Macroeconomic Theory and Policy

Lecture 31

Theories of Investment

Determinants of investment

- Interest rate
- Change in output
- Expected profit as measured by Tobin’s q
- Investment tax credit
- Size of the market
- Capital mobility and exchange rate regime
- Wage rate-cost of labour
- Technology of production

Types of Investment

- Durable and non-durable investments
  - plant and machinery
  - transportation and communication networks,
  - building and vehicles
- Inventories
- Public and Private
- Long term and short term

Why investment is most volatile component of GDP?

- Investment represents a change in the capital stock
- Capital stock is a lot higher than the amount of investment
- A small change in capital stock means a large change in investment
- An example

capital output ratio (K/Y) = 2.5

Investment GDP ratio (I/Y) = .2

Ratio of capital stock to investment (K/I) = (2.5/0.2) =12.5

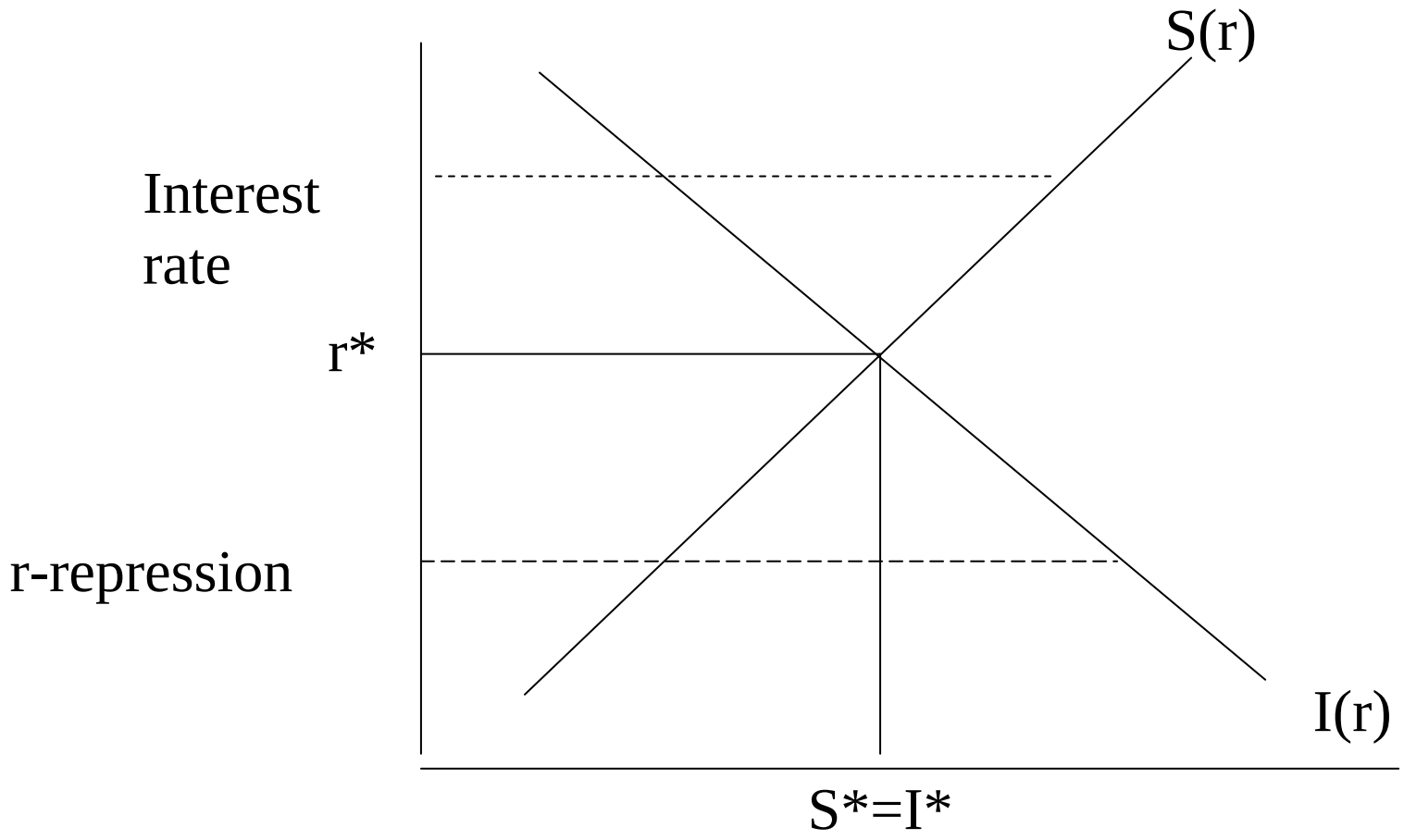
One percent change in K causes 12.5 percent change in I.

- Investment flows are most volatile also because they depend on profit expectations of millions of firms in the economy who differ in their opinion regarding the future of the economy

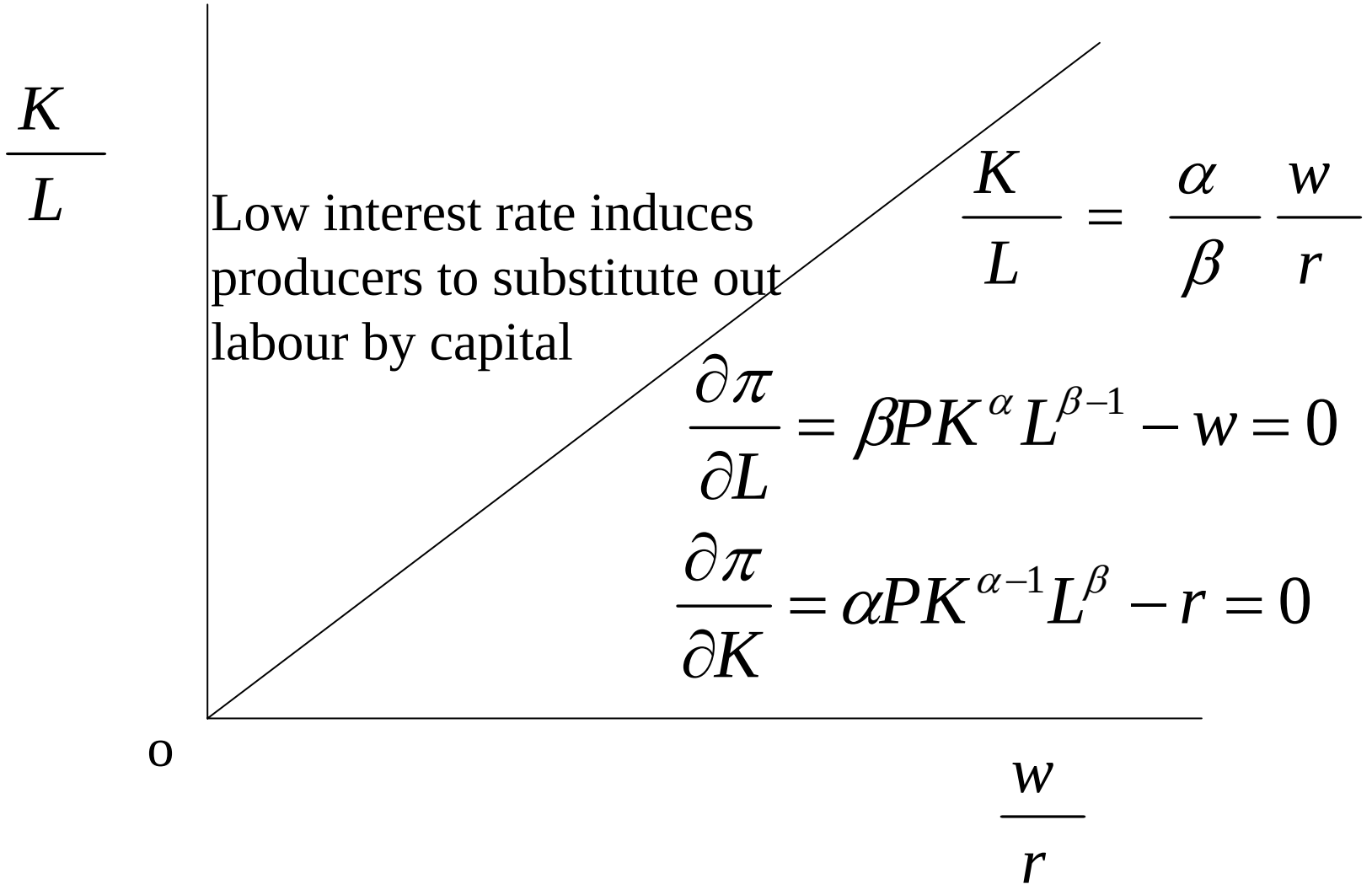
Four major theories of investment

- Marginal productivity theory of investment and IS-LM approach
- Accelerator principle and multiplier accelerator theory of investment
- Tobin’s q-theory and portfolio allocation
- Investment in a simple dynamic general equilibrium model

Equilibrium Interest Rate: Saving and Investment



$$\pi = PK^{\alpha}L^{\beta} - wL - rK$$

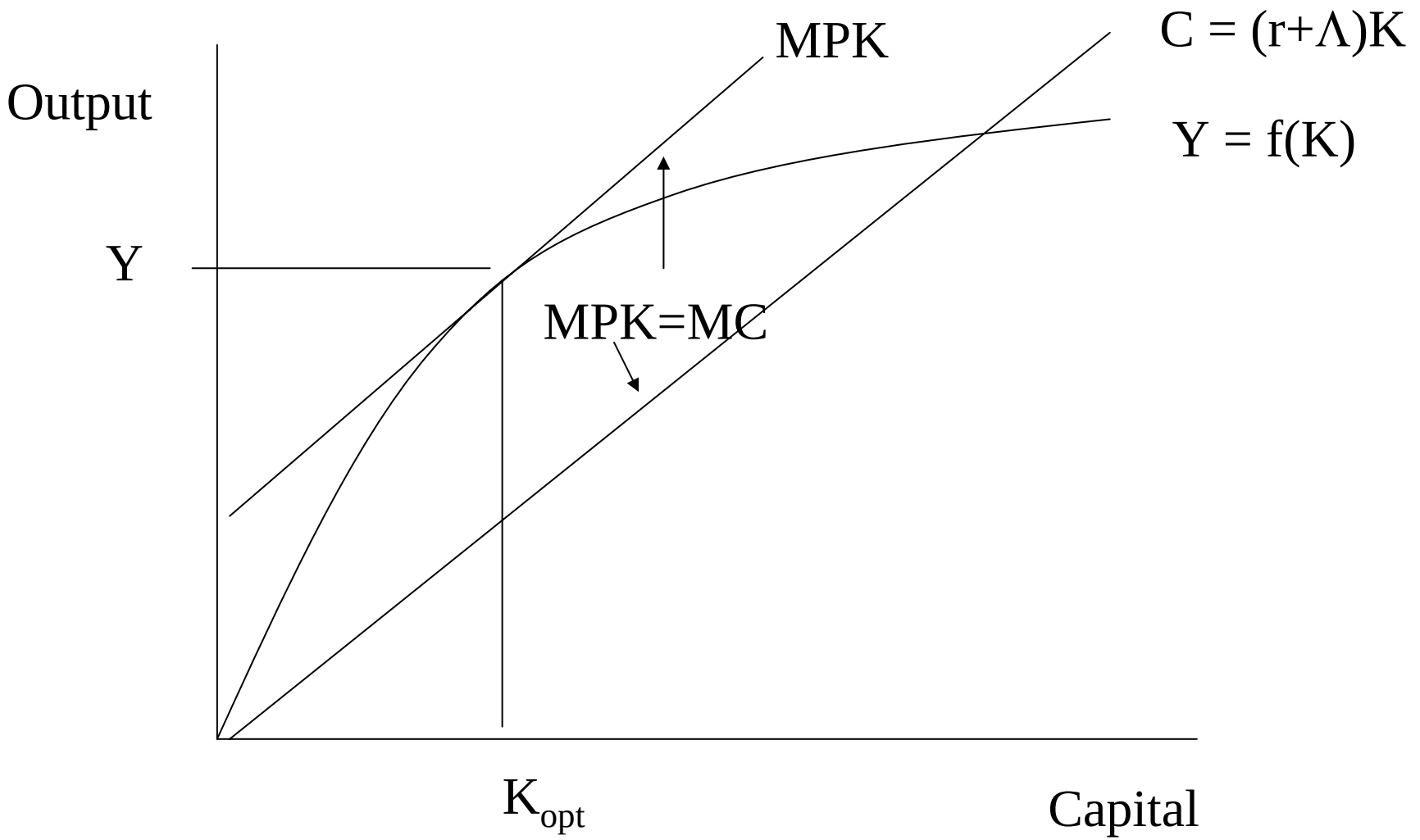


$$\frac{K}{L} = \frac{\alpha}{\beta}\frac{w}{r}$$

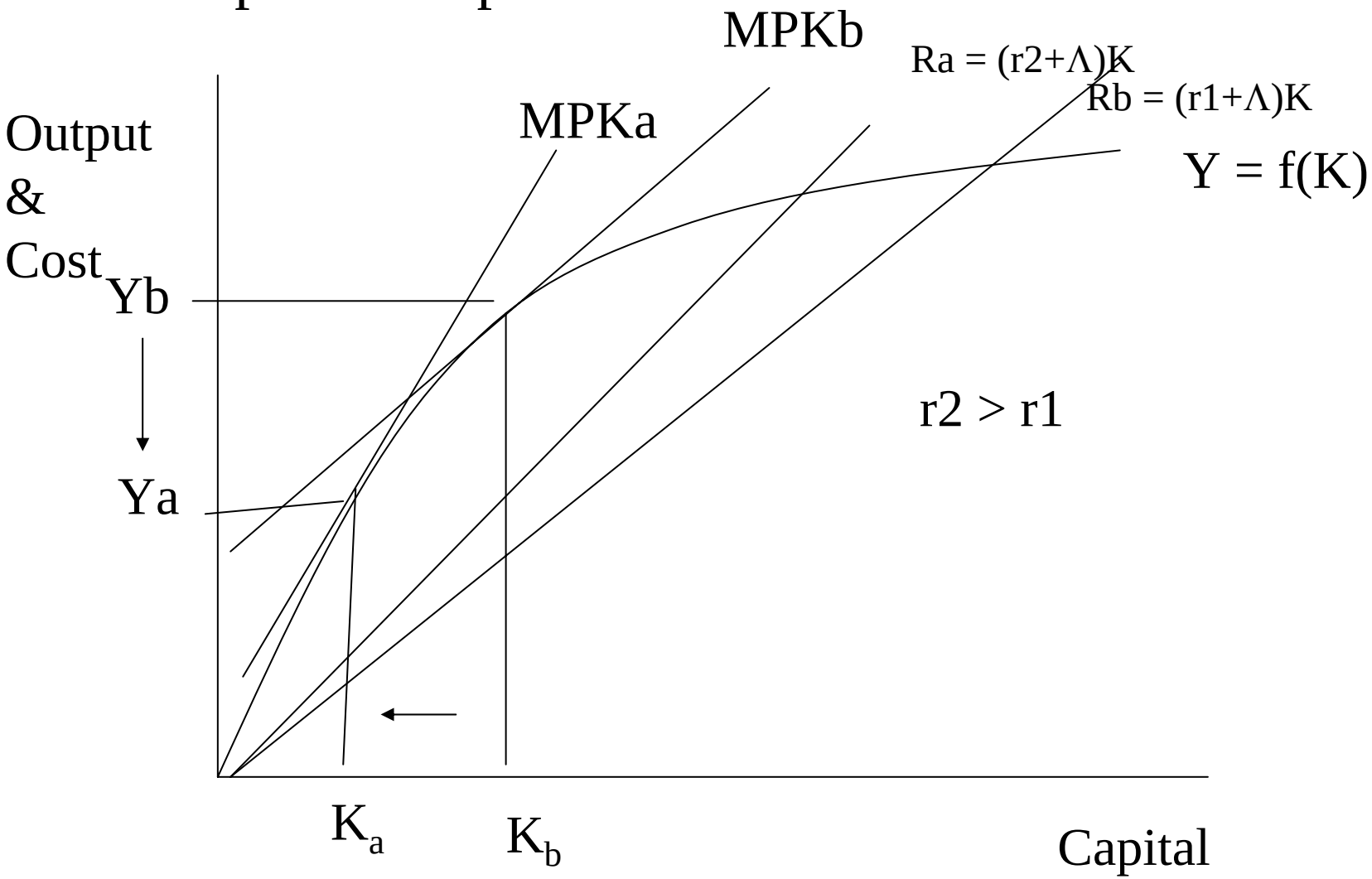
$$\frac{\partial \pi}{\partial L} = \beta PK^{\alpha}L^{\beta-1} - w = 0$$

$$\frac{\partial \pi}{\partial K} = \alpha PK^{\alpha-1}L^{\beta} - r = 0$$

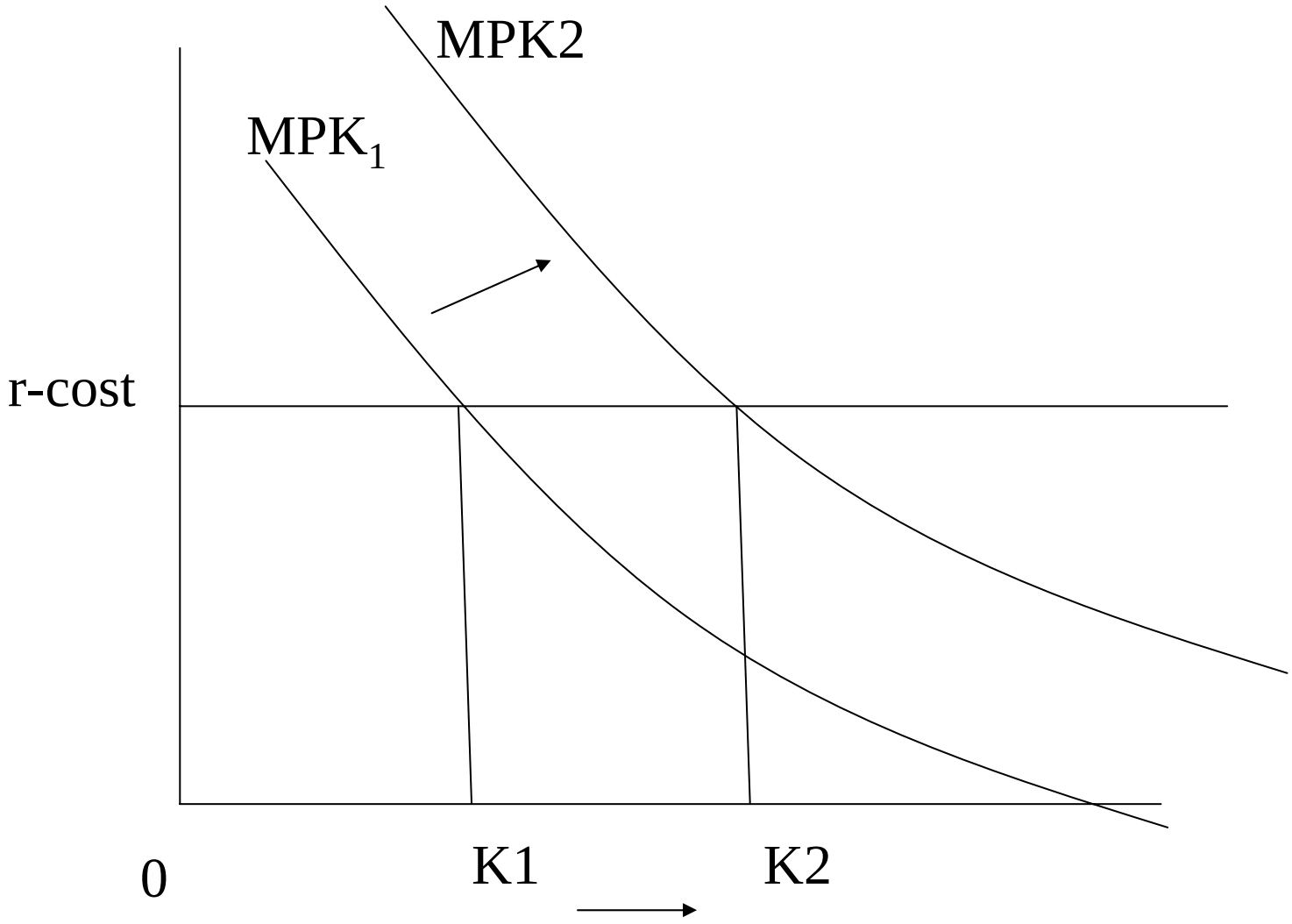
Optimal Capital Stock for a Firm



Impact of Increase in the Interest rate on the Optimal Capital Stock for a Firm



Impact of Technological Advancement in the Capital Stock



Marginal Productivity Theory of Investment -calculations

Output and Capital Accumulation

$$Y = F(K) \text{ and } K_t = K_{t-1}(1-\delta) + I_t$$

Investment

$$I\left[V\left(\Pi_t^e\right)\right] = I\left[\frac{1}{1+r_t}\Pi_{t+1}^e + \frac{1}{\left(1+r_t\right)\left(1+r_t^e\right)}(1-\delta)\Pi_{t+1}^e + ... + \right]$$

and $$\Pi_t = \Pi\left(\frac{Y_t}{K_t}\right)$$

Optimal investment

$$MPK \cong \left[r + \delta + \pi^K\right]P_1^k$$

Marginal Productivity and the User Cost of Capital

$$\Pi = \frac{F(K)}{(1+r)} - P_1^k K + \frac{(1-\delta)P_2^K K}{1+r}$$

$$\frac{\partial \Pi}{\partial K} = \frac{F'(K)}{(1+r)} - P_1^k + \frac{(1-\delta)P_2^K}{1+r} = 0$$

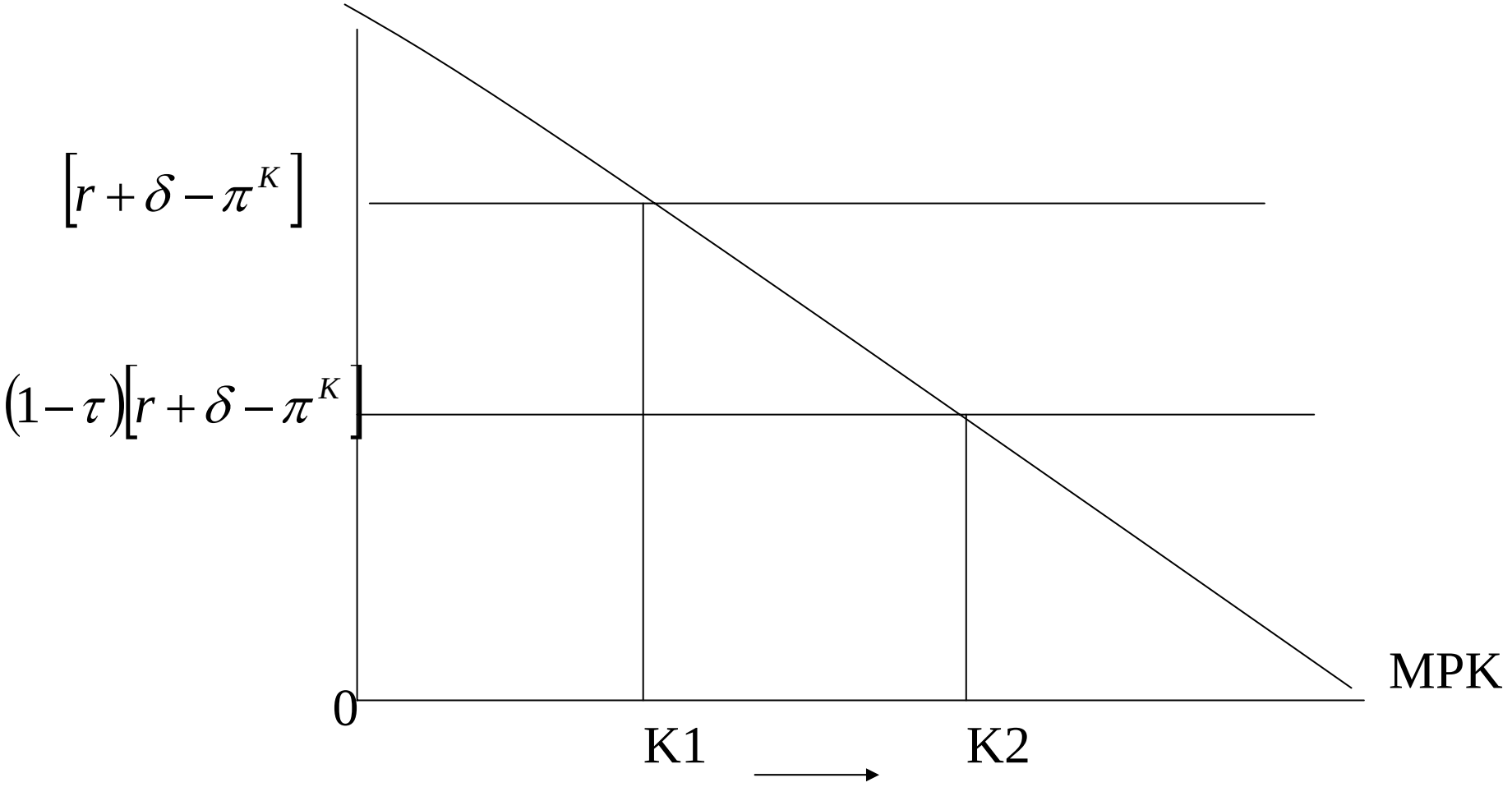
or $MPK = (1+r)P_1^k - (1-\delta)P_2^K$

$$MPK = \left[(1+r) - (1-\delta)(1+\pi^K)\right]P_1^k$$, where

$\pi^K = \frac{P_2^K}{P_1^K} - 1$ is the capital gain. $\delta\pi^K \cong 0$

$$MPK \cong \left[r + \delta - \pi^K\right]P_1^k$$

Role of Investment Tax Credit in Promoting Investment
Why Manufacturers Lobby for a Tax Credit?



Optimal Capital Stock for the Car Company

The user cost of capital

$$i + \delta - \pi^{K} = 6\% + 3\% - 3\% = 6\%$$

Marginal product of capital:

$$F'(K_1) = \alpha K^{\alpha - 1} = 0.75K^{0.75-1}$$

Optimal Investment condition

$$P.F'(K_1) = P_1^{k}\left(i + \delta - \pi^{k}\right) \Rightarrow$$

$$8000(0.75)K^{0.75-1} = 2000(6\% + 3\% - 3\%) \Rightarrow$$

$$8.(0.75)K^{-0.25} = 2(6\%);\ 6K^{-0.25} = 2(6\%) \Rightarrow$$

$$K^{0.25} = \left(\frac{3}{0.06}\right)\ K = (50)^4 = 6.25 \text{ million}$$

A Simple Illustration of the Multiplier Accelerator Theory of Investment

Consumption function: $C_t = c_0 + c_1 Y_t$

National income identity: $Y_t = C_t + I_t$

Investment Multiplier: $\frac{\partial Y}{\partial I} = \frac{1}{1 - c_1}$

Investment is Change in Capital Stock $I_{n,t} = K_t^d - K_{t-1}$

Capital stock is multiple of output: $K_t = \alpha Y_t;\ \alpha > 0$.

$$I_{n,t} = \alpha Y_t - \alpha Y_{t-1} = I_{n,t} = \alpha(\Delta Y_t)$$

Accelerator: $\alpha = \frac{I_{n,t}}{\Delta Y_t}$

Multiplier Acceleration effect on Output: $\Delta YT = \frac{\alpha(\Delta Y)}{1 - c_1}$

Interest Rate, Factor Substitution and Income Distribution

$$Y_t = A_t K_t^{\alpha} L_t^{\beta} \qquad \frac{rK}{Y} + \frac{wL}{Y} = 1$$

$$\alpha = \frac{rK}{Y} = \frac{\alpha A K^{\alpha-1} L^{\beta} . K}{Y} \qquad \beta = \frac{wL}{Y} = \frac{\beta K^{\alpha} L^{\beta-1} L}{Y}$$

$$\sigma = \frac{\frac{\Delta(K/L)}{K/L}}{\frac{\Delta(w/r)}{w/r}} = \frac{\frac{\Delta(K/L)}{K/L}}{\frac{\Delta\left(\beta A K^{\alpha} L^{\beta-1} \Big/ \alpha A K^{\alpha-1} L^{\beta}\right)}{\beta A K^{\alpha} L^{\beta-1} \Big/ \alpha A K^{\alpha-1} L^{\beta}}} = \frac{\frac{\Delta(K/L)}{K/L}}{\frac{\Delta(K/L)}{K/L}} = 1$$

Simple Dynamic General Equilibrium Model of Investment
Cass (1966)

Max $U_t = \sum_{t=0}^{\infty} \beta^t \ln(C_t)$ $\quad 0 < \beta < 1$ (4.1)

Subject to:

Output and the technology constraint: $Y_t = AK_t^{\alpha}$ $\quad 0 < \alpha < 1$ (4.2)

Market clearing condition: $C_t + I_t = Y_t$ (4.3)

Capital formation: $K_{t+1} = I_t$ (4.4)

Boundary (initial) condition $K_0 = K_0$ (4.5)

Capital formation: $K_{t+1} = K_t(1-\delta) + I_t$ (4.4')

Solution of the Dynamic General Equilibrium Model of Investment
Cass (1966)

$$U_t = +\beta^t \ln\left(AK_t^{\alpha} - K_{t+1} + K_t\left(1-\delta\right)\right) + \beta^{t+1} \ln\left(AK_{t+1}^{\alpha} - K_{t+2} + K_{t+1}\left(1-\delta\right)\right) + ..+$$

$$\overline{Y} = A^{\frac{2-\alpha}{1-\alpha}} \left(\frac{\alpha\beta}{1-\beta\left(1-\delta\right)}\right)^{\frac{\alpha}{1-\alpha}}$$

$$\bar{I} = \delta\overline{K} = \delta\left(\frac{\alpha A\beta}{1-\beta\left(1-\delta\right)}\right)^{\frac{1}{1-\alpha}}$$

$$\overline{C} = \left(\frac{\alpha A\beta}{1-\beta\left(1-\delta\right)}\right)^{\frac{\alpha}{1-\alpha}} - \delta\left(\frac{\alpha A\beta}{1-\beta\left(1-\delta\right)}\right)^{\frac{1}{1-\alpha}}$$

Questions

- Why investment ratio is high in newly emerging economies?
- Low in high income economies?
- Very low in poor countries?
- What is the optimal level of investment?

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