wage)
- ▶ Understand the (conceptional) differences between Perato Optimal and the competitive market
- ▶ Analyze and interpret the effects of changes in the exogenous variables, such as fiscal policy

The Government

- ▶ In our model the government is benevolent: **maximizes welfare of its citizen**
- ▶ Question: why do we need a government?
 - ▶ It provides public goods:
 - ▶ Schools, Police, Fire, Military
 - ▶ Infrastructures
 - ▶ It corrects market failures:
 - ▶ Regulations: financial markets, pollution

The Government: Budget Constraint

- ▶ Let G be the dollar value of the public goods. In a static world, the budget constraint is:

$$G = T$$

- ▶ When we will look at *dynamics* (more than one-period model) we will have

$$G = T + \Delta debt$$

The Government: Budget Constraint

- ▶ Static government budget constraint is:

$$G = T$$

- ▶ Taxes T also appear in the household budget constraint:

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

- ▶ In the data, from where does the government draw revenue?

The Government: Budget Constraint, Con't

The impact of government policy on households and firms:

- ▶ τ_y : income tax (appears in Households budget constraint)

$$C = (1 - \tau_y)wN + \pi - T$$

- ▶ τ_c : consumption tax (appears in Households budget constraint)

$$(1 + \tau_c)C = wN + \pi - T$$

- ▶ τ_r : tax on revenue (appears in firm profits)

$$\pi = (1 - \tau_r)zF(K, N^d) - wN^d$$

Equilibrium

Why do we need an equilibrium concept?

- ▶ Suppose government consumption (G) increases by 10%. What happens to c and ℓ ?
- ▶ Suppose the government subsidizes employment. What happens to wages and GDP?

Remember:

- ▶ Our consumer is a representative consumer: it represents ALL of the consumers in Hong Kong
- ▶ Our firm is a representative firm: it represents ALL of the firms in Hong Kong

Equilibrium, Con't

Exogenous variables vs. *endogenous* variables.

For example, y is a function of x . We can write the following

$$y = f(x)$$

- ▶ Exogenous variable: x .
- ▶ Endogenous variable: y .

Equilibrium, Con't

- ▶ The idea:
 - ▶ Set some external conditions (exogenous variables)
 - ▶ Determine what happens to all of the other variables of interest (endogenous variables)
- ▶ In our static model:
 - ▶ Exogenous variables: (K, G, z)
 - ▶ Endogenous variables: (C, N^s, N^d, T, Y, w)

Equilibrium, Con't

How do we know what is going to happen?

- ▶ Must be *optimal*:
 - ▶ everybody (household and firm) must like the decision it has taken.
- ▶ Must be *feasible*:
 - ▶ cannot have more consumption than goods produced.

Competitive Equilibrium: Static

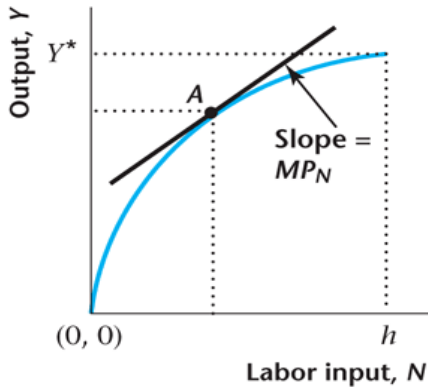
For a set of exogenous variables (K, G, z) A *competitive equilibrium* is a set of endogenous variables (C, N^s, N^d, T, Y, w) , so that:

- ▶ The consumer chooses C (consumption) and N^s (labor supply) optimally, taking as given w (wage), T (taxes), π (dividends)
- ▶ The firm chooses N^d (labor demand) to maximize profits, taking as given w (wage), K (capital stock), z (productivity)
- ▶ The markets must be cleared
 - ▶ Labor market: $N^d = N^s$
 - ▶ Goods market: $Y = C + G$

Arrow-Debreu-Mckenie (ADM) Model.

Suggestion: read Chapter 1 in [Big Ideas in Macroeconomics: A Nontechnical View](#) by Kartik Athreya.

Working With the Model



Production Function

(a)

Working With the Model, Con't

Derive a relation (production possibility frontier - PPF) so that given (K, G, z) we can determine all the feasible (C, ℓ) pairs

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

Since market clear $N^d = N^s$:

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

Substitute feasibility of hours of household: $N^s = h - \ell$

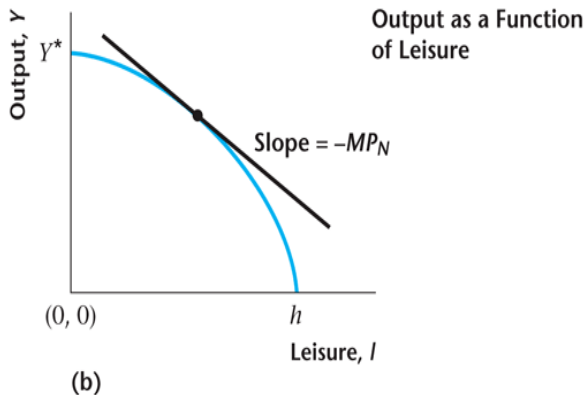
$$Y = zF(K, h - \ell)$$

Substitute the goods market clearing: $Y = C + G$

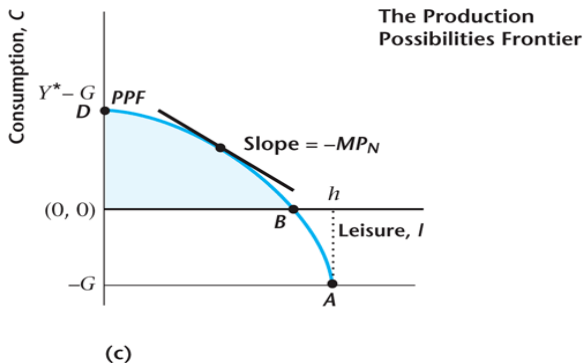
$$C = zF(K, h - \ell) - G$$

The Production Possibilities Frontier

- ▶ Some properties of the PPF: $C(\ell) = zF(K, h - \ell) - G$
 - ▶ Equilibrium consumption decreasing in leisure
 - ▶ Decreasing returns - PPF is concave



The Production Possibilities Frontier, Con't

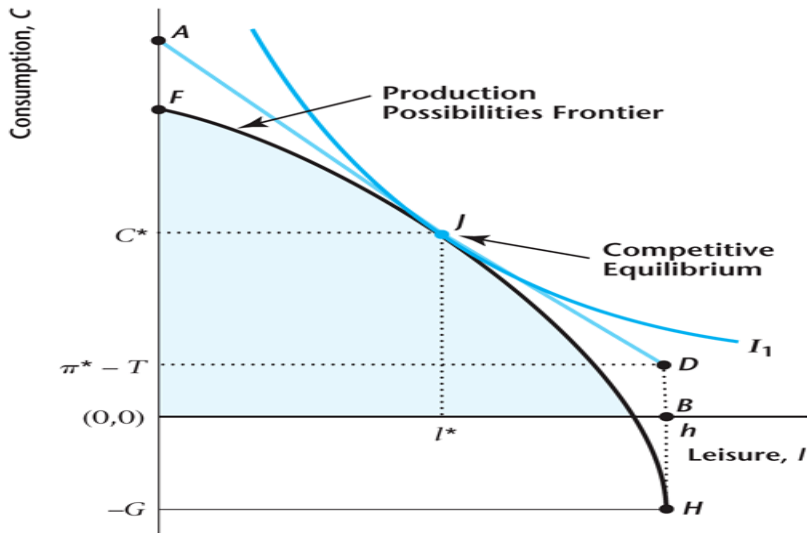


- ▶ The negative slope of the PPF is the marginal rate of transformation
- ▶ this implies: Marginal rate of transformation, $MRT_{\ell.c} =$ marginal product of labor, MP_N , so for any (C, ℓ) on the PPF we can find the wage

Moving Towards the Competitive Equilibrium

- ▶ To the production possibilities frontier, we need to add the following:
 - ▶ Add the household's budget constraint $C = w(h - \ell) + \pi - T$
 - ▶ Find the slope: done
 - ▶ Find the intercept
 - ▶ Add indifference curves.

The Competitive Equilibrium (CE)



Competitive Equilibrium: Static

For a set of exogenous variables (K, G, z) A *competitive equilibrium* is a set of endogenous variables (C, N^s, N^d, T, Y, w) , so that:

- ▶ The consumer chooses C (consumption) and N^s optimally, taking as given w (wage), T (taxes), π

$$\max_{C, N^s} U(C, h - N^s)$$

$$s.t. \quad C = wN^s + \pi - T$$

- ▶ The firm chooses N^d (labor demand) to maximize profits, taking as given w (wage), K (capital stock), z (productivity)

$$\max_{N^d} zF(K, N^d) - wN^d$$

- ▶ The markets must be cleared
 - ▶ Goods market: $Y = C + G$

The Competitive Equilibrium

Algorithm to find a Competitive Equilibrium (graphically):

- ▶ Find the values of capital (K), government expenditures (G) and productivity (z): these are the exogenous variables.
- ▶ Given exogenous variables determine PPF,
- ▶ Find a point of tangency between PPF and preferences,
- ▶ Recover endogenous variables (C, N^s, N^d, T, Y, w).
- ▶ Use the constructed equilibrium to determine the relationship between exogenous and endogenous variables.

Key Properties of a Competitive Optimum:

$$MRS_{\ell,c} = MRT_{\ell,c} = MP_N$$

The Competitive Equilibrium, Con't

Algorithm to find a competitive equilibrium (numerically):

1. Find the values of capital (K), government expenditures (G) and productivity (z): these are the exogenous variables.
2. Guess a w ,
3. Solve the household's (utility maximization) problem,
4. Solve the firm's (profit maximization) problem,
5. Check the good market clearing condition:
 - ▶ If $Y = C + G$, the guessed w is the equilibrium wage. Stop!
 - ▶ If $Y < C + G$, guess a lower w , redo 2 – 5.
 - ▶ If $Y > C + G$, guess a higher w , redo 2 – 5.

It is challenging to solve for the equilibrium wage!

Pareto Optimum (PO)

Definition

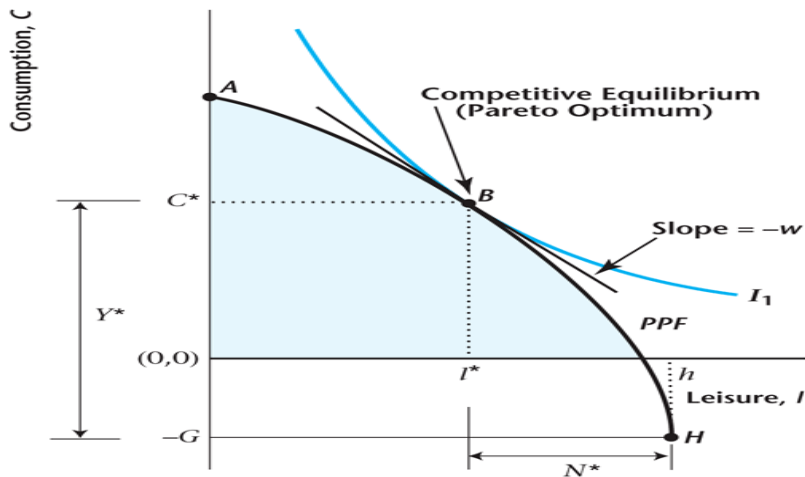
The Pareto optimum is the point that a social planner would choose where the representative consumer is as well off as possible given the technology for producing consumption goods using labor as an input.

Write as an optimization problem:

$$\max_{C, N} U(C, h - N)$$

$$s.t. \quad C = zF(K, N) - T$$

Pareto Optimum, Con't



Key Properties of a Pareto Optimum:

$$MRS_{\ell, c} = MRT_{\ell, c} = MP_N$$

Example

- ▶ The representative household's preference:
$$U(c, h - N^s) = \beta \log(c) + (1 - \beta) \log(h - N^s).$$
- ▶ The representative household's production function:
$$Y = zK^\alpha (N^d)^{1-\alpha}.$$
- ▶ Government: $G = T = 0$.
- ▶ $0 < \alpha, \beta < 1$.
 1. Solve for the PO.
 2. Write down the algorithm for the CE.

First Welfare Theorem

Definition

The first fundamental theorem of welfare economics states that, under certain conditions, a competitive equilibrium is Pareto optimal.

Not too useful because the CE is much harder to solve than the PO

Second Welfare Theorem

Definition

The second fundamental theorem of welfare economics states that, under certain conditions, a Pareto optimum is a competitive equilibrium.

Very useful because the PO is “easy” to solve

- ▶ We solve the PO,
- ▶ Use the PO to calculate MP_N to back out wage w ($MP_N = w$),
- ▶ We get the CE.
- ▶ Now, we can use PO to represent CE.

Sources of Social Inefficiencies

- ▶ Externality and public goods
- ▶ Distorting taxes
- ▶ Imperfect competition
- ▶ Information asymmetry

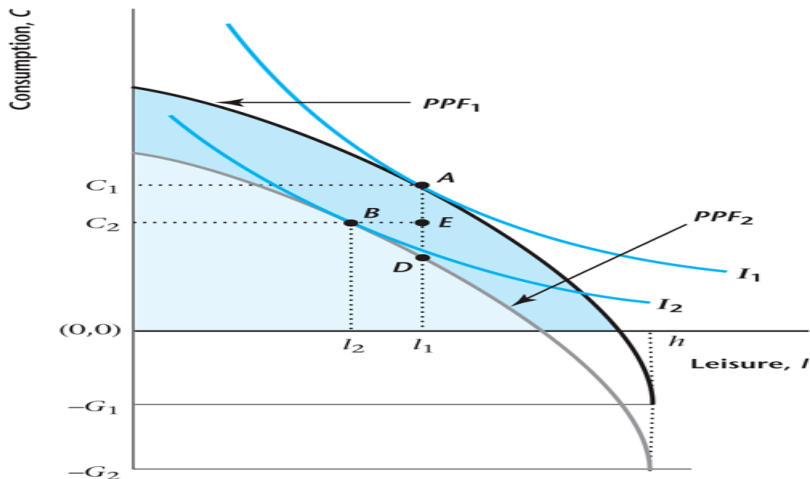
Examples

We are going to consider the following two exogenous changes:

- ▶ Changes in government expenditures: G .
- ▶ Changes in productivity: z .

Government Spending

Suppose the government increases its expenditure: $\Delta G > 0$:



Government Spending

Suppose the government increases its expenditure:

$$\Delta G = G_2 - G_1 > 0$$

- ▶ Balanced budget: if $G_2 > G_1$ then $T_2 > T_1$. An increase in government spending means a negative income effect on consumption and leisure;
- ▶ Reduces household's disposable income: $C_2 < C_1$ and $l_2 < l_1$;
- ▶ Increase in equilibrium hours worked: $N_2 > N_1$ implies $Y_2 > Y_1$.

Questions:

- ▶ what has happened to the real wage?
- ▶ does GDP increase?
- ▶ does the household prefer the increase in G ?
- ▶ ΔC vs. ΔG ?

Government Spending

Questions:

- ▶ what has happened to the real wage?
Decrease. Because $N_2 > N_1$, MP_N decreases, so is real wage w .
- ▶ does GDP increase?
Yes. Because $N_2 > N_1$ and $Y = zF(K, N)$.
- ▶ does the household prefer the increase in G ?
No. Because the utility level is lower, as shown in the graph.
- ▶ ΔC vs. ΔG ?

Government Spending, Con't

The income-expenditure identity: $Y = C + G$, so

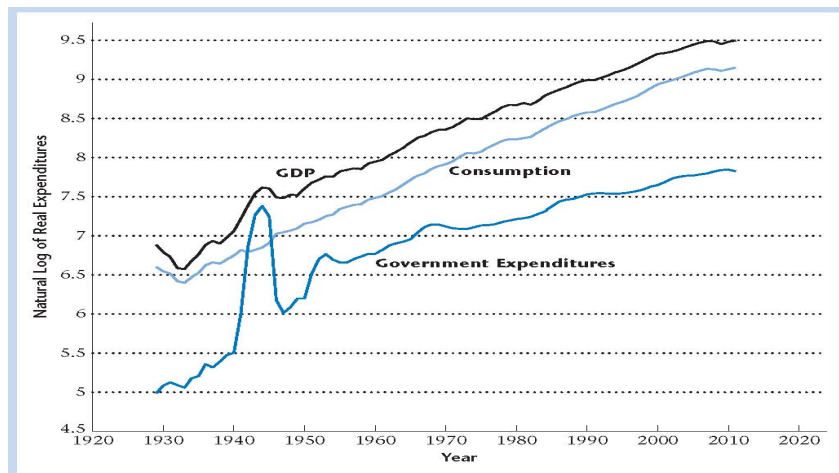
$$\Delta Y = \Delta C + \Delta G$$

We know $\Delta Y > 0$ and $\Delta G > 0$, so we get $\Delta C > -\Delta G$.

That means government purchases crowd out private consumption, but it is not completely crowded out as a result of the increase in output.

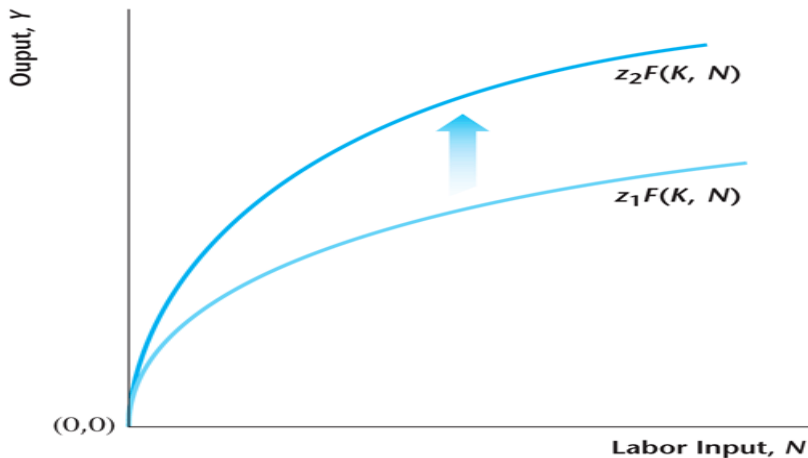
Government Spending, Con't

Suppose the government increases its expenditure: $\Delta G > 0$:



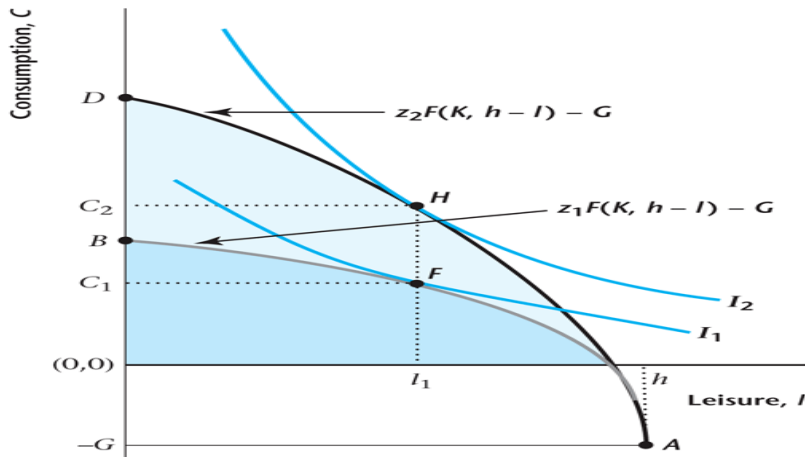
Changes in TFP

Suppose there is an increase in TFP: $\Delta z > 0$



Changes in TFP, Con't

Suppose there is an increase in TFP: $\Delta z > 0$



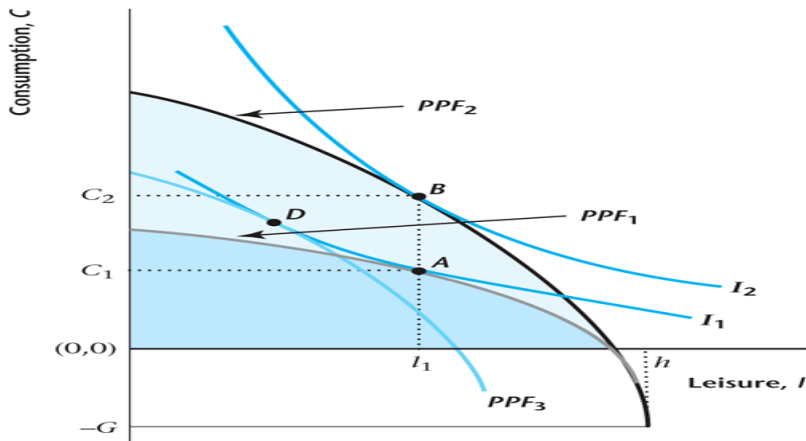
Changes in TFP, Con't

Summarizing:

- ▶ $z_2 > z_1$
- ▶ Wage increases $w_2 > w_1$
- ▶ Consumption increases $C_1 < C_2$
- ▶ Hours worked? depends on income and substitution effects

Separating Income and Substitution Effects

PPF_3 is PPF_2 adjusting the income of the HH so that it's indifferent between new and old equilibrium.



Changes in TFP

