The Classical Model

Chapter 7
Lecture notes posted online

The Classical Model

- Model of output determination and economy-wide equilibrium
- Can be used to study economic growth and business cycles
- Considered a more complete description of the long-run than the short-run

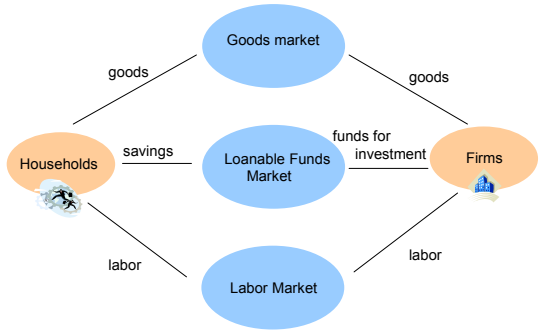
Key Building Blocks

- Closed economy (no exports and imports)
- Populated by two types of agents
  - Households
  - Firms
- (Later will also add government)

Key Building Blocks

- Agents interact in *three* markets
  - Goods Market (GM)
  - Loanable Funds Market (LFM)
  - Labor Market (LM)
- Markets are competitive
  - Like in Econ 101, demand and supply determine the equilibrium outcome

Agents and Markets in Classical Model



Markets

- Goods market is where firms sell their output to households (consumption goods) and other firms (investment goods)
- Loanable funds market is where household save funds for interest, and firms seek funds to finance investment projects
- Labor market is where households offer labor, and firms hire them to produce goods

Households

- Recipients of all factor payments by firms = income
- Make *two* important decisions:
  - Given income, decide how much to save S and consume C
  - Given time endowment, decide how much labor to supply to the market, and how much leisure to consume

7

Firms

- Produce output using capital (machines) and labor (people)
- Make two important decisions:
  - How much labor to employ
  - How much to invest in new machines, that will result in more capital in the future

8

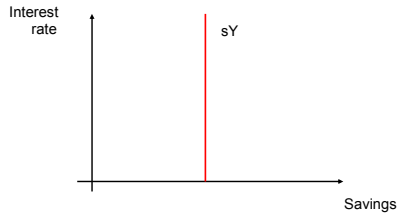
Savings/Consumption Decision of HH

- Will assume households decide to save a constant fraction of their income: S=sY
  - Implies consumption is also a constant fraction of income: C=Y-S=(1-s)Y
  - Example: s=1/3, if income is 150, S=50, consumption is C=Y-S=(1-1/3)150=100

9

Implied Supply of Savings

- Supply of savings by households as function of interest rate (return on savings)



10

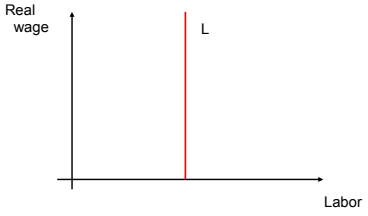
Labor/Leisure Choice of HH

- Assume households supply 1 unit of labor each, and so supply of labor simply equals population size = L

11

Supply of Labor

- Supply of labor by households as a function of real wage (real compensation of labor)



12

Production in Firms

- Produce output using capital (machines) K and labor (people) L
  - Production summarized is by a production function
  - Example: $Y = \sqrt{KL}$
- Assumed properties of the production function:
  - Output increasing in labor and capital
  - Diminishing returns from labor and capital
  - Returns to scale are constant

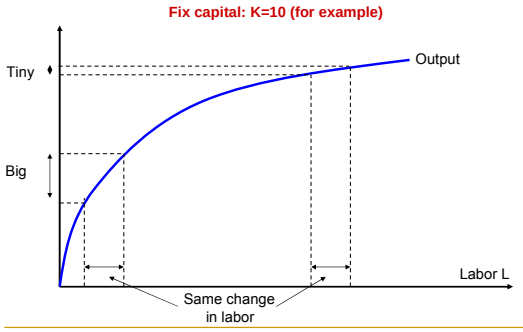
13

Properties of Production Function

- Increasing in labor and capital
  - Add labor or capital → output will increase
- Diminishing returns from labor and capital
  - Add labor while keeping capital fixed → output increases, but increments smaller and smaller as you keep adding more and more labor
- Returns to scale are constant → production process is replicable – double labor and capital, and output will *exactly* double

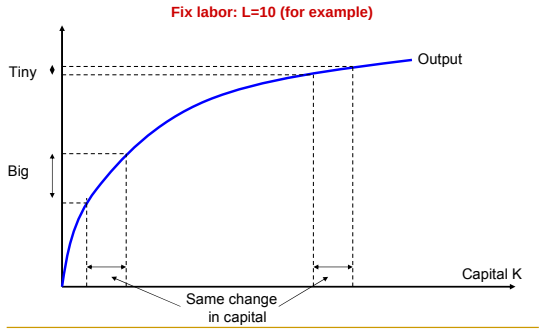
14

Diminishing Returns From Labor



15

Diminishing Returns From Capital



16

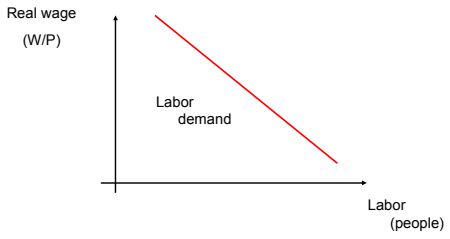
Demand for Labor

- Diminishing returns from labor → demand for labor decreasing function of real wage
  - Given a fixed level of capital K, each incremental worker adds *less and less* to production
    - Cost of hiring a worker increases → firms are willing to hire *fewer* workers

17

Demand for Labor

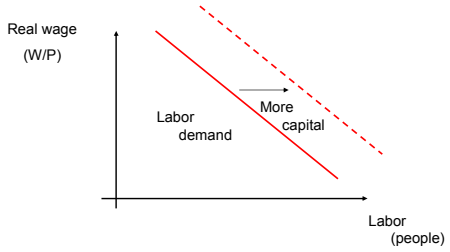
- Demand for labor (for a fixed level of capital K)



18

Demand for Labor

- Increase in capital K shifts labor demand



19

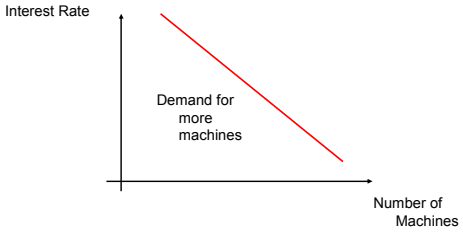
Demand for Investment (Funds)

- Diminishing returns from capital → demand for investment decreasing function of interest rate
  - Given a fixed level of labor L, each incremental unit of capital adds less and less to production
    - Cost of funds increases → firms want to invest less

20

Demand for Investment (Funds)

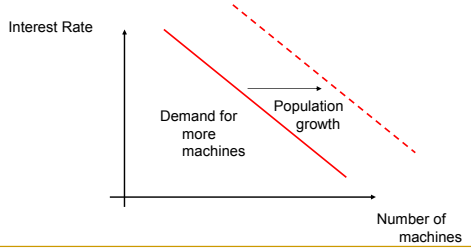
- Demand for funds (for a fixed level of labor)



21

Demand for Investment (Funds)

- Increase in labor force (here=population) shifts demand for investment



22

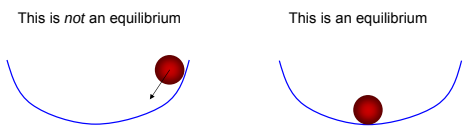
Recap

- So far, determined demand and supply in
  - Labor market
  - Loanable funds market
- Now, need to answer what will be the outcome in the entire economy

23

What is Going to Happen?

- Equilibrium of a system is a state of the system in which there are no internal forces in the system to produce a change



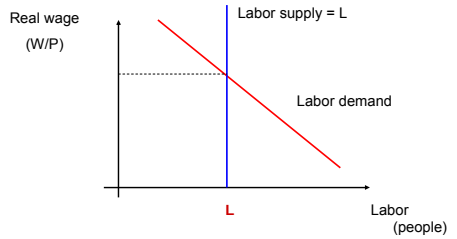
24

What is Going to Happen?

- Equilibrium in this model is when all markets clear
  - Demand for labor = supply of labor
  - Demand for investment = supply of funds
  - All output gets sold, i.e. planned consumption and planned investment equals output (C+I=Y)

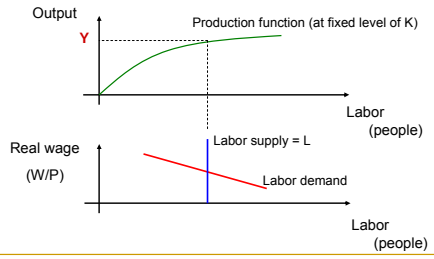
Equilibrium Employment *L*

- Labor market equilibrium determines L



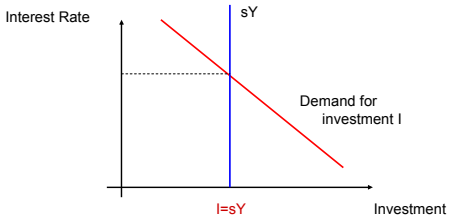
Equilibrium Output *Y*

- Y determined by L (capital K predetermined)



Equilibrium (Planned) Investment *I*

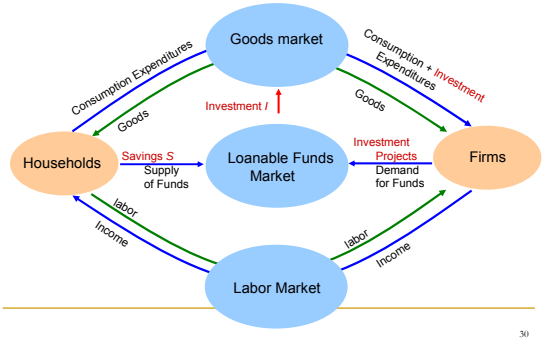
- Loanable funds market determines investment I



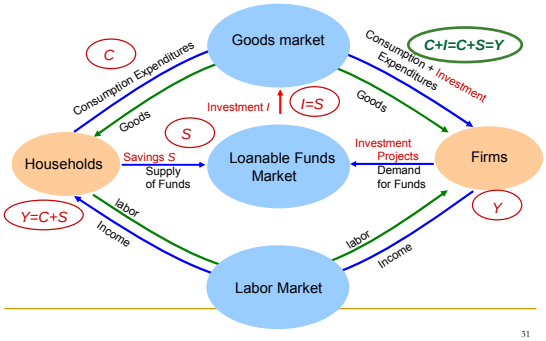
Say's Law: Spending Purchases Output

- In the classical model, all output gets sold automatically, and so C+I=Y
- We do not need to worry about the goods market
  - Follows from a simple accounting identity implied by the circular flows

Circular Flows in the Classical Model



Say's Law: Outflows = Inflows



Say's Law: Outflows = Inflows

- Y flows from firms to households (by definition Y=C+S)
- On the expenditure side
  - S flows out
  - I flows in
  - Since in equilibrium in the loanable funds market S=I, outflows = inflows, and so C+I = Y

What Happens to Capital K?

- Today's K predetermined, but future K evolves with investment
  - Capital tomorrow = capital today – depreciation of capital + investment

$$K_{tomorrow} = (1-\delta)K_{today} + I$$

- Where δ is depreciation rate of capital (fraction of capital worn out in production)

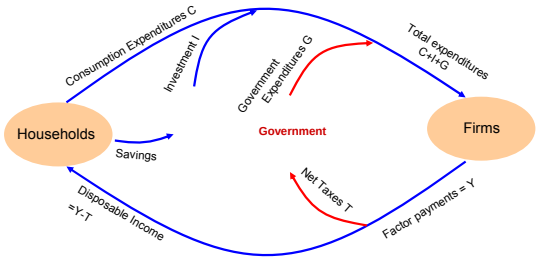
What Happens to Capital K?

- Our equilibrium is a static equilibrium
  - Given capital, we pin down investment, employment and output
- It raises questions where the economy is heading in the future
  - Will make capital part of our analysis soon

Adding Government to the Model

- Key assumptions:
  - Government takes away net taxes *T* from households factor income *Y* and spends *G* in the goods market on goods and services

Adding Government to the Model



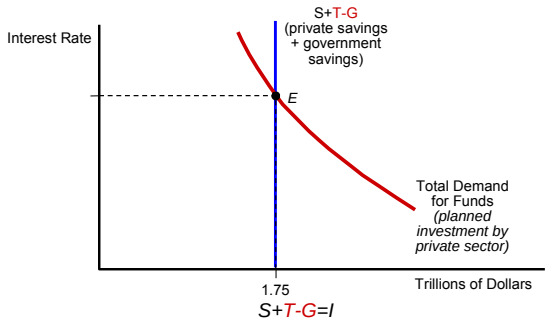
Key Modifications

- Government savings T-G (or deficit if negative) *affects* the loanable funds market
  - When T-G>0, governments saves and supplies funds to the LF market
  - When T-G<0, government borrows from the private sector and takes away funds from LF market
- Households' after tax income is *Y-T*

Budget Deficit and Surplus

- Budget deficit is a situation when government spending exceeds net tax receipts *G-T>0*
  - Government borrows in the loanable funds market
- Budget surplus is a situation when government net tax receipts exceeds spending *T-G>0*
  - Government saves in the loanable funds market

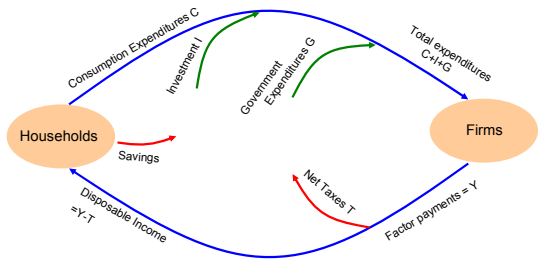
Modified Loanable Funds Market



Say's Law Holds with Government

- Again, think in terms of inflows and outflows
  - Y flows from firms to households
  - S and T flows out
  - I and G flows in
  - S+T-G=I in equilibrium in loanable funds market
- So, again, what flows out S+T, flows in as I+G, and so C+I+G=Y
  - Algebraically, C+I+G=C+S+T-G+G=C+S+T=Y

Say's Law Holds: Red = Green



Numerical Example

- Suppose, G=0, T=0, s=.2, L=10, K=10, and $Y=K^{1/2}L^{1/2}$, calculate output and investment in the equilibrium of the classical model
- Assume depreciation rate of capital = 10% (10% of capital stock wears out each period due to aging). What will be the level of capital next period?
- Is it more or less than today?

Solution

- $Y=K^{1/2}L^{1/2}=10$
- S=s(Y-T)=.2x10=2
  - In equilibrium, I=S+T-G, and so I=2
- K tomorrow = .9K today + 2 = .9x10+2=11
- 11>10, K is growing
  - K today = 10
  - K tomorrow = 11

Dynamic (Long-run) Equilibrium

Dynamic Equilibrium

- So far, silent about K
  - Given predetermined capital K, determined: output, investment and employment
  - In other words, determined static equilibrium (within a period)…but not dynamic (across periods)
- Our goal: Find out where the economy is heading in the future?

Basic Idea

- Future output, investment and employment depends on today's investment
- Evolution of capital from one period to the next critical to determine where the economy is heading

Evolution of Capital

- Recall our assumption:

$$K_{tomorrow} = (1-\delta)K_{today} + I$$

- IMPLIES: Future capital depends how investment *I* compares to depreciation δK

$$K_{tomorrow} = (1-\delta)K_{today} + I = K_{today} - \delta K_{today} + I,$$

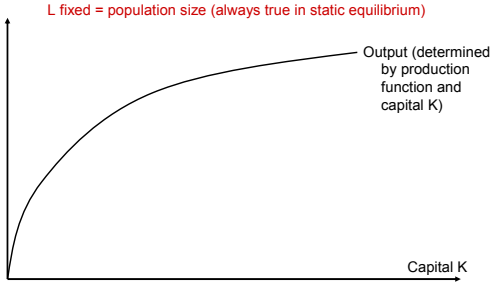
and so, $K_{tomorrow} - K_{today} = I - \delta K_{today}$

Evolution of Capital

$$K_{tomorrow} - K_{today} = I - \delta K$$

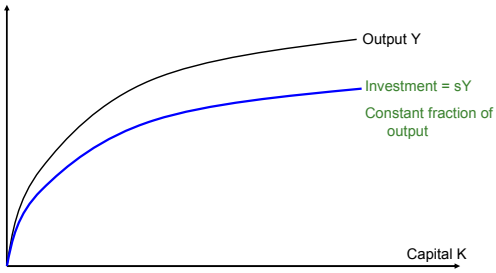
- The above equation implies:
  - $I > \delta K_{today}$ → capital K *grows*
  - $I < \delta K_{today}$ → capital K *falls*
  - $I = \delta K_{today}$ → capital K remains *unchanged*

Finding Out Where Economy Is Heading



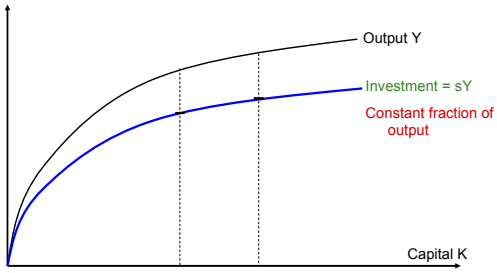
49

Finding Out Where Economy Is Heading



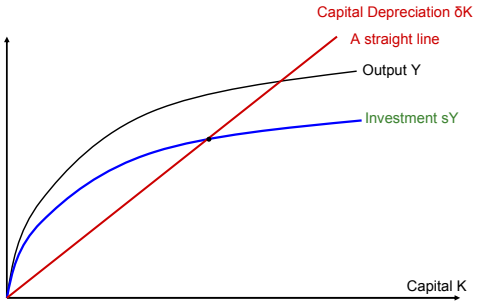
50

Finding Out Where Economy Is Heading



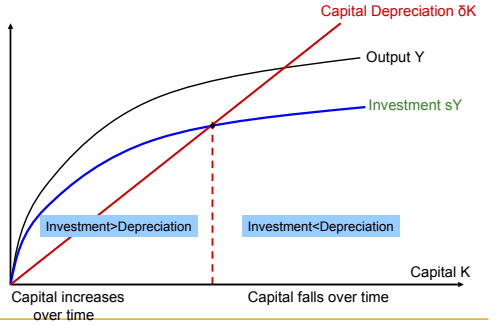
51

Finding Out Where Economy Is Heading



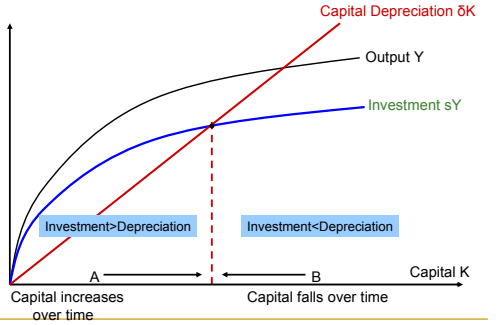
52

Finding Out Where Economy Is Heading



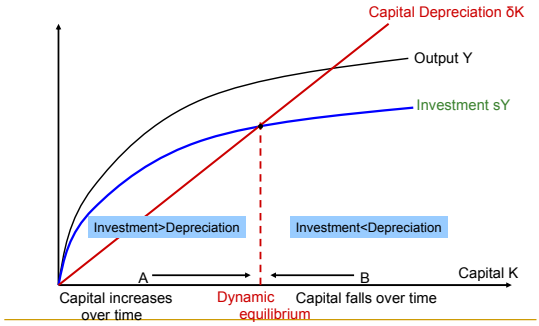
53

Finding Out Where Economy Is Heading



54

Finding Out Where Economy Is Heading



What Is Dynamic Equilibrium?

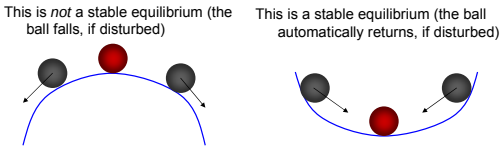
- Recall: Given predetermined level of capital K, static equilibrium is employment, output and investment such that all three market are in equilibrium
- Dynamic equilibrium is the level of capital K such that in the underlying static equilibrium investment *I* = depreciation of capital *δK*

Key Properties of Dynamic Equilibrium

- Dynamic equilibrium is an equilibrium as there are no internal forces to produce a change
  - You start there, you stay there forever
- But, it is also a stable equilibrium
  - No matter where you start, internal forces bring you back to this this point

Stable Equilibrium

- Stable equilibrium of a system is an equilibrium such that the system automatically returns to it, if disturbed



Numerical Example Continued

- Suppose, G=0, T=0, s=.2, L=10, K=10, and $Y=K^{1/2}L^{1/2}$
  - Assuming depreciation rate of capital = 10%, find the dynamic equilibrium

Solution

- Need to find K such that in the underlying static equilibrium $I=\delta K$
- In any static equilibrium, L=10, $I=s(Y-T)+T-G=$ $=.2K^{1/2}L^{1/2}=.2K^{1/2}10^{1/2}$
  - Thus, need K such that $.2K^{1/2}10^{1/2}=\delta K$ (*)
- Calculating, we obtain K=40
  - *HINT: Divide both sides of (*) by the square root of K, and then raise both sides to the square. Compute K.*