Macroeconomics[†]

Origins and Paths of Income

Lec. **2**

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Slides primarily based on *Macroeconomics* by N. Gregory Mankiw (2022), and *Macroeconomics* by Olivier Blanchard (2020)

Quotation

"A large income is the best recipe for happiness I ever heard of."

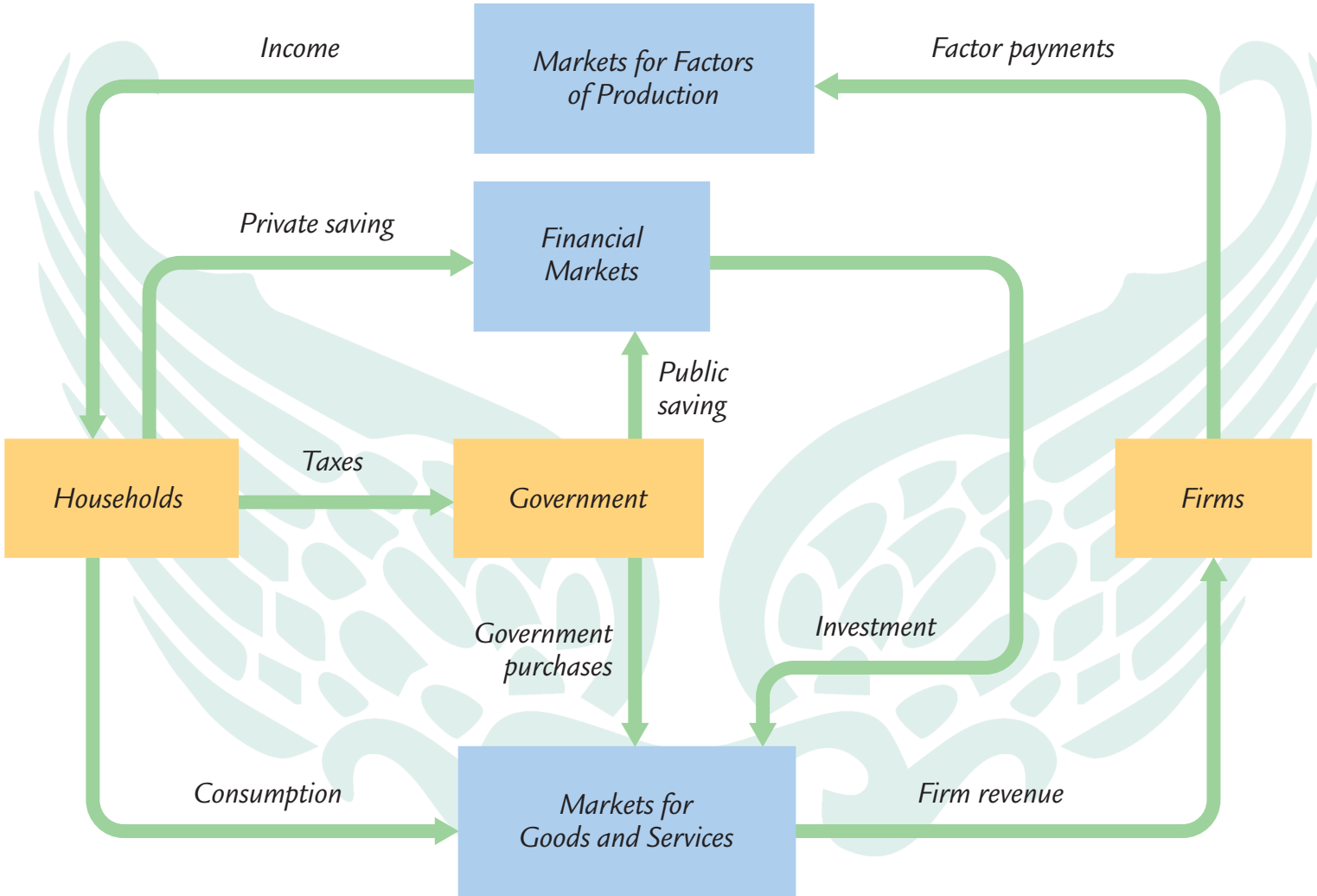
—Jane Austen

Key Questions

Note that the following questions are addressed based on the assumption of a closed economy framework. and in the long-run perspective.

- ✔ How is a nation's total income determined?
- ✔ Who receives the income from production: workers or capital owners?
- ✔ What are the main components of economic spending by households, firms, and the government?
- ✔ What ensures the equilibrium between demand and supply of goods and services?

Circular Flow (more realistic)



Production Inputs

Production Inputs (or simply factors of production) are used to produce goods and services in an economy.

- ✔ Although there are many types of factors of production, the two most important inputs are labor and capital.
  - ✗ **Labor**: Labor represents the time and effort that people spend working. It is denoted by the symbol L.
  - ✗ **Capital**: Capital refers to the set of tools and equipment that workers use in the production process. Examples include construction equipment, computers, etc. It is denoted by the symbol K.
- ✔ Here it is assumed that the economy has fixed amounts of inputs, and the technology level is fixated!
- ✔ Also, the factors are utilized to their full extent; hence, no resources are wasted!

Production Function

- ✔ The production function represents the mathematical relation between the output (Y) and inputs of production.

$$Y = F(L, K)$$

- ✔ This function reflexes the available technology for turning inputs to income.

- ✔ It is assumed that the function has constant returns to scale (homogeneous of degree 1); meaning:

$$zY = F(zL, zK)$$

- ✔ Since the amounts of inputs are given, it is expected that Y is also unchanged.

$$\begin{aligned} Y &= F(\overline{L}, \overline{K}) \\ &= \overline{Y} \end{aligned}$$

★ *Dig Deeper*

Homogeneous Produnction Functions

A production function is said to be homogeneous if when each input factor is multiplied by a positive real constant z, the constant can be completely factored out. Mathematically, a function is **homogeneous of degree n** if: $(z \in \mathbb{R}^+)$

$$f(zL, zK) = z^n f(L, K)$$

A production function exhibits decreasing returns to scale if $a < 1$, and a production function exhibits constant returns to scale if $a = 1$, and a production function exhibits increasing returns to scale if $a > 1$:

$$f(zL, zK) = z^a f(L, K)$$

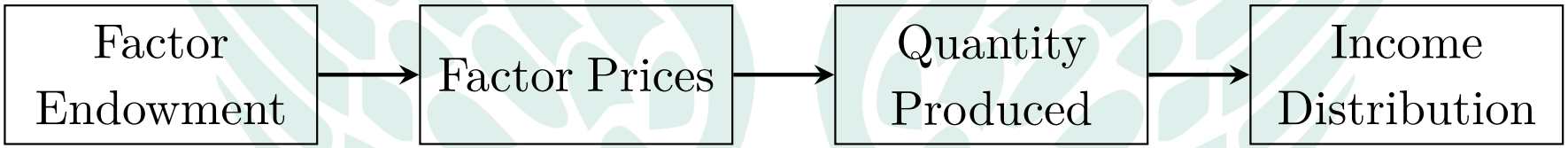
Practice: Find the homogeneity degree of the following production functions. Also, provide real-world examples for each case.

$$Y = min(L/a, K/b) \tag{1}$$

$$F(L, K, E) = 2\frac{L}{KE} \tag{2}$$

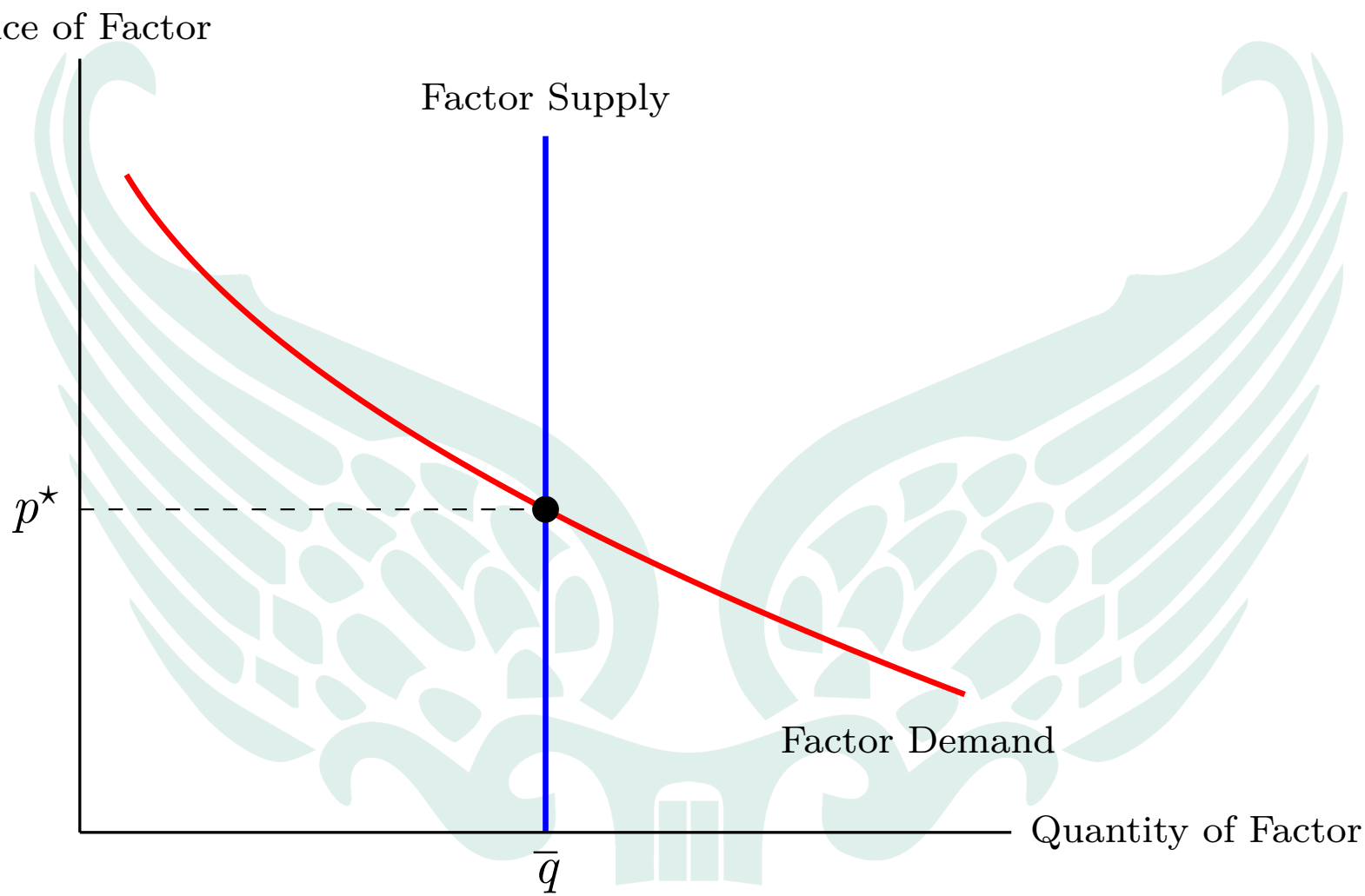
Factor Prices

- ✔ In economics, when we talk about "*distribution*," the presence of "*prices*" is sensed.
- ✔ The price of labor is wage (denoted by w), and the price of capital is rent (denoted by r).
- ✔ The distribution of income is indirectly determined by factor prices.



- ✔ The Black Death in 14^{th}-century Europe increased wages for workers and reduced land rents due to the reduced labor force.

Factor Prices (cont'd)



A Firm's Perspective

- ✔ Now on a micro level, how do competitive firms (the simplest assumption possible!) respond to factor prices?
- ✔ How much labor does a firm employ and what levels of capital does the firm utilize?
- ✔ Obviously, all firms encounter some costs. A considerable part of these costs consists of labor and capital payments and rents respectively.
- ✔ Also, we know that many the firm's objective is to **maximize profits**.

$$\begin{aligned}\max_{L,K}\big(\pi(L,K)\big) &= \max_{L,K}\big(R(L,K)-C(L,K)\big)\\ &= \max_{L,K}\big(pY-(wL+rK)\big)\\ &= \max_{L,K}\big(\text{Revenue}-\big(\text{Labor Costs}+\text{Capital Costs}\big)\big)\end{aligned}$$

Neoclassical Theory of Distribution

- ✔ What would be the **optimal** (or profit-maximizing) set of inputs?
- ✔ To answer the mentioned question, the *Neoclassical Theory of Distribution* is proposed.
- ✔ This theory premises that the demand for each factor depends on the **marginal** productivity of that factor.

The Law of Diminishing Marginal Productivity

Adding more of one input eventually results in smaller increases in output. (ceteris paribus)

Neoclassical Theory of Distribution (cont'd)

- ✔ Profit-maximizing firms have a **marginalist** view.
- ✔ In other words, they only pay attention to the change in output while utilizing the last unit of factor.
- ✔ In the case of a two-factor firm:

$$F(L,K) \xRightarrow{\nabla F} \begin{cases} MPL = \frac{\partial F(L,K)}{\partial L} \\ MPK = \frac{\partial F(L,K)}{\partial K} \end{cases}$$

- ✔ Most production functions have the property of diminishing marginal product.
- ✔ According to the Neoclassical Theory of Distribution, the last unit of input should be equal to the **real price of factor**.

Neoclassical Theory of Distribution (cont'd)

$$\overbrace{d\pi(L,\overline{K})}^{0} = \left(\frac{\partial pY}{\partial L} - \frac{\partial(wL + r\overline{K})}{\partial L}\right) dL$$

$$= \underbrace{p \times MPL}_{VMPL} - w$$

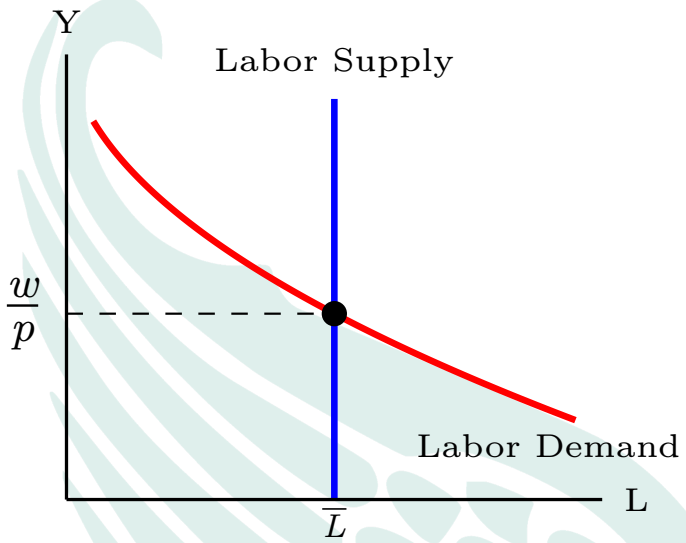
$$\Rightarrow MPL = \frac{w}{p} \,(\text{also } VMPL = w)$$

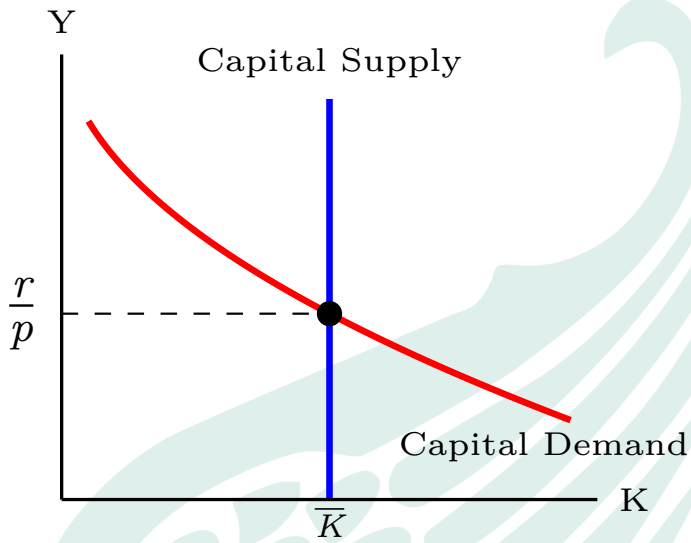
$$\overbrace{d\pi(\overline{L},K)}^{0} = \left(\frac{\partial pY}{\partial K} - \frac{\partial(w\overline{L} + rK)}{\partial K}\right) dK$$

$$= \underbrace{p \times MPK}_{VMPK} - r$$

$$\Rightarrow MPK = \frac{r}{p} \,(\text{also } VMPK = r)$$

Neoclassical Theory of Distribution (cont'd)





A Rule of Thumb

To convert nominal indicators to real indicators, adjust for inflation by dividing by the price index or omitting the price effects. For instance:

- w (nominal wage) $\xrightarrow{\times \frac{1}{p}}$ $\frac{w}{p}$ (real wage)
- r (nominal rent) $\xrightarrow{\times \frac{1}{p}}$ $\frac{r}{p}$ (real rent)

Neoclassical Theory of Distribution (cont'd)

- ✔ Thus, the income is divided between return to labor, return to capital, and another term which is called economic profit.
- ✔ If production function has constant returns to scale properties, then the term economic profit is approximately **zero**, and another term, accounting profit, is defined.
  - ✗ **Economic Profit**:The income that remains after the firms have paid the factors of production.
  - ✗ **Accounting Profit**: Since firm owners usually possess their capital, accounting profit is the summation of economic profit and return to capital.

$$Y = (L \times MPL) + \overbrace{(K \times MPK) + \underbrace{\text{Economic Profit}}_{\approx 0}}^{\text{Accounting Profit}}$$

A Special Function

- A well-known production function is **Cobb-Douglas** production function, which is written as:

$$Y = AL^{\alpha}K^{1-\alpha}$$

  - Where A (abbr. automation) takes account of technological advancements,
  - and α reflexes the share of income and is greater than or equal to zero.

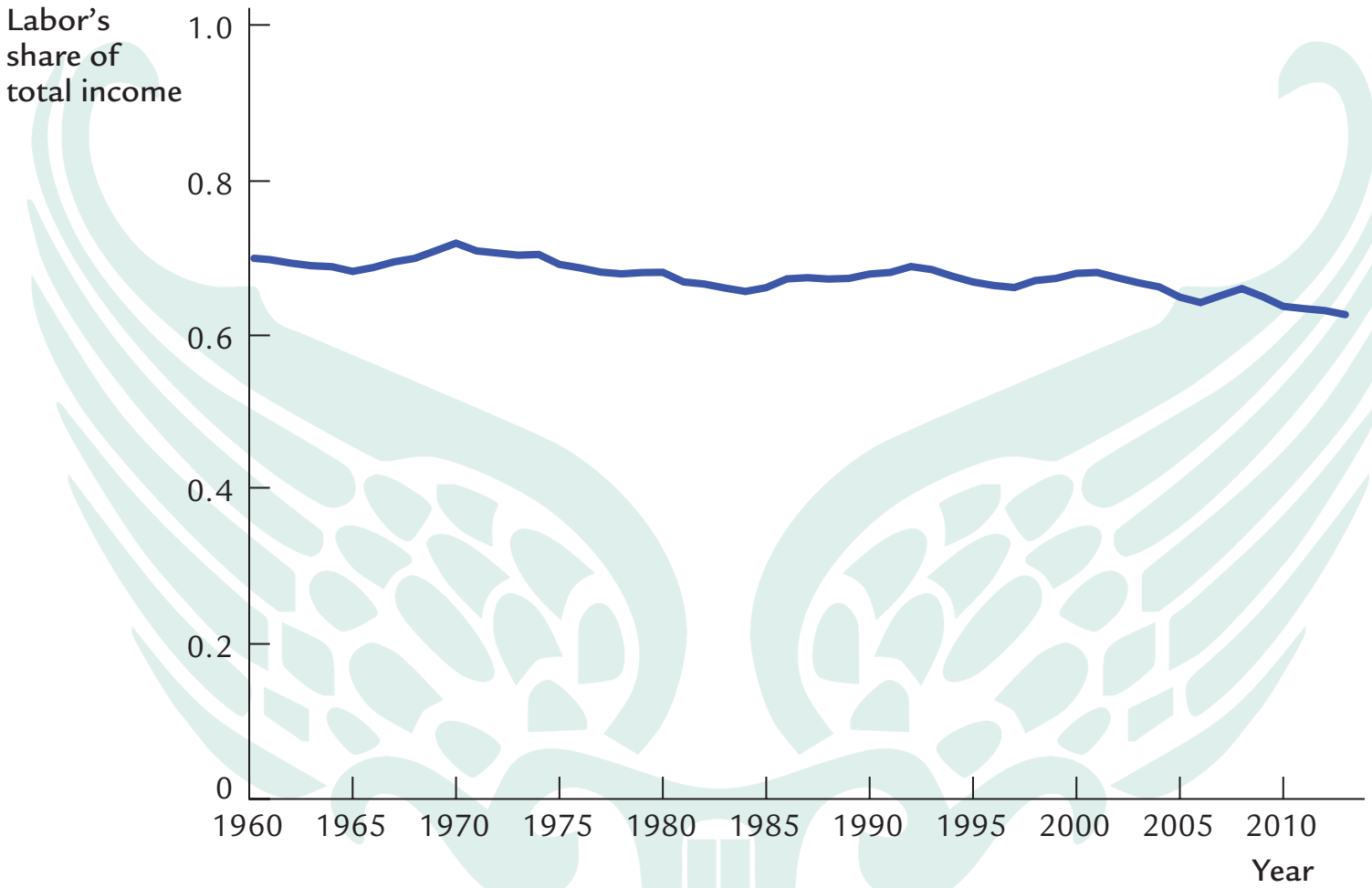
- In this particular form, MPL and MPK would be:

$$MPL = \alpha\frac{Y}{L}$$

$$MPK = (1-\alpha)\frac{Y}{K}$$

- Paul Douglas and Charles Cobb found out that this function is consistent with the division of national income between labor and capital.

A Special Function (cont'd)



Ratio of Labor Income to Total Income, United States

★ Dig Deeper

CES Production Functions

The constant elasticity of substitution (CES) production functions refer to those production functions that have a **fixed elasticity of substitution** between the inputs of production, such as labor and capital. Elasticity of substitution is defined as:

$$\sigma = \frac{\Delta \frac{K}{L}\%}{\Delta \frac{w}{r}\%}$$

Where σ is greater than or equal to zero.
The general form of a two-factor CES production function is:

$$Y = A\left(\alpha L^{-\beta} + (1-\alpha)K^{-\beta}\right)^{\frac{-1}{\beta}}$$

Where A is the *efficiency parameter*, α is the *distribution parameter*, *and* β *is the substitution parameter*. Cobb-Douglas and Leontief production functions are good examples of CES function. (Proof?)
Practice: Prove that in the two-factor form of CES production function, the equation $\sigma = \frac{1}{1+\beta}$ holds, if σ is the elasticity of substitution.

The Components of Aggregate Demand

- **Aggregate Demand** (denoted by AD) represents the overall demand for goods and services in an economy.
- AD is made of consumption (denoted by C), investment (denoted by I), government spending (denoted by G), and net exports (denoted by NX).
- Since we assumed a closed economy, NX is zero. So, AD could be written as:

$$AD = C + I + G$$

Consumption

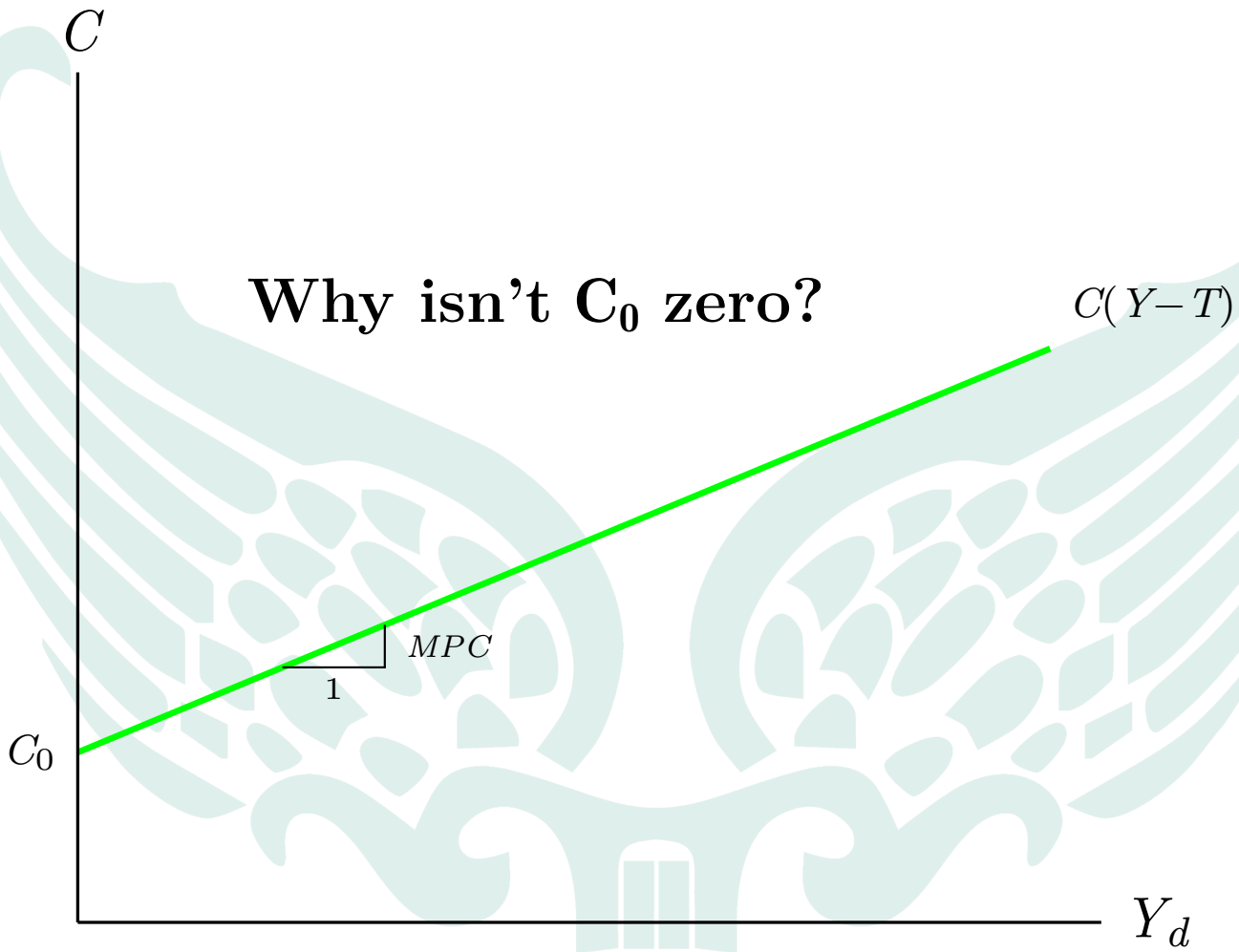
- **Consumption** (C) refers to the purchases made by households on goods and services for their own use and enjoyment.
- It is influenced by factors such as disposable income, consumer confidence, interest rates, and wealth.
  - **Disposable Income**: Refers to the amount of income that households have available for consumption and saving after taxes have been deducted.
- The relationship between consumption and disposable income is called the consumption function.

$$C = C(\overbrace{Y - T}^{Y_d})$$

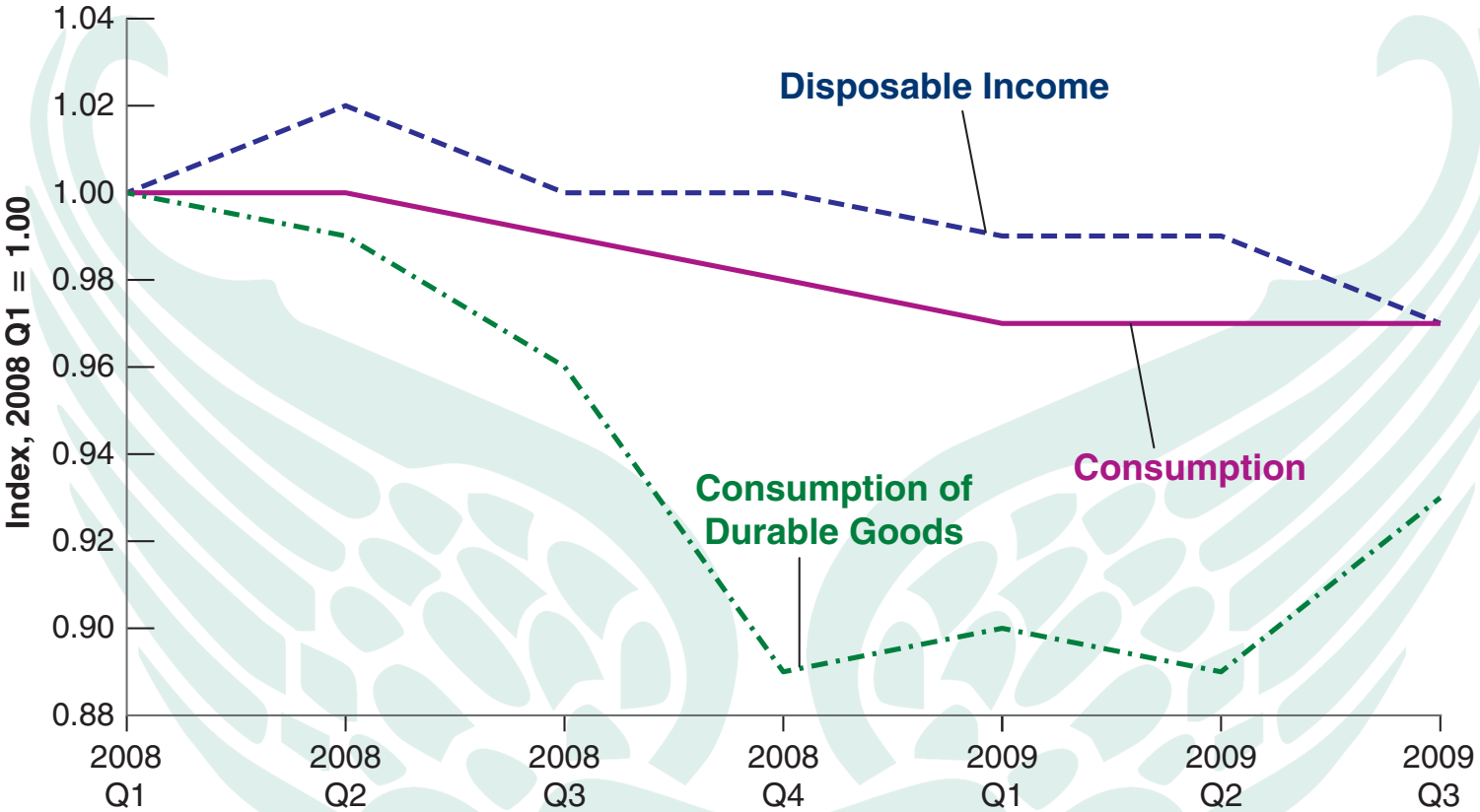
  - **Marginal Propensity to Consume (MPC)**: Measures the amount by which consumption changes when disposable income increases by one dollar.

$$0 \leq MPC = \frac{dC}{dY_d} \leq 1$$

Consumption (cont'd)



Consumption (cont'd)



Disposable Income, Consumption, and Consumption of Durables, United States

Investment

- **Investment** (I) refers to the purchase of investment goods by both firms and households.
- Examples of investment could be, firms replacing old machinery, or households purchasing new houses.
- The quantity of investment goods demanded depends on the **real interest rate** (denoted by r), which measures the cost of funds used to finance investment.
- There is also **nominal interest rate** (denoted by i), which it also takes account of inflation.

★ *Dig Deeper* (Fisher Equation)

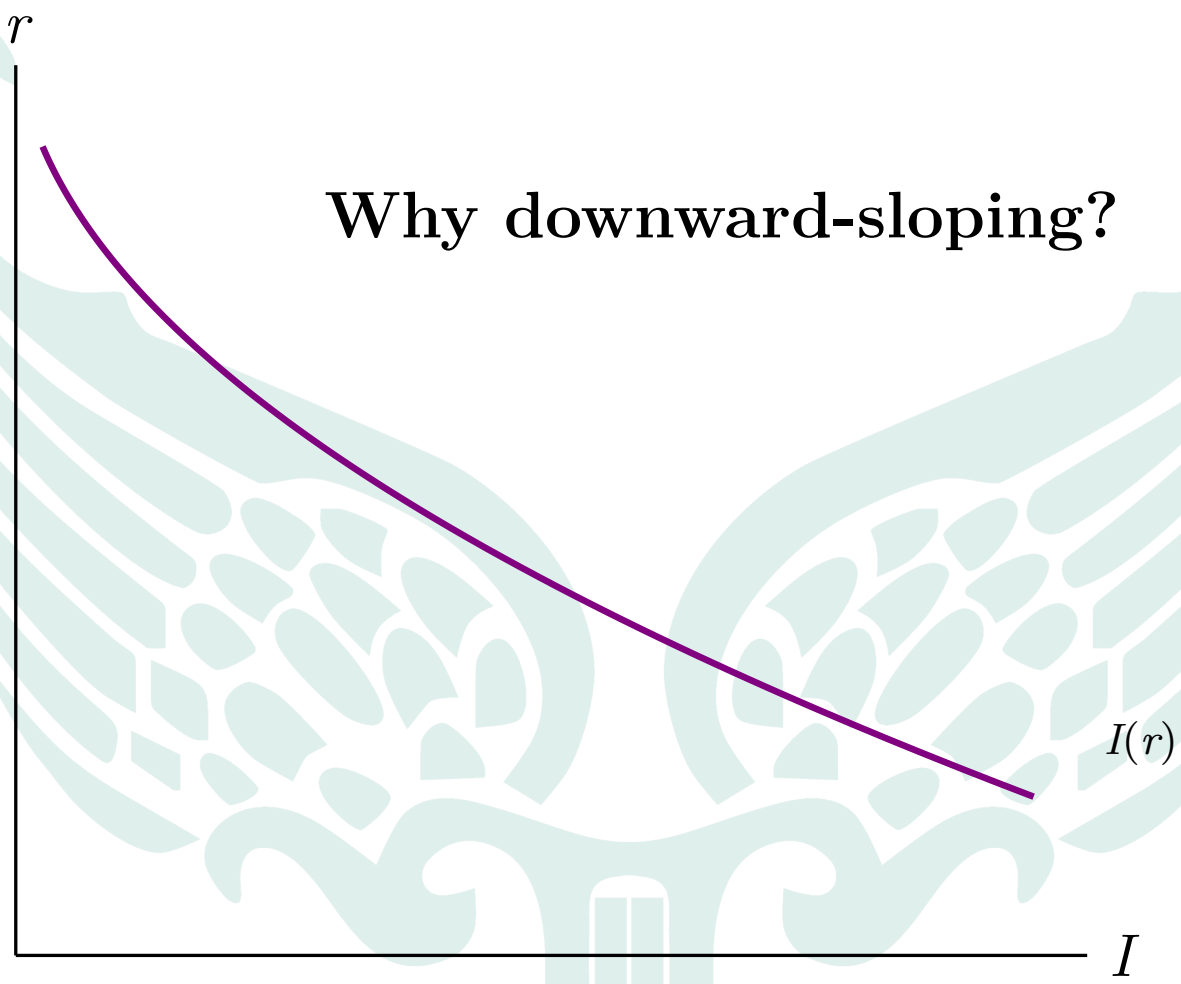
The Fisher Equation displays the relation between real and nominal interest rates. (where π^e is expected inflation rate)

$$i \approx \pi^e + r$$

- Investment function highlights the relation between the investment demand and real interest rate and is shown by:

$$I = I(r)$$

Investment (cont'd)



Why So Many Different Interest Rates?

- ✔ **Term**
  - Different loans have different durations, ranging from short-term loans to long-term loans.
  - The interest rate on a loan depends on its term, with long-term loans usually having higher interest rates than short-term loans.
- ✔ **Credit Risk**
  - Lenders must consider the probability of borrowers defaulting on their loans.
  - Loans with higher credit risk, such as junk bonds issued by financially shaky corporations, have higher interest rates to compensate for the higher risk of default.

Why So Many Different Interest Rates? (cont'd)

- **Tax Treatment**
  - The interest on different types of bonds is taxed differently.
  - Municipal bonds issued by state and local governments, for example, do not require holders to pay federal income tax on the interest income.
  - This tax advantage allows municipal bonds to have lower interest rates compared to other bonds.
- **Inflation Protection**
  - Some bonds include protection against inflation by indexing the interest and principal to a price index, such as the CPI.
  - Bonds with inflation protection typically offer lower interest rates than other bonds due to the added value of inflation protection.

Government Spending

- **Government spending** (G) refers to the purchases of goods and services made by the government.

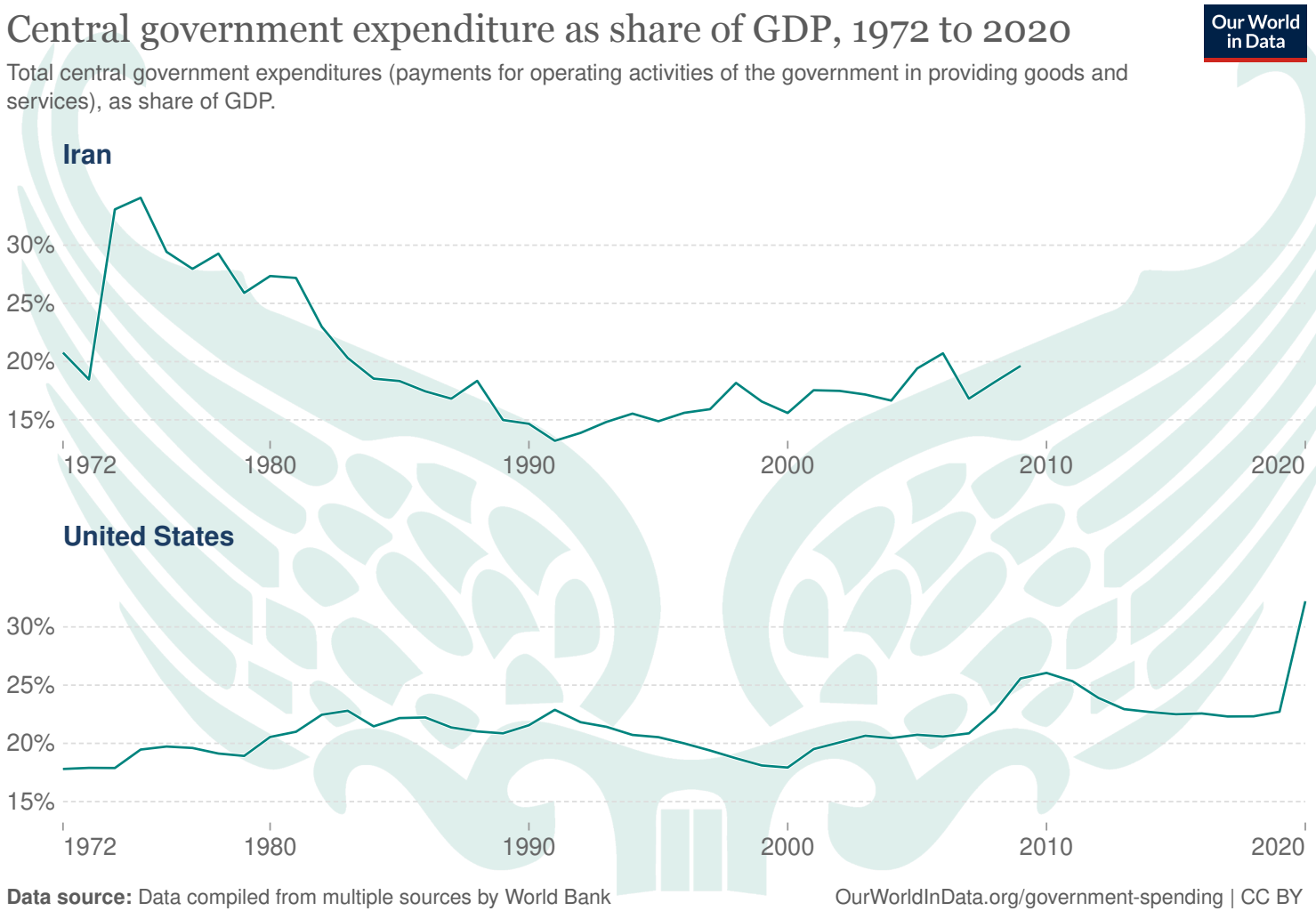
- Government spending can be categorized into two types.
  - The first type is **government purchases of goods and services**, which include investments in infrastructure, education, and public works.
  - The second type is **transfer payments** to households, such as public assistance for the poor and Social Security payments for the elderly. Yet, these payment are not considered part of government spending! (**why?**)

- Government purchases of goods and services directly contribute to AD by increasing the demand for goods and services in the economy. This increase in demand stimulates economic activity and can lead to higher GDP.

- But, how do transfer payments contribute to the demand for goods and services?

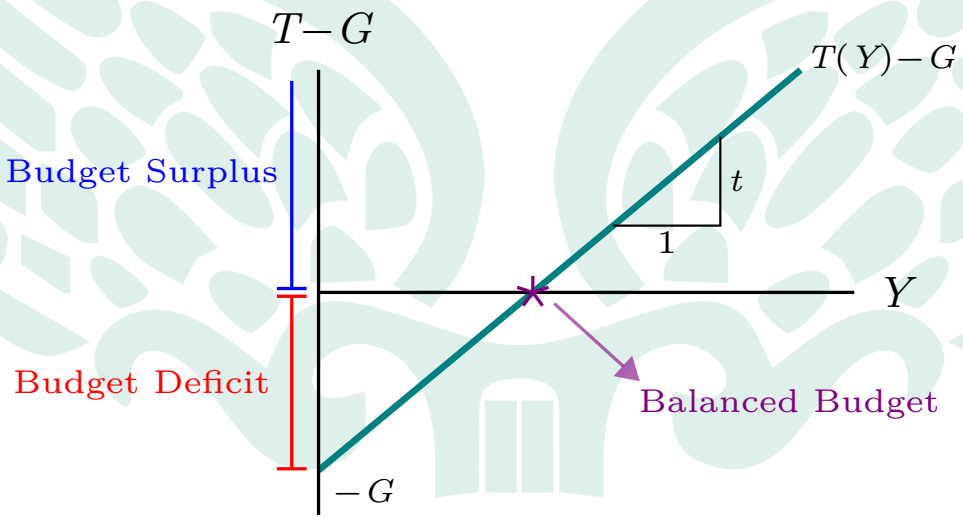
$$Y_d \uparrow \implies C \uparrow \implies AD \uparrow$$

Government Spending (cont'd)



Government Spending (cont'd)

- ✔ The level of government purchases and taxes is determined by fiscal policy.
- ✔ Fiscal policy has direct impact on **budget balance**.
  - $G > T \implies$ Budget Deficit
  - $G = T \implies$ Balanced Budget
  - $G < T \implies$ Budget Surplus



Reaching Equilibrium

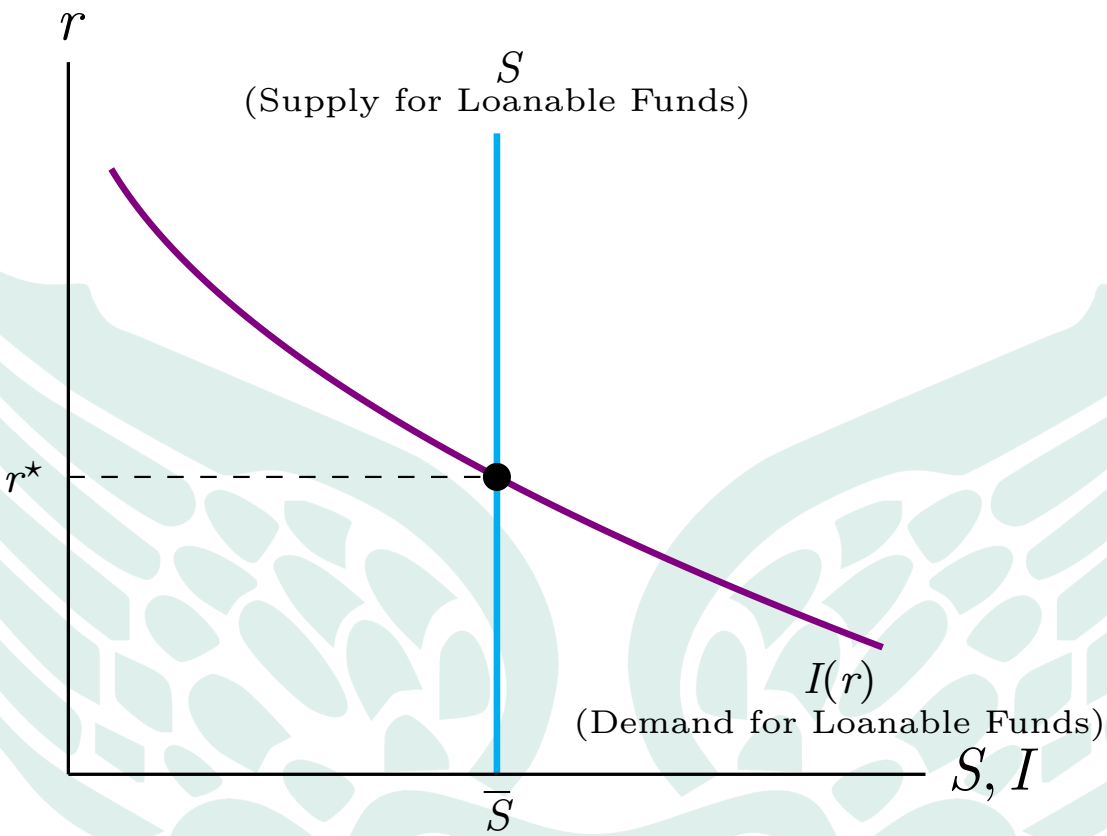
Supply:
$$Y = F(\overline{L}, \overline{K})$$
$$= \overline{Y}$$

Demand:
$$AD = C + I + G$$
$$C = C(\overline{Y} - \overline{T})$$
$$T = \overline{T}$$
$$I = I(r)$$
$$G = \overline{G}$$

Equilibrium:
$$\overline{Y} = C(\overline{Y} - \overline{T}) + I(r) + \overline{G}$$

$$\xrightarrow{\text{rearranged}} I(r) = \underbrace{\overline{Y} - C(\overline{Y} - \overline{T}) - \overline{G}}_{\overline{S}}$$

Reaching Equilibrium (cont'd)



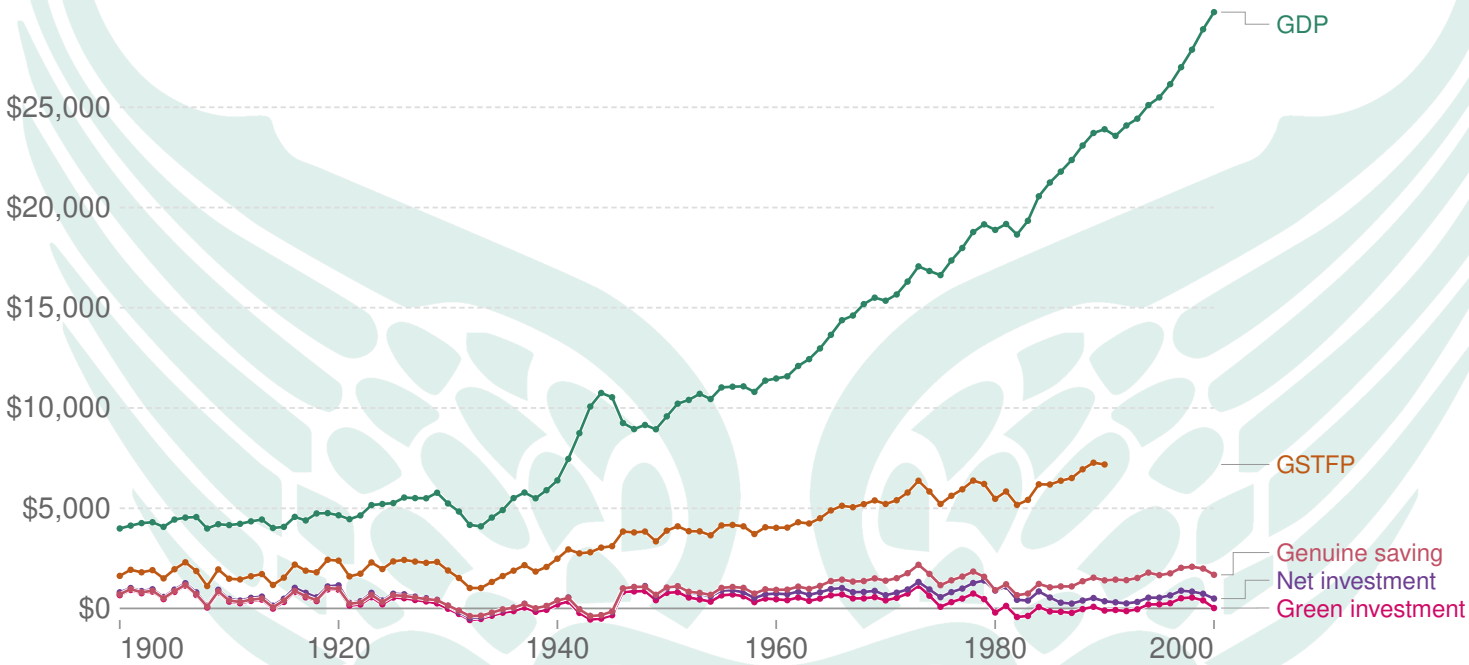
$$S = \overbrace{(Y - T - C)}^{\text{Private Saving}} + \overbrace{(T - G)}^{\text{Public Saving}} = I(r)$$

Reaching Equilibrium (cont'd)

Various measures of national saving/investment compared to GDP per capita, United States, 1900 to 2000

Our World in Data

GDP (gross domestic product) represents a nation's total income. The rest of the variables are various measures of national saving and investment, or in other words, changes in total wealth.



Data source: Blum, Ducoing, McLaughlin (2017) OurWorldInData.org/economic-growth | CC BY

Note: Measured in 1990 international dollars. In order of increasing comprehensiveness, these measures include: Net investment = net fixed produced capital formation and overseas investment; Green investment = Net investment + change in natural capital; Genuine savings = Green investment + education expenditure; GSTFP = Genuine savings + Net present value of total factor productivity (i.e. technological change).

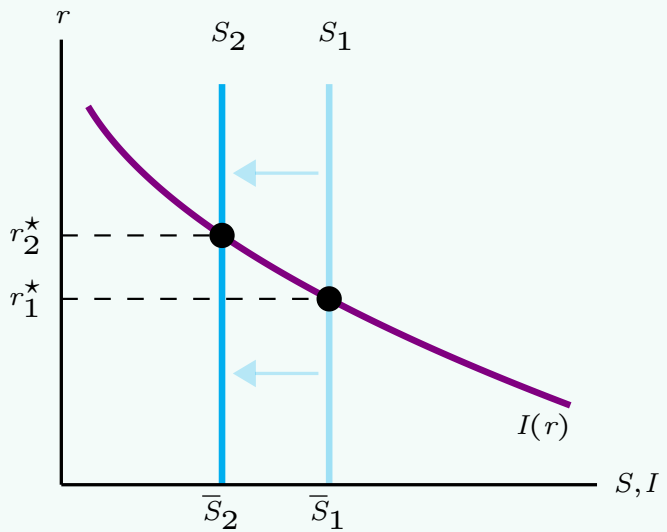
Changes in Saving

Fiscal Policy ($G \uparrow$)

How do higher government purchases impact the a closed economy in long-run?

$$G \uparrow \Longrightarrow \begin{cases} \overline{Y} \\ \overline{T} \end{cases} \Longrightarrow \overline{Y_d} \Longrightarrow \overline{C} \xrightarrow{\text{neutralizing effects}} I \downarrow \Longrightarrow r \uparrow$$

- So government purchases are **crowding out** investment.
- Try to distinguish exogenous variables from endogenous variables.



Changes in Saving (cont'd)

Fiscal Policy ($T\downarrow$)

What about a tax cut in a closed nation in long-run?

$$T\downarrow \Longrightarrow \begin{cases} \overline{Y} \\ \overline{G} \end{cases} \Longrightarrow C\uparrow \xrightarrow{\text{neutralizing effects}} I\downarrow \Longrightarrow r\uparrow$$

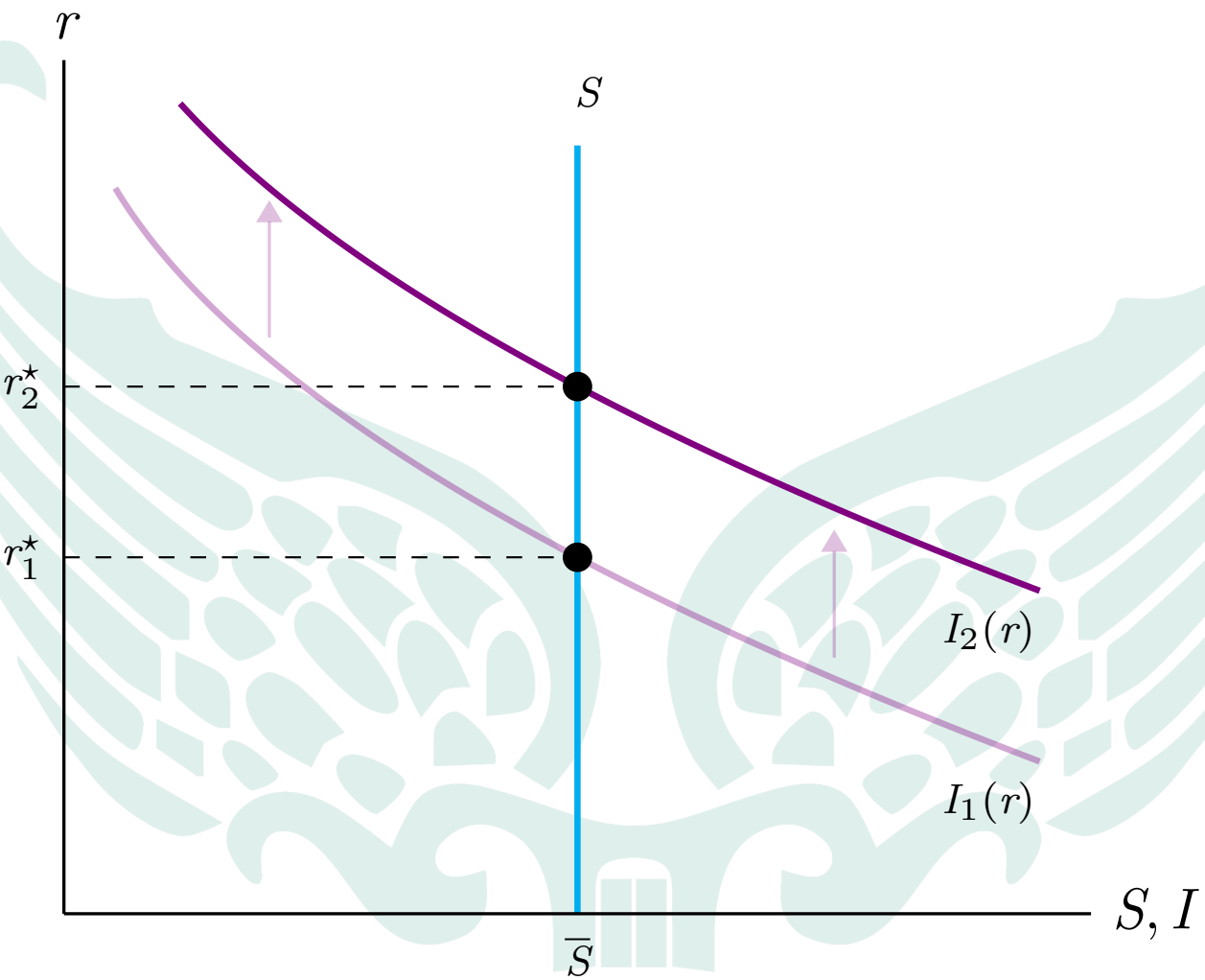
- So taxes are **crowding out** investment.
- The graph is still the same as the previous slide. ◀ View Graph
- How much more do people consume after a tax cut, precisely?
- How did the composition of exogenous and endogenous variables change from the previous slide?

Changes in Investment

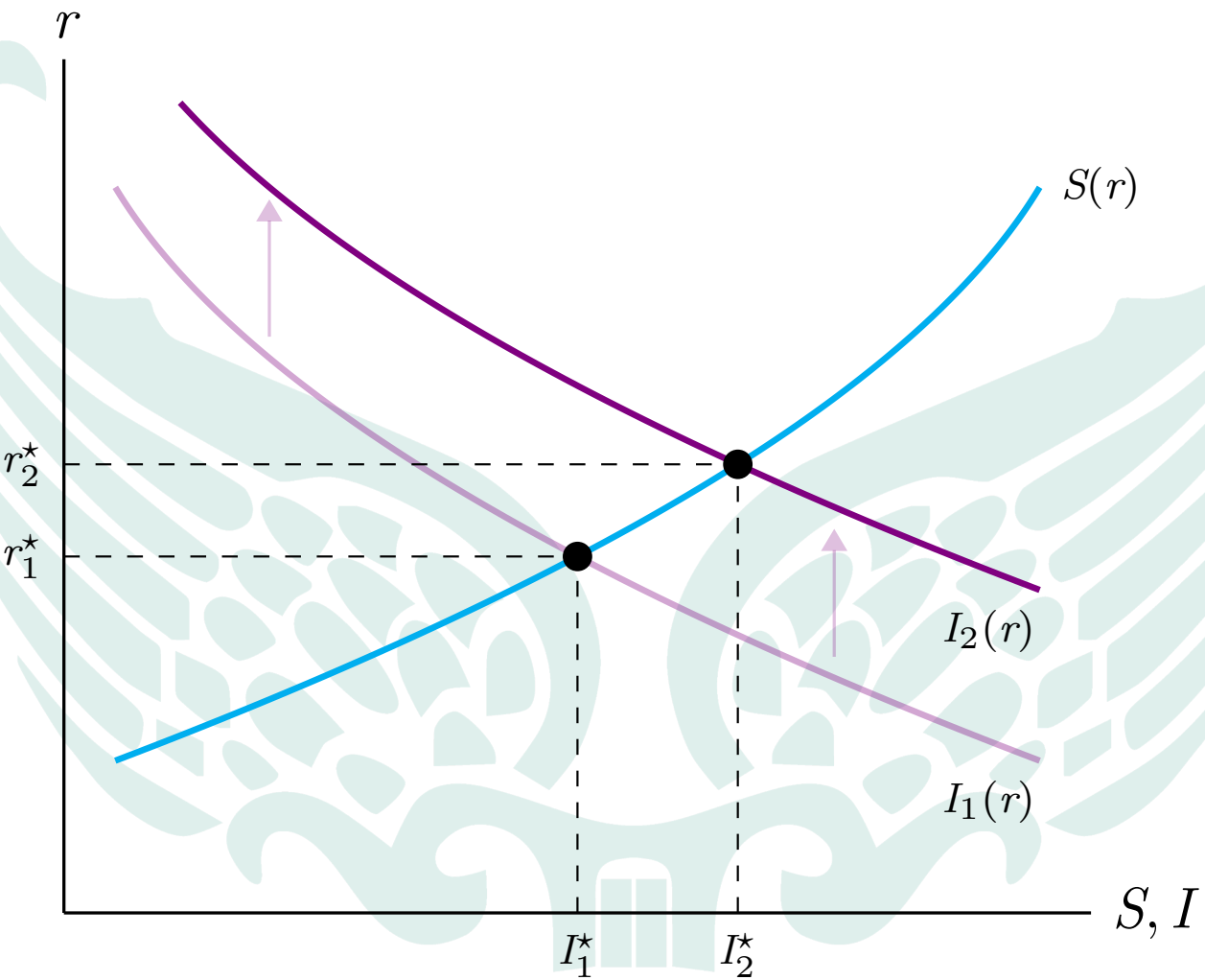
- ✔ Investment demand can change due to technological innovation, which leads to higher levels of demand for investment goods.
- ✔ Government policies, such as changes in tax laws, can also affect investment demand.
  - For example, if the government provides tax cuts for those who invest in new capital, it makes more investment projects profitable and increases the demand for investment goods.
- ✔ A positive exogenous impact on investment demand can result in a shift in the investment curve, which ensures higher interest rates.
- ✔ But the investment level is dependent on the shape of saving:
  - Saving is held constant. ▶ View Graph
  - Saving (flip side of consumption) is subject to interest rates, a.k.a. **saving function**. ▶ View Graph

$$S = S(r)$$

Changes in Investment (cont'd)



Changes in Investment (cont'd)



Farewell & Gratitude

The End of Lecture 2

Thank You for Listening

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