

National Income

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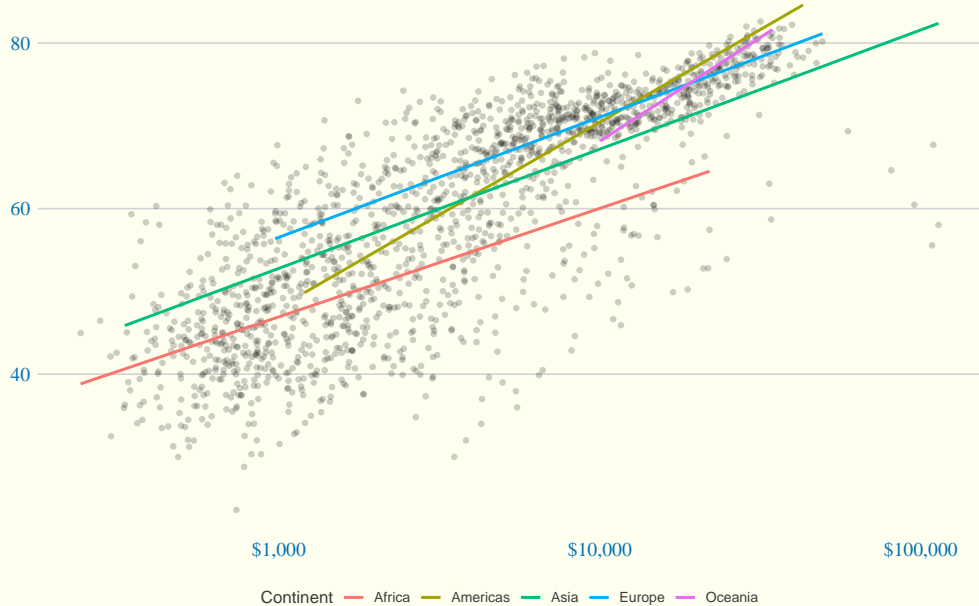
How much do the firms in the economy produce? What determines a nation's total income?

Who gets the income from production? How much goes to compensate workers, and how much goes to compensate owners of capital?

Who buys the output of the economy? How much do households and firms purchase for investment, and how much does the government buy for public purposes?

What equilibrates the demand for and supply of goods and services? What ensures that desired spending on consumption, investment, and government purchases equals the level of production?

Relationship between GDP and Life Expectancy



Modern Circular Flow Diagram

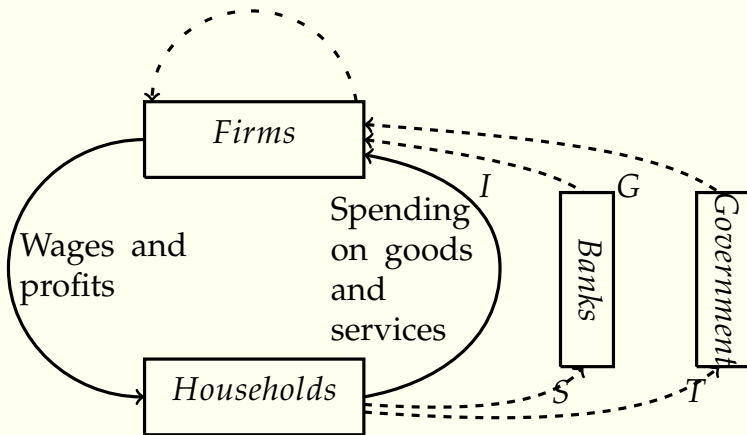


Figure 2: Circular Flow of Dollars Through the Economy

What Determines the Total Production of Goods & Services?

Factors of Production

Factors of Production are the inputs used to produce goods and services.

- Labor
- Capital

$$K = \bar{K}$$

$$L = \bar{L}$$

The *overbar* means that each variable is fixed at some level. Additionally, we are assuming that each factor is fully utilized.

The Production Function

Production Function:

$$Y \leq F(K, L)$$

- Y: output
- K: capital
- L: labor

Example: Cobb-Douglas production function

$$Y = AK^{\alpha}L^{1-\alpha}$$

Constant Returns to Scale

- A PF is **constant returns to scale (CRS)** if an equal proportion increase to all factors of production leads to an equally proportionate increase in output.

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

for any positive number z .

Is the Cobb-Douglas PF CRS?

$$Y = F(K, L)$$
$$Y = AK^{\alpha}L^{1-\alpha}$$

Let's proportionally scale the factors by z

$$\begin{aligned} &= A(zK)^{\alpha}(zL)^{1-\alpha} \\ &= Az^{\alpha}z^{1-\alpha}K^{\alpha}L^{1-\alpha} \\ &= AzK^{\alpha}L^{1-\alpha} \\ &= zY \end{aligned}$$

Supply of Goods & Services

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

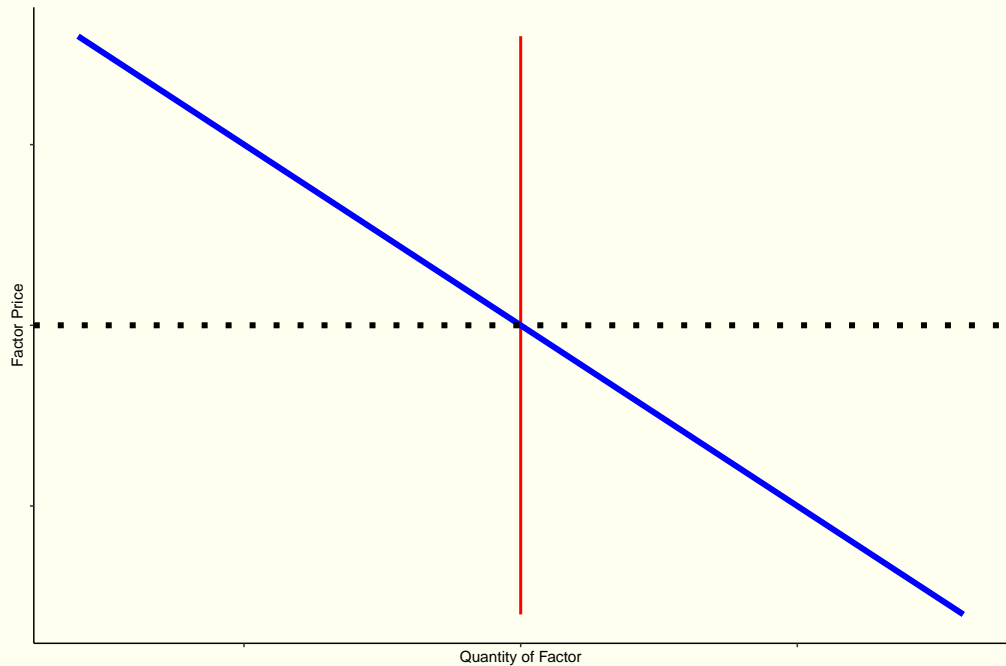
Because we have assumed that capital and labor are fixed, output is also fixed.

How is National Income Distributed to the Factors of Production?

Factor Prices

- **Factor prices** are the amounts paid to each unit of the factors of production.

How a Factor of Productivity is Compensated



The Decisions Facing a Competitive Firm

- A **competitive firm** is small relative to the markets in which it trades, so it has little influence on market prices

The Decisions Facing a Competitive Firm

The firm sells its output $Y = F(K, L)$ at price P , hires workers at wage W and rents capital at rate R . The firm wants to maximize profit. **Profit** is leftover revenue after all expenses have been paid. In this world those costs come from two components: costs attributable to labor, $W \times L$, and costs attributable to capital, $R \times K$.

Competitive Firm's Profit Problem

$$\begin{aligned}\text{Profit} &= \text{Revenue} - \text{Labor Costs} - \text{Capital Costs} \\ &= PY - WL - RK \\ &= PF(K, L) - WL - RK\end{aligned}$$

The Firm's Demand for Factors

From the profit problem, we know it is in the firm's best interests to maximize revenue while minimizing costs, but what are the optimal inputs to achieve this? Let's first consider the factors separately.

Marginal Product of Labor (MPL)

- The **marginal product of labor (MPL)** is the extra amount of output the firm gets from one extra unit of labor holding the amount of capital fixed.

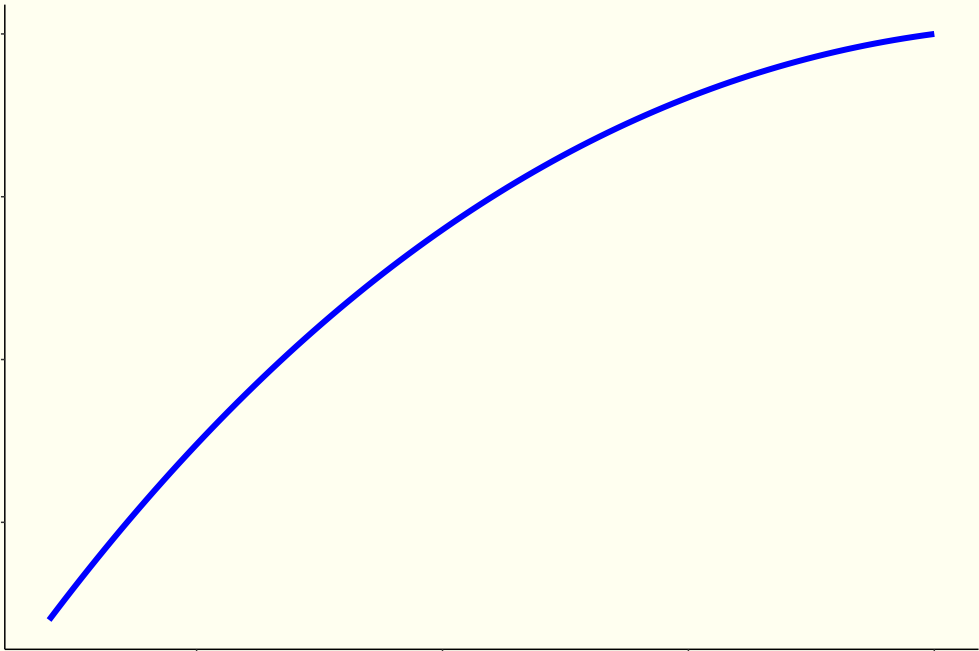
$$MPL = F(K, L + 1) - F(K, L)$$

In general we'll note that most production functions have the property of **diminishing marginal product**, that is holding capital fixed, the amount of additional output produced diminishes for each additional unit of labor.

Diminishing Marginal Product

Output, Y (units)

Labor, L (hours)



MPL to Labor Demand

When does or when should the competitive firm hire an additional unit of labor?

$$\begin{aligned}\Delta Profit &= \Delta Revenue - \Delta Cost \\ &= (P \times MPL) - W\end{aligned}$$

The firm should hire additional labor as long as an increase in hours leads to positive profit.

MPL to Labor Demand

$$P \times MPL = W$$

$$MPL = W/P$$

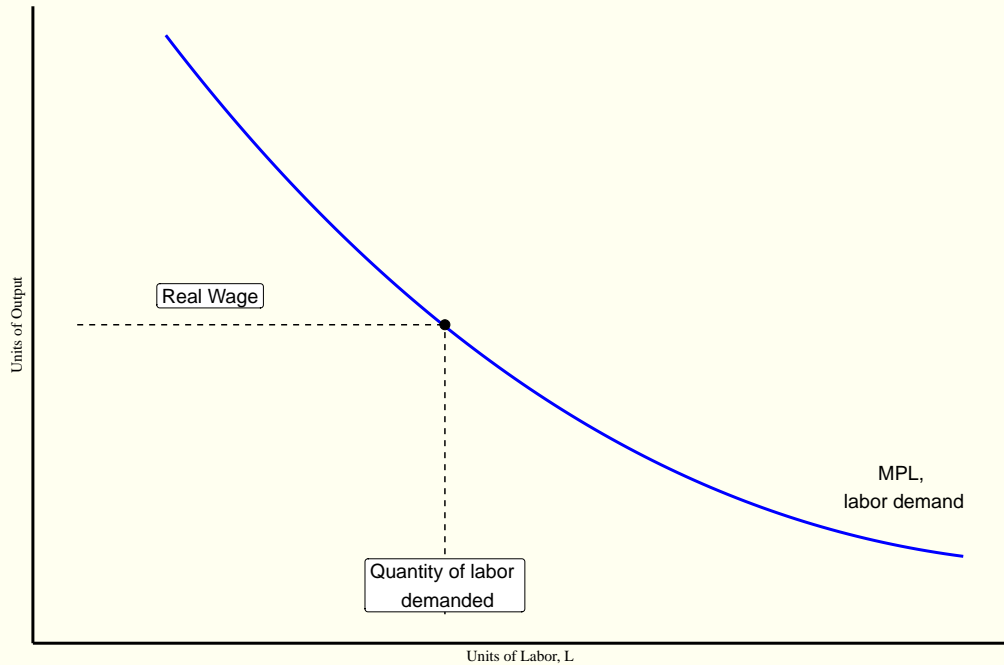
W/P is the **real wage**, the payment in labor measured in units of output rather than in dollars. We can also say the firm hires additional labor until the MPL equals the real wage.

Simple Illustration

Consider a bakery. Suppose the price of bread P is \$2/loaf, and a worker earns a wage W of \$20/hr. The real wage W/P is 10 loaves per hour.

The firm hires additional workers as long as they produce at least 10 loaves per hour.

Marginal Product of Labor Schedule



Marginal Product of Capital (MPK)

$$MPK = F(K + 1, L) - F(K, L)$$

In a similar way to labor, we can uncover the firm's decision rule regarding capital.

$$\begin{aligned}\Delta \text{Profit} &= \Delta \text{Revenue} - \Delta \text{Cost} \\ &= (P \times MPK) - R\end{aligned}$$

The firm will continue to rent capital until the real rental price of capital equals the marginal product of capital.

$$MPK = R/P$$

In summation ...

The firm demands each factor of production until that factor's marginal product falls to equal its real factor price

The Division of National Income

Economic Profit

$$\text{Economic Profit} = Y - (MPL \times L) - (MPK \times K)$$

Note, Y and *Economic Profit* are being expressed in real terms.

$$Y = (MPL \times L) + (MPK \times K) + \text{Economic Profit}$$

How Large is Economic Profit?

$$\text{Economic Profit} = 0$$

Why?

The PF is CRS

Firms are profit-maximizing

Firms are competitive

But Then, Why Aren't Profits Zero?

Economic Profit \neq Accounting Profit

Remember, income is divided among wages, return to capital, and economic profit. Often, firms own rather than rent their capital. Thus, profit received by the firm is often lumped between return on capital and economic profit.

$$\text{Accounting Profit} = \text{Economic Profit} + (MPK \times K)$$

How is National Income Divided

Total output is divided between the payments to capital and the payments to labor, depending on their marginal productivities.

Cobb-Douglas Production Function

$$\text{Capital Income} = MPK \times K = \alpha Y$$

$$\text{Labor Income} = MPL \times L = (1 - \alpha)Y$$

$$\alpha \in [0, 1]$$

α measures capital's share of income.

$$F(K, L) = AK^\alpha L^{1-\alpha}$$

A is a parameter that measures the productivity of available technology.

Properties of the Cobb Douglas PF

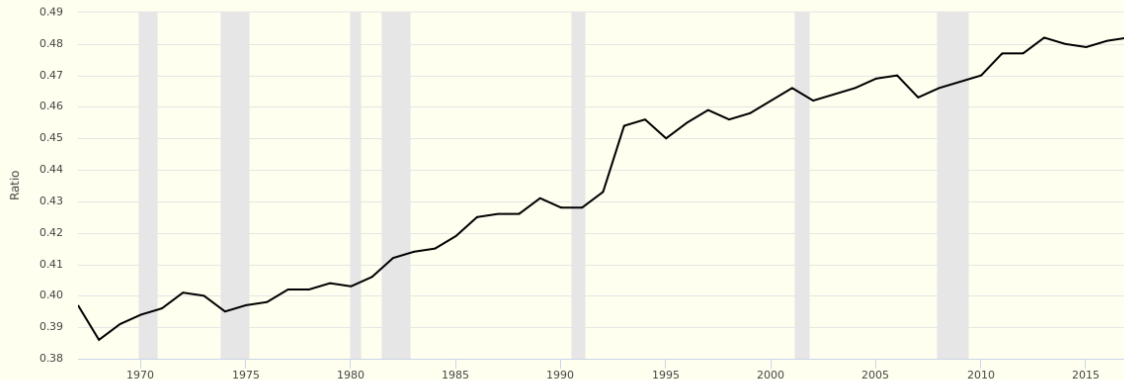
1 CRS

2 $MPL = (1 - \alpha)AK^\alpha L^{-\alpha} = (1 - \alpha)Y/L$

3 $MPK = \alpha AK^{\alpha-1}L^{1-\alpha} = \alpha Y/K$

Income Inequality

FRED — Income Gini Ratio for Households by Race of Householder, All Races



Shaded areas indicate U.S. recessions

Source: U.S. Census Bureau

fred.stlouisfed.org

What Explains the Increase in Income Inequality?

- Concentration of capital income
- Within labor income divergence in wages
- Skill-biased technological change
- Slow growth in the supply of skilled workers

What Determines the Demand for Goods & Services

Recall the four components of GDP:

- Consumption (**C**)
- Investment (**I**)
- Government Purchases (**G**)
- Net Exports (**NX**)

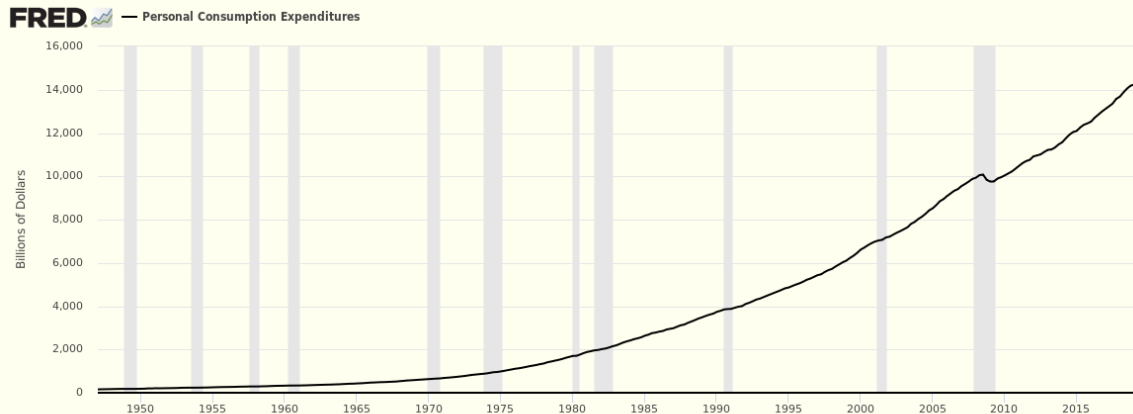
For now, we will assume a *closed economy* meaning the economy does not trade with other countries \therefore .

$$Y = C + I + G$$

Consumption

- Consumption accounts for $\approx 2/3$ of GDP

Consumption



Shaded areas indicate U.S. recessions

Source: U.S. Bureau of Economic Analysis

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Consumption

Households

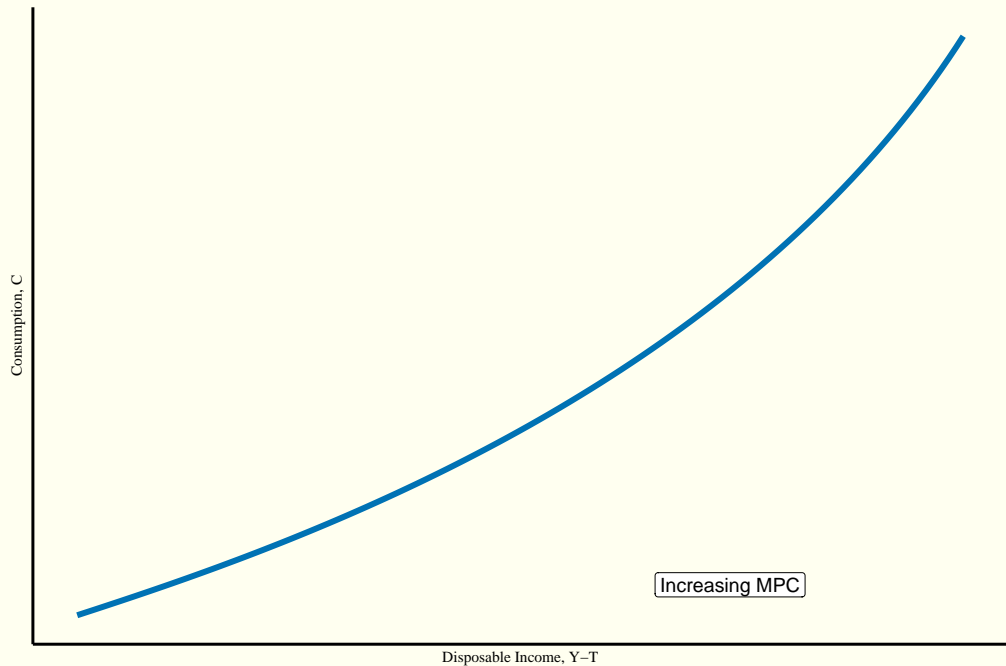
- receive income from their labor and capital ownership
- pay taxes to the government
- decide how much of their after-tax income to spend and how much to save

Then, consumption is a direct function of **disposable income**, written

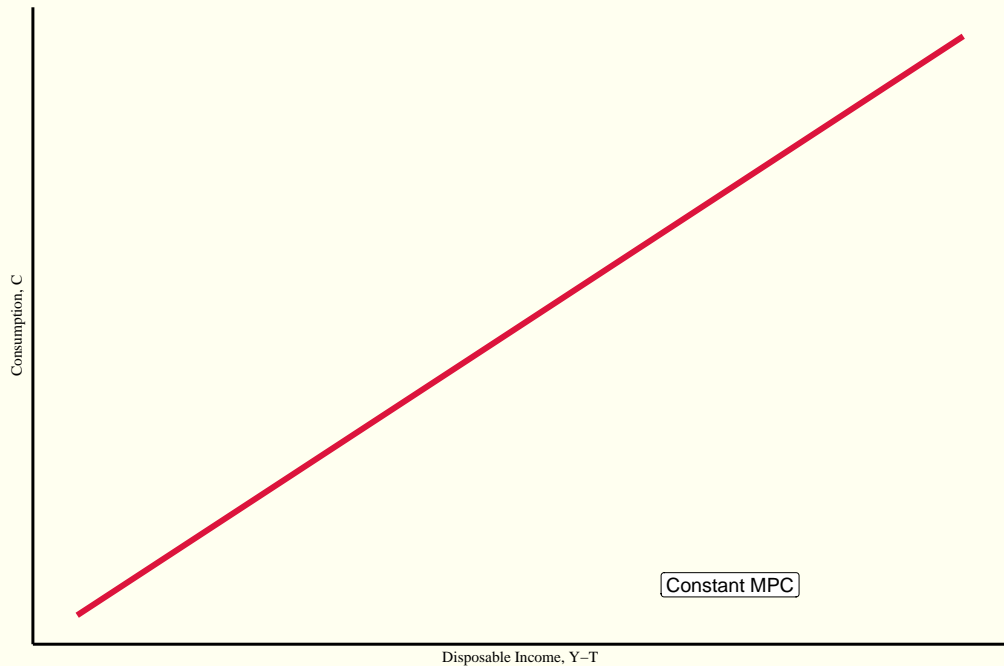
$$C = C(Y - T)$$

This function is called the **consumption function**.

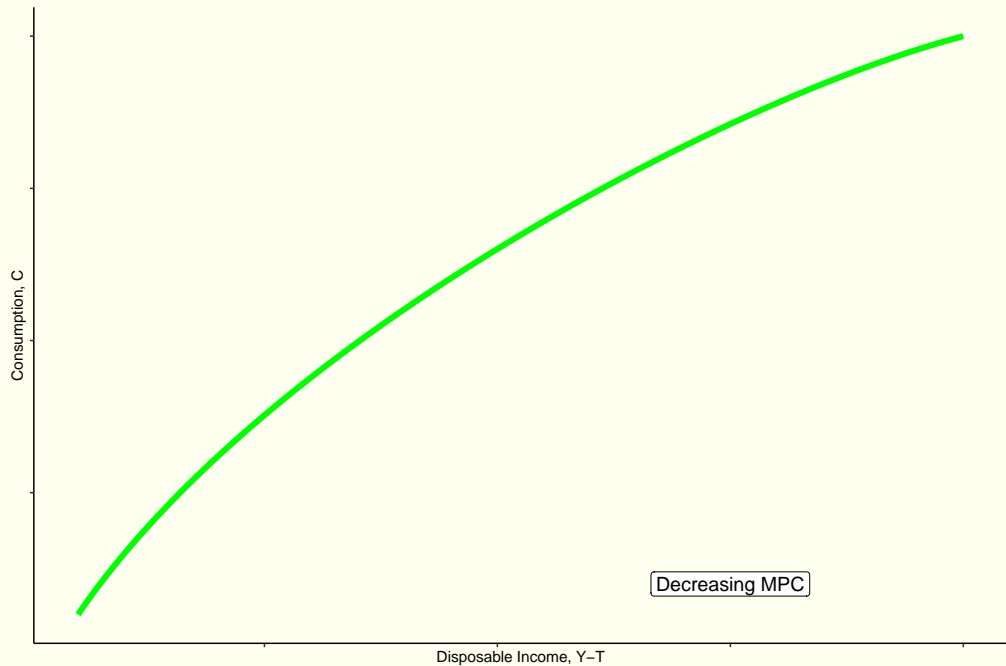
The Consumption Function



The Consumption Function



The Consumption Function



Investment

The **interest rate** measures the cost of the funds used to finance investment, i.e. the cost of borrowing. For an investment to be profitable, the **return** — the revenue from increased future production of goods and services — must be greater than the cost — the payments for borrowed funds — of the project.

Investment

You have the opportunity to build a \$1M factory which yields a return of \$.1M per year.

- interest payments $> 10\%$ \rightarrow Don't build
- interest payments $< 10\%$ \rightarrow Build
- interest payments $= 10\%$ \rightarrow indifferent

We haven't supposed there is an interest rate which is risk-free in this setup. If there were this changes the analysis.

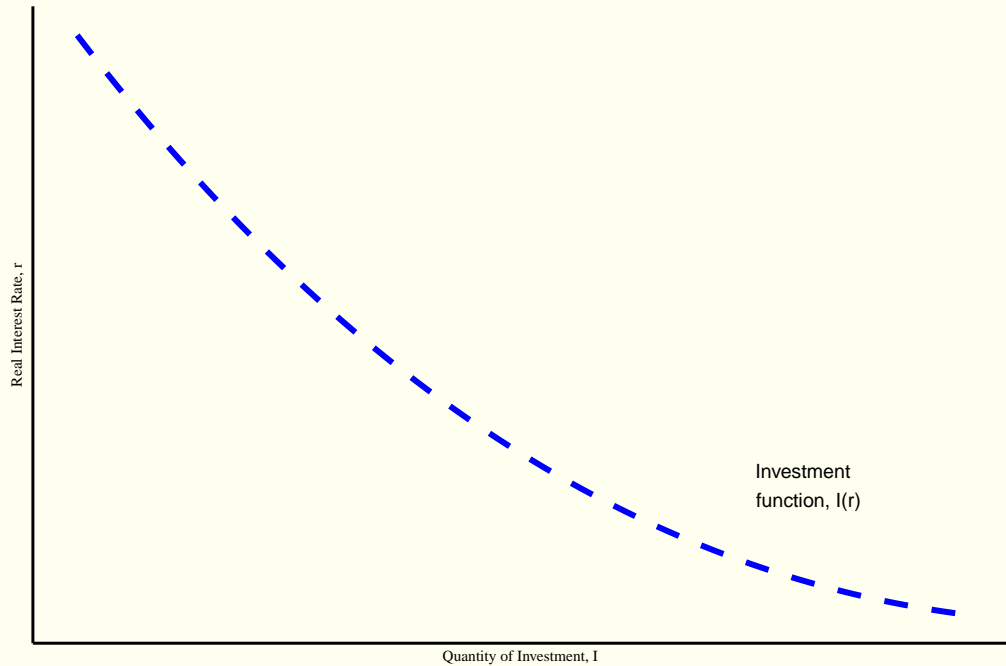
Interest - Nominal v. Real

- The **nominal interest rate** is the interest rate as usually reported; the rate at which investors borrow money
- The **real interest rate** is the nominal interest rate corrected for inflation

Investment is directly related to the interest rate. Thus, we can write

$$I = I(r)$$

The Investment Function



Government Purchases

- Government purchases account for 20% of GDP.
- Transfer payments are not included in **G**
- Transfer payments do indirectly affect the demand for goods & services

Government Purchases

- purchases = taxes \rightarrow *balance budget*
- purchases $>$ taxes \rightarrow *budget deficit*
- purchases $<$ taxes \rightarrow *budget surplus*

In our simplified model, we will assume that these are both determined. That is

$$G = \bar{G}$$

$$T = \bar{T}$$

What Brings the Supply and Demand for Goods and Services into Equilibrium

Equilibrium in the Market for Goods and Services: The Supply and Demand for the Economy's Output

$$Y = C + I + G$$

$$C = C(Y - T)$$

$$I = I(r)$$

$$G = \bar{G}$$

$$T = \bar{T}$$

We know that output is determined by the factors of production and production function.

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

Let's Combine What We Know

$$Y = C(Y - T) + I(r) + G$$

$$\bar{Y} = C(\bar{Y} - \bar{T}) + I(r) + \bar{G}$$

At the equilibrium interest rate, the demand for goods and services equals the supply.

Equilibrium in the Financial Markets: The Supply and Demand for Loanable Funds

$$Y - C - G = I$$

The LHS is the output that remains after the demand of consumers and the government has been met. It is called **saving (S)**. This identity implies that saving equals investment.

Saving

$$S = (Y - T - C) + (T - G) = I$$

- $(Y - T - C)$: **Private Savings**
- $(T - G)$: **Public Savings**

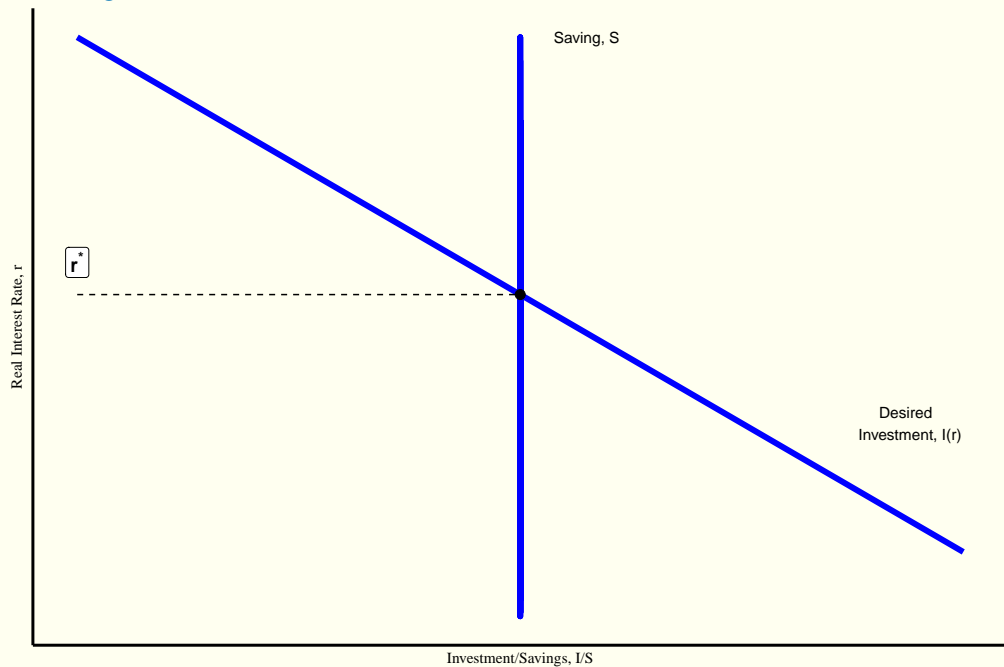
$$Y - C(Y - T) - G = I(r)$$

$$\bar{Y} - C(\bar{Y} - \bar{T}) - \bar{G} = I(r)$$

$$\bar{S} = I(r)$$

At the equilibrium interest rate, households' desire to save balances firms' desire to invest, and the quantity of loanable funds supplied equals the quantity demanded.

Saving, Investment, and the Interest Rate



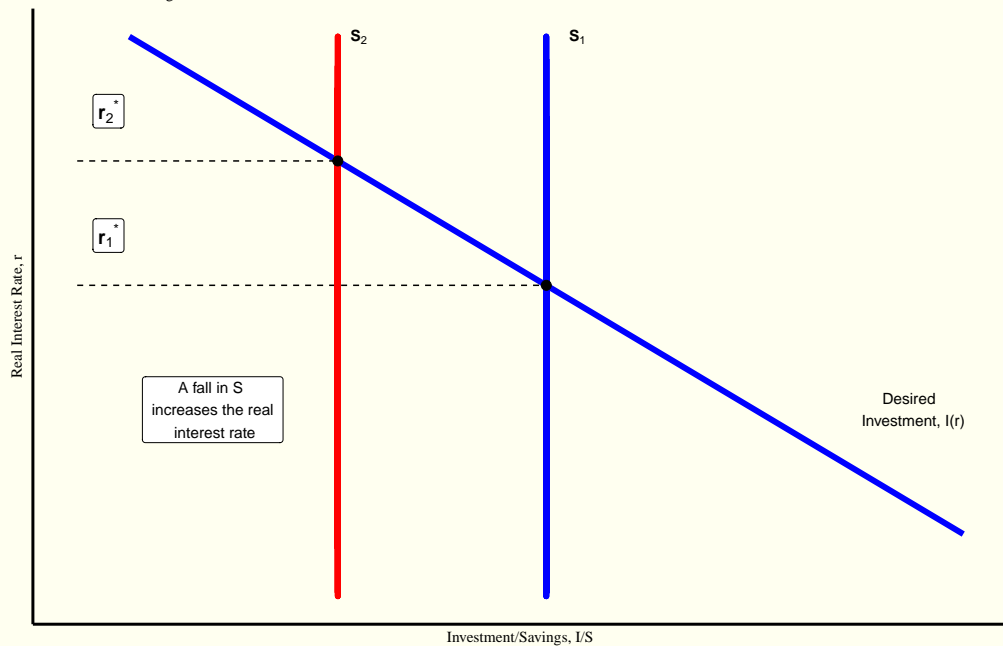
Effects of a Change in Fiscal Policy

Suppose there is an increase in government purchases, ΔG .

- Demand increases immediately for goods and services
- Because all other factors are fixed, $I \downarrow$
- $S \downarrow$
- $r \uparrow$
- In total, \uparrow in G is said to **crowd out** I

Savings, Investment, and the Interest Rate

A Reduction in Saving

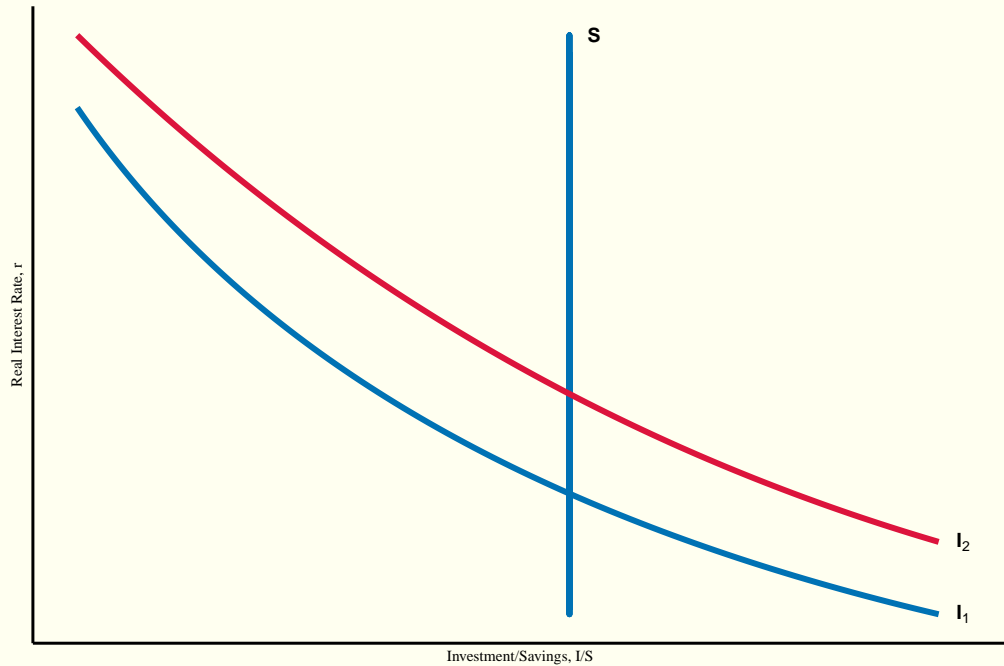


Changes in Investment Demand

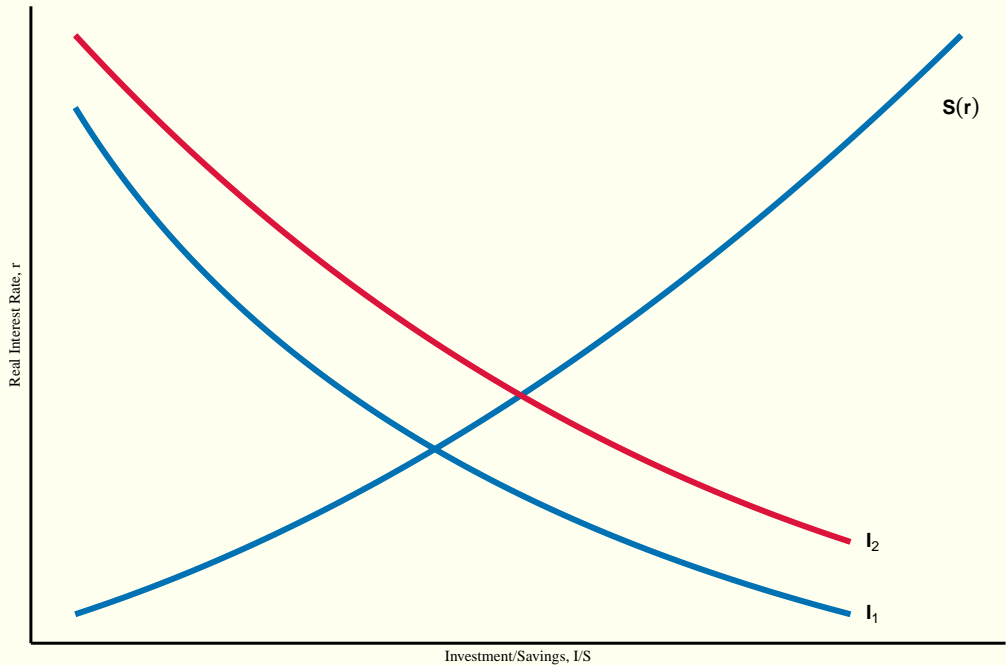
Let's consider two cases

- 1 Preferable changes in the tax code increase investment demand
- 2 S depends on r

Increase in Investment Demand



Increase in Investment Demand When Saving Depends on the Interest Rate



Conclusion

- The factors of production and the production technology determine output
- Each factor of production is paid its marginal product
- The economy's output is used for **C, I, & G**
- The real interest rate adjusts to equilibrate the supply of and demand for the economy's output