

# Macroeconomics

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Part of this note is taken from Mankiw (2009).

# Goals

- The first goal of this course is to acquaint you with fundamental principles and methods of modern macroeconomic theories.
- The second goal of this course is to teach you how to use these principles and methods to think about macroeconomic issues in real life.
- The third goal, which is more specific, is that after this course, you should be able to understand almost all the reports and debates related to macroeconomic data and policy in the Wall Street Journal.

# Chapter 1

## Introduction

### 1 What is Macroeconomics?

- Macroeconomics studies the economy as a whole. It tries to explain how the economy as a whole works and seeks to find out ways (design economic policies, institutions) to make it work more efficiently.
- Microeconomics is the study of how individual economic agents (workers, managers, students and professors, firms, universities) make decisions (behave) and how these decision makers (their behavior) interact in individual markets.

## 2 A List of Macro and Micro Economic Questions

- What determines a country's Real GDP (which measures the total income of everyone in the economy, adjusted for price changes)? What determines an economy's growth path in the long-run?
- How does a farmer set the price of corn? How does a firm decide what to produce, and how much to produce? What determines a firm's dividend policy? Why do firms pay dividends? What explains mergers and takeovers? Why are prices sticky? Why do firms use stock options to compensate their managers? What explains the Golden Parachute?
- What explains business fluctuations? what explains unemployment? What caused the great depression? What explains the new economy? What is the so-called globalization?
- How to reduce unemployment and business fluctuations? What is the optimal size of the government deficit or surplus? How does the Fed decide what kind of monetary policy to implement? How does the federal reserve decide to cut or raise the interest rate?

### 3 Why Macroeconomics?

Macroeconomics is important for anybody that must live a life in a modern economic society.

You are a student. You probably want to know how the labor market is going to be in two or three years. That has a lot to do with how the macroeconomy is performing in two or three years, whether the economy is going to keep growing or go into a new recession. That in turn may have to do with the government's macro policies, fiscal and monetary policies. If the government sees inflation rising and then follows a policy to tighten money supply, the economy is likely to slow down and that can have a negative effects on the labor market.

If you are an investor. To invest in real estate or in stocks? It again depends on how you think the macroeconomy is doing. If you think the macroeconomy is picking up speed and so stocks are rising higher, whereas interest rates are likely to increase to crash the real estate market, you probably want to invest more in stocks.

Macroeconomics is important for each of us in a sense because each of us must live in the macroeconomy. Each of us is part of the macroeconomy. Each of us must make decisions that depend on how the economy as a whole is doing.

Likewise, business firms and institutions must also operate in the macro economy. Macroeconomy is thus also essential for business decision making.

For instance, suppose your firm is thinking about invest in a new project. You must borrow to invest. You must then consider the cost of borrowing—the interest rate. Interest rates that are too high can make your project's NPV negative. You must then think how the central bank's policy is going to be. That's macro. The interest rate is a key macro variable.

If your company wants to acquire a smaller competitor. That costs cash. You must be careful. Where the macroeconomy is standing? Is it going into a recession? If yes, you may want to conserve cash to prepare for it. If on the other hand the economy is booming and future cash flows are expected to be higher, then you are in a very different position.

Your company is thinking about entering an exporting business. You worry about the exchange rates and the government's trade policies. Macroeconomics again. If the domestic currency is appreciating, that's going to make it harder for you to sell in foreign markets. Higher exchange rates make your product more expensive for foreigners.

## 4 How Do Economists Think?

- I want to make this course a *serious* economics course.
- *Serious* in the sense that most material I teach will be based on rigorous scientific treatments.
- *Serious* also in the sense that I am going to treat all of you in this classroom as future economists. Starting this course, you have to learn how to think like an economist.
- How does the economist approach a question he has in mind? The answer is: He constructs and uses models.
- A model is a simplified version of reality. Reality is often multi-dimensional and complex, a model leaves out details which are not essential to the issue at hand.

A model is like a map that shows the connections of economic variables that you are interested in.

A model is a like a lab which economists use to conduct thought experiments. Each model is a vehicle that economists use for studying a specific set of questions.

- For economists, models are often mathematical. Making models mathematical has benefits which I will discuss as I proceed.
- How to construct models? What makes a good model? How to use models? — One purpose of this course is teach you how to construct a model, and then use it to derive answers to the questions at hand.

## 5 The Model of Demand and Supply — A Review

- Suppose an economist wants to analyse what determines the price of potatoes and the quantity of potatoes sold in the market. He most likely would construct a model with three major components: One component that describes the buyers' behavior, the second describing the sellers' behavior, and the third describing how the market functions (the market structure).
- He assumes that the buyers' behavior can be summarized by the demand function

$$Q^d = D(P, Y) \quad (1)$$

where  $Q^d$  denotes the aggregate quantity of potatoes demanded,  $D$  is the “demand function”,  $P$  is the price of potatoes, and  $Y$  is the economy's total income (real GDP). The above equation simply states that the aggregate demand for potatoes is determined by the price at which potatoes are to be sold and the economy's total purchasing power.

- He then assumes that the sellers' behavior can be summarized by the following supply function

$$Q^s = S(P, P_m) \quad (2)$$

where  $Q^s$  denotes the aggregate quantity of potatoes supplied,  $S$  is the “supply function”,  $P$  is the price of potatoes, and  $P_m$  is the price of materials involved the production of potatoes (i.e.,  $P_m$  indicates the cost of producing potatoes).

- The economist then makes an assumption about how the buyers and sellers interact in the market. Specifically, he assumes

(1) If  $Q^s > Q^d$ , that is, if there is “excess supply”, then price will fall.

(2) If  $Q^s < Q^d$ , that is, if there is “excess demand”, then price will rise.

And thus the price is stable (when the market reaches an equilibrium) only when demand and supply are in balance (the market clears):

$$Q^s = Q^d. \quad (3)$$

The above equation shows how the market works: it sets the price to equate demand and supply.

- To summarize, equation (1) states how the buyers behave, equation (2) describes how the sellers behave, equation (3) describes how buyers and sellers interact.
- Figures 1-5,1-6

## 6 The Model of Demand and Supply – An Example

Suppose the demand function is

$$D(P, Y) = 60 - 10P + 2Y.$$

Suppose the supply function is

$$S(P, P_m) = 60 + 5P - P_m.$$

Suppose it is given that  $Y = 10$  and  $P_m = 10$ .

Question: What is the equilibrium price and what is the equilibrium quantity?

Well, the equilibrium price must equate demand and supply:

$$60 - 10P + 2Y = 60 + 5P - P_m.$$

Given  $Y = P_m = 10$ , we have

$$60 - 10P + 2 * 10 = 60 + 5P - 10$$

which in turn implies  $30 = 15P$  or

$$P = 2,$$

and the equilibrium quantity bought and sold is equal to

$$Q = 60 - 10P + 2Y = 60.$$

Classwork: What happen if  $Y$  falls from 10 to 5?

## 7 Exogenous and Endogenous Variables

- Models have two kinds of variables: endogenous variables and exogenous variables.
- Exogenous variables are the variables that are determined outside the model, the variables that the model takes as given, the variables that the economist does not intend to use the model to explain.
- Endogenous variables are the variables that the model tries to explain, these are the variables that are to be determined inside the model.
- The endogenous variables in the above model of demand and supply are the price of potatoes and the quantity of potatoes exchanged.
- Models are built to show how changes in the model's exogenous variables affect its endogenous variables.

Readings: Mankiw: Chapter 1.

# Chapter 2

## Macro Economic Variables

### 8 Gross Domestic Product (GDP)

- GDP is the total dollar value of all final goods and services produced in a country within a given period of time.
- GDP includes the value of goods produced, such as houses and corns. It also includes the value of services, such as airplane rides and the professors' lectures. The output of each of these is valued at its market price, and the values are added together to get GDP.
- The level of GDP is computed every three months by the Bureau of Economic Analysis (a part of the U.S. Department of Commerce).
- In 1997, the GDP of the United States is about 8 trillion dollars. In 1997 the US population is about 268 million. Thus in 1997 the *per capita* GDP (GDP per person) is roughly 30,000 US dollars.

## 9 Computing GDP

- Suppose the economy produces two types of goods, apples and oranges. Then

$$\begin{aligned}GDP &= \text{Price of Apples times quantity of apples} \\ &+ \text{Price of oranges times quantity of oranges}\end{aligned}$$

- Suppose the price of apples is 0.5 and the price of oranges is 1.0. Suppose the economy produced 4 units of apples and 3 units of oranges. Then

$$GDP = 0.5 * 4 + 1.0 * 3 = 5.00.$$

- Suppose the economy produces  $N$  types of goods, the price of the  $i$ th type is  $P_i$ , and the quantity of the  $i$ th type good is  $Q_i$ . Then

$$GDP = P_1 * Q_1 + P_2 * Q_2 + \dots + P_N * Q_N.$$

## 10 Nominal versus Real GDP

- Prices of goods change over time. The value of final goods and services measured at current prices is called *Nominal* GDP. The value of goods and services measured using a set of constant prices (base year prices, the base year can be for example 1992) is called the *Real* GDP.

Suppose again the economy produces two types of goods, apples and oranges. Suppose we choose 1998 as the base year. Then

$$\begin{aligned} & \text{Real GDP of 2002} \\ &= 1998 \text{ Price of Apples} * 2002 \text{ quantity of apples} \\ &+ 1998 \text{ Price of oranges} * 2002 \text{ price of oranges} \end{aligned}$$

and

$$\begin{aligned} & \text{Nominal GDP of 2002} \\ &= 2002 \text{ Price of Apples} * 2002 \text{ quantity of apples} \\ &+ 2002 \text{ Price of oranges} * 2002 \text{ price of oranges} \end{aligned}$$

## 11 Some Notes

- GDP measures the value of currently produced goods and services. Used goods are not included. The sale of used cars, for example, are not included in GDP.
- The sale of intermediate goods are not included in GDP. GDP includes only final goods and services.  
For example, suppose a cattle rancher sells one unit of meat to McDonald's for 0.5 dollars, and then McDonald's sells you a hamburger for 1.50 dollars. Should GDP include both the meat and the hamburger (a total of 2 dollars) or just the hamburger (1.5 dollars)?
- Inventories are often included in GDP.

## 12 National Income Accounting

- Goods and services produced by the economy are ultimately purchased by consumers and other agents who spend money to buy them. A useful division of GDP according to alternative uses of the economy's output is the following:

$$Y = C + I + G + NX$$

where  $Y$  stands for GDP,  $C$  is consumption,  $I$  is investment,  $G$  is government purchases, and  $NX$  is net exports.

- **Consumption** consists of goods and services bought by households or consumers.

Durable goods: goods that last a long time, such as cars and TVs.

Nondurable goods: goods that last a short time, such as food and clothing.

Services: such as haircuts and airplane rides.

- **Investment** consists of good bought for future use. Investment can also be divided into three categories.

Business fixed investment: new machinery and equipment bought by firms.

Residential fixed investment: new houses bought by households.

Inventory investment: increase in firms' inventories.

- **Government Purchases** are the goods and services bought by federal, state and local governments. This includes military equipment, highways and bridges, and the services of government employees.
- **Net Exports** are the goods and services purchased by foreigners.

## 13 The Components of GDP

- Table 2.1.

- The Increasing role of services:

In 1992, the service sector in the US accounts for 72 percent of its GDP (in Germany it is 57 percent) and employed 76 percent of its labor force.

Meanwhile, the share of manufacturing has fallen in all the big economies. In 1992, it accounts for only 23 percent of America's GDP and even smaller 18 percent of jobs. In Britain and Canada manufacturing has also tumbled to less than 20 percent. Even in Japan and Germany, the strongholds of manufacturing, services is no more than 30 percent of GDP.

Services are also the fastest growing part of international trade, accounting for 20 percent of total world trade and 30 percent of American exports.

- The services Sector:

Legal services, business services (consulting), health, hotels, education, financial services, transport and communications.

## 14 Other Measures of Income

- GNP, gross national product, measures total income earned by *nationals*.

GNP is equal to GDP plus total income earned by US nationals in other countries minus income earned domestically by foreign nationals.

- NNP, net national product, is GNP net of the depreciation of capital. Depreciation, the consumption of fixed capital, is the amount of the economy's capital stock that wears out during the year. Depreciation equals 10 percent of GNP each year.

Because the depreciation of capital is a cost of producing the output of the economy, subtracting it from GNP shows the net result of economic activity.

- National Income is NNP minus Indirect Business Taxes (sales taxes). NNP measures how much everyone in the economy has earned after the indirect taxes.

Indirect business taxes are the difference between the price the consumers pay and the the price the firm receives.

Important: employee compensation accounts for 70 percent of national income, corporate profits 12 percent.

- Disposable Personal Income is the amount households and noncorporate businesses have available after satisfying their tax obligations to the government.

## 15 The GDP Deflator

Different goods and services have different prices and they change over time and relative to each other. Economists want to summarize the Overall level of prices in the economy in one number.

One index that does that is the GDP Deflator, also called the implicit price deflator for GDP.

$$GDP\ Deflator = \frac{Nominal\ GDP}{Real\ GDP}.$$

or

$$Nominal\ GDP = Real\ GDP \times GDP\ Deflator$$

Thus the definition of the GDP deflator separates nominal GDP into two parts: the part that measures quantities (real GDP) and the other that measures prices (the GDP deflator).

Here, nominal GDP measures the *current* dollar value of the output of the economy. Real GDP measures the economy's current output valued at constant (base-year) prices. The GDP deflator measures the price of output (or the overall level of current prices) relative to its price in the base year.

To better understand this, consider an economy with only one good, corns. Let  $P$  be the current price of corns. Let  $Q$  be the quantity of corns the economy produces currently. Let  $P_{bas}$  be the price of corns in some base year. Then Nominal GDP is  $P * Q$  and real GDP is  $P_{bas} * Q$  and

$$GDP\ Deflator = \frac{P}{P_{bas}}$$

which is just the price of corns in the current year relative to the price of corns in the base year.

**Note:** Suppose the economy produces two goods, or three goods, do you know how compute the GDP deflator?

## 16 The Consumer Price Index

The Consumer Price Index (CPI) is the most commonly used measure of the economy's overall level of prices.

The aim of CPI is to measure in a single index the cost of living. It focuses on the prices of goods and services that typical consumers buy (or the goods and services included in a typical consumer's basket), not the prices of all goods and services produced in the whole economy.

Suppose a typical consumer buys 5 apples and 2 oranges every month. Suppose 1992 is chosen to be the base year. Then

$$CPI = \frac{5 * \text{current price of apples} + 2 * \text{current price of oranges}}{5 * 1992 \text{ price of apples} + 2 * 1992 \text{ price of oranges}}$$

CPI tells us how much it costs now to buy 5 apples and 2 oranges relative to how much it costs to buy the same basket in the base year.

Notice in the above definition, the quantities of the goods in the typical consumer's basket are fixed, or in other words the weights of the different goods in the formula are fixed. Thus CPI is also called a fixed-weight price index.

## 17 The GDP deflator vs. the CPI

The GDP deflator and the CPI give somewhat different information about what's happening to the overall level of prices in the economy.

The first difference is that the GDP deflator measures the prices of all goods and services produced, whereas the CPI measures the prices of only the goods and services bought by consumers.

The second difference is that the GDP deflator includes only those goods produced domestically. Imported goods are not part of GDP and do not show up in the GDP deflator.

The third and most subtle difference results from the way the two measures aggregate the many prices in the economy. The CPI assigns fixed weights to the prices of different goods, whereas the GDP deflator assigns changing weights. In other words, the CPI is computed using a fixed basket of goods, whereas the GDP delator allows the basket of goods to change over time as the composition of GDP changes.

Class Work: Mankiw page 38. Problem 6:

Two goods: bread and car.

Year 2000: 100 cars produced and sold at 50,000 dollars each; 500,000 units of bread produced and sold at 10 dollars each unit.

Year 2010: 120 cars produced and sold at 60,000 dollars each; 400,000 units of bread produced and sold at 20 dollars each unit.

(a) Let year 2000 be the base year. Compute: nominal GDP, real GDP, and the GDP deflator of year 2010.

(b) Suppose a typical consumer consumes 1 car and 10 units of bread. Compute the year 2010 CPI, taking again year 2000 as the base year.

## 18 The Inflation Rate

Let  $P_t$  be the price level of period  $t$ . Let  $P_{t-1}$  be the price level of period  $t - 1$ . Then the rate of inflation over periods  $t$  and  $t - 1$  is

$$\pi = \frac{P_t - P_{t-1}}{P_{t-1}}.$$

Correspondingly, period  $t$  price level is equal to last year's price level adjusted for inflation:

$$P_t = P_{t-1} + \pi \times P_{t-1}$$

In the United States in the mid-and-later-1990s, the inflation rate was relatively low, around 2 to 3 percent per year, even though prices were much higher than they were 20 years earlier. High inflation rates in the 1970s had pushed up the price level. Once raised, the price level does not fall unless the inflation rate is negative- that is, unless there is deflation.

## 19 The Unemployment Rate

The unemployment rate measures the percentage of those people wanting to work who do not have jobs.

A person is employed if he or she spent most of the previous week working at a paid job, as opposed to keeping house, going to school, or doing something else.

A person is unemployed if he or she is not employed and is waiting for the start date of a new job, is on temporary layoff, or has been looking for a job.

A person who fits into neither of the above two categories, such as a student or retiree, is not in the labor force. A person who wants a job but has given up looking – a discouraged worker – is counted as not being in the labor force.

The labor force is defined as the sum of the employed and unemployed, and the unemployment rate is defined as the percentage of the labor force that is unemployed.

The labor-force participation rate measures the percentage of the adult population that is in the labor force:

## 20 The Okun's Law

What relationship should we expect to find between unemployment and real GDP?

Employed workers help to produce goods and services and unemployed workers do not, increases in the unemployment rate should be associated with decreases in real GDP. This negative relationship between unemployment and GDP is called Okun's law, after Arthur Okun, the economist who first studied it in 1962.

Question: Can you think of a scenario in which the Okun's law is violated?

Readings: Mankiw, chapter 2.

# Chapter 3

## The Supply Side of the Economy

(Mankiw, Chpt. 3)

### 21 The Production Function: What Determines the Total Production of Goods and Services?

- An economy's output of goods and services - its GDP - depends on (1) its quantity of inputs, called the factors of production, and (2) its ability to turn inputs into output, as represented by the production function.
- Factors of production are the inputs used to produce goods and services. The two most important factors of production are capital and labor.

Capital is the set of tools that workers use (the construction worker's crane, the accountant's calculator, and your personal computer).

Labor is the time (the number of hours) people spend working.

We use the symbol  $K$  to denote the amount of capital and the symbol  $L$  to denote the amount of labor.

- Assume that the economy has a fixed amount of capital and a fixed amount of labor. We write

$$K = \bar{K}$$

$$L = \bar{L}$$

The overbar means that each variable is fixed at some level.

We also assume here that the factors of production are fully utilized—that is, that no resources are wasted.

- Technology determines how much output is produced from given amounts of capital and labor. Economists express the available technology using a production function. Letting  $Y$  denote the amount of output, we write the production function as

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

This equation states that output is a function of the amount of capital and the amount of labor.

- Example 1 (linear production function)

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

For example, suppose  $K = 2$  and  $L = 5$ , then  $Y = F(K, L) = 2 + 5 = 7$ .

This production has the property that capital and labor are perfect substitutes. For example, if one reduces  $K$  by 1 unit but increases  $L$  by 1 unit, then output remains the same.

- Example 2

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

This production function exhibits complementarity between capital and labor. To see this, suppose the initial capital and labor are  $K$  and  $L$ . Suppose now one additional unit of labor becomes available. How much more output is produced because of the additional labor? Answer:

$$K * (L + 1) - K * L = K * 1$$

which depends positively on  $K$ . That is, a higher stock of capital makes the additional amount of labor more productive.

(Does this explain the higher labor productivity in the US than in Mexico?)

- Example 3 (A Cobb-Douglas Production Functions)

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

where  $A$  and  $\alpha$  are constants,  $A > 0$  and  $0 < \alpha < 1$ .

For example,  $A = 0.5$ ,  $\alpha = 1/2$ . Let  $K = 4$  and  $L = 9$ , then  $Y = 0.5 * \sqrt{4}\sqrt{9} = 3$ .

- Example 4 (A Leontieff production function)

$$F(K, L) = \min\{L, K\}$$

This production function describes a technology with which in order to produce one unit of output, exactly (no more and no less) one unit of capital and one unit of labor is required. For example if  $L = 5 < K = 6$ , then  $Y = 5$ , the extra unit of capital is useless.

- The production function reflects the current technology for turning capital and labor into output. If someone invents a better way to produce a good, the result is more output from the same amounts of capital and labor. Thus, technological change alters the production function.
- Suppose today's production function is  $Y = F(K, L)$ , suppose tomorrow's new technology is such that for any given amounts of capital and labour, output is doubled. Then tomorrow's production function is

$$Y = 2 * F(K, L)$$

- Suppose today's production function is  $Y = K + L$ . suppose tomorrow's new technology makes tomorrow's capital twice as productive as today's capital. Then tomorrow's production function is

$$Y = 2 * K + L$$

## 22 Constant Returns to Scale

A production function has constant returns to scale if an increase of an equal percentage in all factors of production causes an increase in output of the same percentage. If the production function has constant returns to scale, then we get 10 percent more output when we increase both capital and labor by 10 percent.

- Mathematically, a production function has constant returns to scale if

$$zF(k, L) = F(zK, zL)$$

for any positive number  $z$ . This equation says that if we multiply both the amount of capital and the amount of labor by some number  $z$ , output is also multiplied by  $z$ .

- Example 1

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

- Example 3

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

- Example 4

$$F(K, L) = \min\{K, L\}$$

## 23 The marginal product of Labor

- The Marginal Product of Labor (MPL) is the extra amount of output that the economy gets from one extra unit of labor, holding the amount of capital fixed.

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

That is,  $MPL$  is the difference between the amount of output produced using  $K$  units of capital and  $(L + 1)$  units of labor and the amount of output produced using  $K$  units of capital and  $L$  units of labor.

Important to note:  $MPL$  depends on  $(K, L)$ , the levels of capital and labor at which  $MPL$  is computed.

- Let  $F(K, L) = K + L$ . Then

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

Thus  $MPL$  is constant at one for all combinations of  $K$  and  $L$ .

- Let  $F(K, L) = KL$ . Then

$$MPL(K, L) = K(L + 1) - KL = K.$$

In this example,  $MPL$  depends on  $K$  : it is higher when  $K$  is higher.

- Let  $F(K, L) = K^{1/2}L^{1/2} = \sqrt{KL}$ . Then

$$MPL(K, L) = \sqrt{K(L + 1)} - \sqrt{KL} = \sqrt{K} \left[ \sqrt{L + 1} - \sqrt{L} \right]$$

For example,

$$MPL(1, 0) = \sqrt{1}[\sqrt{0+1} - \sqrt{0}] = 1$$

$$MPL(1, 1) = \sqrt{1}[\sqrt{1+1} - \sqrt{1}] = 0.414$$

$$MPL(1, 2) = \sqrt{1}[\sqrt{2+1} - \sqrt{2}] = 1.73 - 1.41 = 0.32$$

Notice that here  $M(1, L)$  decreases as  $L$  increases.

## 24 The Law of Diminishing Marginal Product

- Many production functions have the property of **Diminishing Marginal Product**: Holding the amount of capital fixed,  $MPL$  decreases as  $L$  increases.
- Consider the production of bread at a bakery. As a bakery hires more labor, it produces more bread. As more workers are added to a fixed amount of capital, however, the  $MPL$  falls. Fewer additional loaves of bread are produced because workers are less productive when the kitchen is more crowded. In other words, holding the size of the kitchen fixed, each additional worker adds fewer loaves of bread to the bakery's output.
- Consider a farmer's production of potatoes. He has a fixed amount of land that's his capital  $K$ . Labor input  $L$  here is the number of hours he spends working on his land. Output is higher as the farmer puts in more effort, but the productivity (additional output) associated with each additional hour the farmer puts in declines.
- Professor Wang has a computer that he uses as his capital. Professor Wang produces research by spending time with the computer. He is very productive at 9:00 in the morning, he is slower at 1:00pm, and he feels his brain is useless at 6:30 in the afternoon.

## 25 The Marginal Product of Capital

The Marginal Product of Capital (MPK) is the extra amount of output that the economy gets from one extra unit of capital, holding the amount of labor fixed.

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

That is,  $MPK$  is the difference between the amount of output produced using  $K + 1$  units of capital instead of  $K$  units of capital.

- Let  $F(K, L) = K + L$ . Then

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

Thus  $MPK$  is constant at one for all combinations of  $K$  and  $L$ .

- Let  $F(K, L) = K * L$ . Then

$$MPL(K, L) = (K + 1)L - KL = L.$$

In this example,  $MPK$  depends on  $L$  : it is higher when  $L$  is higher.

## 26 MPL and the demand for Labor (1)

- Consider a firm which has a fixed amount of capital and wants to determine how many workers to hire. Let  $P$  denote price and  $W$  be the nominal wage (number of dollars paid to a worker).

- Suppose

$$P * MPL(K, L) > W$$

Then the firm would want to hire more workers.

- Suppose

$$P * MPL(K, L) < W$$

Then the firm would want to hire less workers.

- The firm's equilibrium  $L$  is setermined by

$$P * MPL(K, L) = W$$

or

$$MPL(K, L) = \frac{W}{P}$$

where  $W/P$  is called the real wage.

Figure 3-4.

## 27 MPL and the demand for labor (2)

- We know that given  $K$ , the firm's optimal amount of labor,  $L^*$ , is determined by the following equation

$$MPL(K, L) = \frac{W}{P}$$

- Suppose it is now given that

$$MPL(K, L) = K - L$$

where  $K = 10$  is fixed. Suppose also  $W = 10$ ,  $P = 2$ . Then  $L^*$  satisfies

$$10 - L^* = \frac{10}{2}$$

or

$$L^* = 5$$

- Suppose now the firm has just made some new capital investment and capital stock has increased from 10 to 15. Then the new  $L^*$  satisfies

$$15 - L^* = \frac{10}{2}$$

and  $L^* = 10$ .

- Suppose now the economy is heading into a recession and the firm has decided to cut capital stock from 15 to 5. Then the new  $L^*$  satisfies

$$5 - L^* = \frac{10}{2}$$

and  $L^* = 0$ . That is, the firm is shut down.

## 28 MPL and the demand for labor (3)

Suppose a firm (or an industry sector) has the following production function:

$$Y = F(K, L) = \alpha KL - L^2$$

Then

$$\begin{aligned}MPL(K, L) &= [\alpha K(L + 1) - (L + 1)^2] - [\alpha KL - L^2] \\ &= \alpha K - 2L - 1\end{aligned}$$

And so the firm's optimal choice of its work force,  $L^*$ , is determined by:

$$MPL(K, L^*) = \frac{W}{P}$$

or

$$\begin{aligned}\alpha K - 2L^* - 1 &= \frac{W}{P} \\ L^* &= \frac{1}{2} \left[ \alpha K - 1 - \frac{W}{P} \right]\end{aligned}$$

Case (1). Suppose the rest of the economy receives a positive demand shock which makes them want to expand their work force, which in turn bids up the market wage  $W$ . How does this affect this firm's  $L^*$ ?

Case (2) The government (worker union) sets a new minimum wage which is lower than the current market wage. How does this affect  $L^*$ ?

Case (3) Suppose the .com industry is collapsing. A large number of unemployed workers are trying to find jobs in other industries. How does this affect this firm's  $L^*$ ?

Case (4) Suppose, due to globalization, a higher demand for the firm's product drives up  $P$ . How does this affect  $L^*$ ?

Case (5) Suppose the firm succeeded in a major technological innovation that pushes up  $\alpha$ . How does this affect  $L^*$  and  $Y$ ?

Case (6) Suppose the federal reserve bank increases the interest rate to make capital more expensive, and the firm decides to reduce its capital stock. What happens to  $L^*$ ?

Case (7) Suppose there is a fixed number of workers  $\bar{L}$  in a sector. This industry has many firms (all have the same production function). Suppose now  $\alpha$  increases to  $\alpha'$ . Then every firm will want to hire more workers at the current wage  $W$ . Competition thus bids up the wage from  $W$  to  $W'$ . In the end, no firm will hire more workers, but  $W'$  will satisfy

$$\alpha'K - 2L - 1 = W'/P.$$

## 29 Some production functions for you to play with

Consider the following production functions.

$$F(K, L) = K + 2L$$

$$F(K, L) = KL^2$$

$$F(K, L) = L \log(1 + K)L^2$$

(i) Do these production functions show constant returns to scale? (ii) Do these production functions show diminishing marginal product of labor?

## 30 Equilibrium Employment

Suppose the economy's production function is  $Y = F(K, L)$ . Suppose the economy's capital stock is fixed at  $K = \bar{K}$ , and the economy's aggregate labor supply is determined by

$$L^s = 100 + W$$

where  $W$  denotes market wage. Let  $M(K, L)$  denote the marginal product of labor at  $K, L$ .

Then the labor market is in equilibrium if

$$L^d = L^s (= 100 + W) \quad (4)$$

where  $L^d$  denotes the aggregate demand for labor and  $L^d$  must satisfy

$$MPL(\bar{K}, L^d) = \frac{W}{P}. \quad (5)$$

**Example 1.** Suppose  $MPL(K, L) = \alpha K - L$ , where  $\alpha$  is constant. Then equilibrium in the labor market implies:

$$\alpha\bar{K} - (100 + W) = \frac{W}{P}$$

This equation allows us to solve for the equilibrium wage  $W^*$ , and then the equilibrium employment is just  $100 + W^*$ .

## 31 Case Study: Why Doesn't Capital Flow from Rich to Poor Countries

- The Law of Dimishing Marginal Returns implies that, everything else equal, the marginal product of capital is higher in the developing countries (poor in capital) than in the developed countries (rich in capital). Thus capital should flow from rich to poor countries.
- Net flows from developed countries into developing countries:
  - 1984: -10.2 (billion)
  - 1985: -20.5
  - 1986: -23.6
  - 1987: -34.0
  - 1988: -35.2
  - 1989: -29.6
  - 1990: -22.5
- Why?
- Differences in human capital?
- Capital Market Imperfections in Developing Countries?

# Chapter 4

## The Demand Side of the Economy

- We assume a closed economy - a country that does not trade with other countries. Thus, net exports are always zero.
- A closed economy has three uses for the goods and services it produces:

$$Y = C + I + G$$

Households consume some of the economy's output (consumption is the largest source of demand); firms and households use some of the output for investment; and the government buys some of the output for public purposes.

## 32 Consumption: $C$

- The income that households receive equals the output of the economy  $Y$ . The government then taxes households an amount  $T$ . We define income after the payment of all taxes,  $Y - T$ , as disposable income, denoted

$$Y^d = Y - T$$

- The level of consumption depends directly on the level of disposable income. The higher is disposable income, the greater is consumption. Thus,

$$C = C(Y^d)$$

The relationship between consumption and disposable income is called the consumption function.

- An example of a consumption function is

$$C = a + bY^d$$

where  $a$  and  $b$  are constants.

- The marginal propensity to consume (MPC) is the amount by which consumption changes when disposable income increases by one dollar:

$$MPC(Y^d) = C(Y^d + 1) - C(Y^d)$$

- Usually, the MPC is between zero and one: an extra dollar of income increases consumption, by less than one dollar. Thus, if households obtain an extra dollar of income, they save a portion of it.

- For example, if the MPC is 0.7, then households spend 70 cents of each additional dollar of disposable income on consumer goods and services and save 30 cents.

- Suppose

$$C(Y^d) = a + bY^d$$

Then

$$MPC(Y^d) = a + b(Y^d + 1) - [a + bY^d] = b$$

- Suppose  $C(Y^d) = \sqrt{Y^d}$ , then  $MPC$  depends on  $Y^d$ .

### 33 What determines consumption/savings: cases

(1) I am young and poor, but I expect to get wealthier in the future. Should I save more (that is consume less) today?

(2) I am young and productive. My wages are high. But I expect to have my wages fall when I get older. What should I do?

(3) In the 1990s, the Americans were more optimistic about their future economic life than ever. Did they save less or more?

(4) The economy is in a recession. But people are starting to expect things to get better in the near future. Do they save less or more? What if the consumers are more pessimistic and they expect the current slump to last for several years (like what happened in Japan during the 1990s)?

(5) I am employed and healthy. But I may get laid off and become sick in the future? What should I do?

(6) Your parents had fewer ways to borrow when they needed liquidity to cover business losses or sickness. I have access to a financial market where I can lend and borrow, I also have access to sophisticated insurance policies (private or government sponsored) that cover me with benefits and compensation if things go wrong. Do I save more than my parents?

(7) The Canadians have more extensive social programs (UI, Medical insurance) than the Americans. Do the Americans save more?

(8) Do married people save more or less?

(9) Interest rate is going up? What should I do?

### Case Study: Americans are drowning in debt

The American Legacy: Too Much Debt. By the end of 2000, together consumers owe 7.3 trillion dollars. In 1985, total debt was below 2 trillion. It doubled over the last ten years.

Americans are also spending more and save less. Total consumer expenditure went from below 5 trillion in 1995 to above 7 trillion in 2000. Personal savings rate dropped from 8 percent before 1992 to almost negative in 2000.

Why? Credit cards to be blamed? The new economy phenomenon?  
A change in Attitude?

### Case Study: The Consumption Function: a comparison between the U.S. and Japan

(handouts)

Why do the Japanese save so much?

Readings: Mankiw: Chapters 3, 17.

## 34 Investment: $I$

- The main determinant of investment is the interest rate.
- Interest rate measures the cost of the funds used to finance investment. For an investment project to be profitable, its return must exceed its cost. If the interest rate rises, fewer investment projects are profitable, and the quantity of investment goods demanded falls.
- We suppose there is a single interest rate in the economy. This is a reasonable assumption because, although there are many different interest rates in the economy, they tend to move fairly closely together.
- The nominal interest rate is the interest rate as usually reported: it is the rate of interest that investors pay to borrow money. The real interest rate is the nominal interest rate corrected for the effects of inflation. If the nominal interest rate is 8 percent and the inflation rate is 3 percent, then the real interest rate is 5 percent.
- The Investment Function relates investment  $I$  to the real interest rate  $r$ :

$$I = I(r).$$

- The investment function is usually downward slopping: When interest rate rises, financing is more costly, fewer projects are profitable, demand for investment falls.

Figures 3-6.

## 35 Government Purchases: $G$

- The third component of aggregate demand is government purchases of goods and services. (Government also makes transfer payments to individuals and households are not included in  $G$ . Transfer payments contribute indirectly to the aggregate demand through their effects on consumption.)
- Remember  $T$  denotes total taxes. If  $G > T$ , then the government is running a deficit equal to  $G - T$ . If  $G < T$ , then the government has a surplus equal to  $T - G$ . If  $G = T$ , then the government has a balanced budget.

## 36 Equilibrium

- The economy's aggregate supply is determined by:

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

- The economy's aggregate demand is determined by:

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

- Suppose we treat the following variables as the model's exogenous variables:

$$K, L; G, T$$

That is, we take  $K, L, G, T$  as given and not to be determined by the model. Note once  $K$  and  $L$  are given, then  $Y$  is also given, which in turn implies  $C(Y - T)$  is also given.

- The model's only endogenous variable is hence  $r$ , the real interest rate, or the price for the use of capital.  $r$  will be determined by the market.
- The market for goods and services now work to bring aggregate demand and aggregate supply into balance:

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

- This equation, which is called the **equilibrium condition**, determines the equilibrium interest rate  $r^*$ . In other words, at the equilibrium interest rate, the aggregate demand equals aggregate supply.

- As mentioned earlier, the interest rate  $r$  is the cost of borrowing and the return to lending (return on investment) in the financial market.
- Here, if  $Y > C + I(r) + G$ , then investment is too low, and aggregate demand falls short of the aggregate supply, interest rate will fall as suppliers bid down the price of capital.
- If  $Y < C + I + G$ , then investment is too high, and aggregate demand exceeds the aggregate supply, interest rate will rise as firms bid up the price of capital.
- **Example 1** Suppose  $Y = 100$ ,  $G = 10$ ,  $T = 10$ .  $C(Y - T) = 20 + 0.5(Y - T)$ ,  $I(r) = 30 - 50r$ .

Compute the equilibrium  $r$  and  $I$ .

Aggregate supply equal to aggregate demand implies

$$100 = (20 + 0.5 * (100 - 10)) + 10 + (30 - 50r)$$

or  $r = 0.1$  and  $I(r) = 30 - 50 * 0.1 = 25$ .

## 37 Financial (Credit) Market equilibrium

- Rewrite the equilibrium condition as

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

where  $Y - C - G$  the output that remains after the demands of consumers and and government are satisfied; it is called **national saving** or simply **saving (S)**. Thus the above equation shows saving equals investment.

- The left hand side of the equation can be thought of as the supply of loanable funds—households lend their savings to investors through the financial markets (**Direct Lending**) or deposit their saving in a bank that then loans the funds out (**Indirect Lending**).
- The right hand side of the equation is the demand fopr loanable funds—investors borrow from the public by selling stocks or bonds or indirectly by borrowing from banks.
- The price of loanable funds is the interest rate which in the financial market equilibrium makes demand and supply for loanable funds equal.

## 38 Public vs Private Saving

- National saving can be split into two parts:

$$Y - C - G = [Y - T - C] + (T - G)$$

here  $Y - T - C$  is disposable income minus consumption, which is private saving.  $T - G$  is government revenue minus government spending, which is public saving

- Figure 3-7.

## 39 Policy Analysis: An Increase in $G$

- An increase in  $G$  implies a decrease in the supply of the loanable funds. This must be met by a decrease in  $I(r)$ , the demand for loanable funds. This effect of an increase in  $G$  is called the crowding out effect.
- To induce  $I(r)$  to fall, interest rate must increase.
- **Example 1** Suppose  $Y = 100$ ,  $G = 10$ ,  $T = 10$ .  $C(Y - T) = 20 + 0.5(Y - T)$ ,  $I(r) = 30 - 50r$ . Suppose there is now an increase in  $G$  from 10 to 11.
  - (b) Compute the new equilibrium  $I$  and  $r$ .
- Wars and interest in UK, 173 – –1920. Figure 3-9.

## 40 A Decrease in Taxes

- Suppose there is a reduction in taxes of  $\Delta T$ . Then  $Y^d = Y - T$  will increase by  $\Delta T$ .  $C(Y^d)$  will increase by  $MPC \times \Delta T$ . This reduces the supply of loanable funds, So  $I$  must decrease and  $r$  must increase. Once again we have a crowding out effect.
- **Example 1** Suppose  $Y = 100$ ,  $G = 10$ ,  $T = 10$ .  $C(Y - T) = 20 + 0.5(Y - T)$ ,  $I(r) = 30 - 50r$ . Suppose there is now a tax cut of  $\Delta T = 1$ .
  - (c) Compute the new equilibrium  $I$  and  $r$ .
  - (d) Suppose  $C(Y - T) = 20 - M(Y - T)$ , where  $M$  is the constant  $MPC$ . Show that when  $M$  increases, more investment is crowded out due to a fixed amount of tax cut  $\Delta T = 1$ .

## 41 Fiscal Policy in the 1980s

- In 1980 Ronald Reagan was elected president. He increased government (military) spending and reduced taxes. The federal budget deficit skyrocketed in the 1980s. The real interest rate rose from 0.4 percent in the 1970s to 5.7 percent in the 1980s. Gross national saving as a percent of GDP fell from 16.7 in the 1970s to 14.1 in the 1980s.

### Case Study: Cut Capital Income Taxes to Stop Recession?

- What's Capital Income Tax?
- Why should Capital Incomes be Taxed? Why should capital incomes be taxed twice?
- The impact of tax cuts on the budget deficit?—the “Laffer Curve”

## 42 Changes in Investment Demand

- So far we are holding the investment function as given. What happens if there is a change in the investment function  $I(r)$ .
- For example, what happens if the investment function in Example 1 changes from  $I(r) = 30 - 50r$  to  $I(r) = 40 - 50r$ ? (classwork)
- Figure 3-10
- Example 2 Suppose  $Y = 100$ ,  $G = 10$ ,  $T = 10$ .  $C(Y - T, r) = 20 + 0.5(Y - T) - 10r$ ,  $I(r) = 30 - 50r$ .
  - (a) Compute the equilibrium  $r$  and  $I$ .

(b) Suppose  $I(r) = 35 - 50r$ . Compute the new equilibrium  $r$  and  $I$ . Show that with the consumption function downward-sloping, an increase in investment demand would raise both the equilibrium interest rate and the equilibrium quantity of investment.

**Case Study: Why do stocks fall when interest rate rises?**

### 43 Equilibrium in the more general setting

- Suppose  $Y = 100$  is fixed. Suppose the consumption function is  $C(Y - T) = 20 + M(Y - T)$ , where  $M$  is a constant that is between 0 and 1. Suppose the investment function is  $I(r) = 30 - 50r$ . Suppose we leave  $G$  and  $T$  as unspecified constants.
- Remember the equilibrium condition for the economy is

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

Substitute  $Y = 100$  and  $C = 20 + M(Y - T)$  and  $I(r) = 30 - 50r$  into the equilibrium condition to get

$$100 - [20 + M(100 - T)] - G = 30 - 50r$$

solve this equation for the equilibrium interest rate

$$r^* = \frac{50 - M(100 - T) - G}{-50}$$

or

$$r^* = \frac{-50 + M(100 - T) + G}{50}$$

- We can make several predictions based on the above equation.
  - (1) When  $G$  rises,  $r^*$  rises and so  $I(r^*)$  falls. This is what we called the “crowding-out effect”.
  - (2) When  $T$  increases,  $r^*$  decreases and  $I(r^*)$  increases. What happens here is, as  $T$  goes up, disposable income  $Y - T$  falls, so consumption falls, and saving goes up, and this induces the supply of loanable funds to go up. What happens next is competition among banks (who all want to find borrowers for their loanable funds) will bid down the price for the use of funds or the interest rate.
  - (3) When  $M$  increases,  $r^*$  increases.

- Note given the form of the consumption function,  $M$  is equal to the marginal propensity to consume (MPC). Can you show this?
- Suppose we have two countries. Country 1 (Japan) has a lower  $M$  than country 2 (US). According to our model, Which country has a lower interest rate?

# Chapter 5

## The IS-LM Analysis

### 44 The Equilibrium GDP (Mankiw Chapter 10-1)

- Let  $\bar{Y}$  denote the economy's potential GDP.  $\bar{Y}$  is the maximum amount of goods and services that the economy can produce if all the economy's available resources are fully utilized.
- As before, let  $Y^*$  be the economy's equilibrium GDP. Assume

$$Y^* < \bar{Y}.$$

That is, the economy is operating at a level that is strictly below its potential. Imagine the economy is in a recession where many workers are unemployed and factories are closed.

- Question: That can be done to raise the equilibrium GDP?
- Remember the equilibrium condition for the economy is:

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

Note that so far we have always treated  $Y$  (together with  $G$  and  $T$ ) as the model's exogenous variable. This time we want to use the model to determine  $Y$ , that is, we now want to assume  $Y$  is the model's endogenous variable.

- To make our life easy, as a first step let's assume interest  $r$  is fixed (by the Federal Reserve Bank which, we assume, has full control over the financial market) That is treat  $r$ ,  $G$  and  $T$  as the model's exogenous variables. Then the equation  $Y = C(Y - T) + I(r) + G$  can be used to determine the only unknown variable:  $Y$ .
- One interpretation (Keynes' interpretation) of the equation  $Y = C(Y - T) + I + G$  is that the right hand side of the equation represents the aggregate PLANNED EXPENDITURE and left hand side the ACTUAL EXPENDITURE.
- Actual expenditure is the amount households, firms, and the government actually spend on goods and services, and as we know, it equals the economy's GDP. Planned expenditure is the amount households, firms, and the government would like to spend on goods and services.
- Why should actual expenditure equal planned expenditure in equilibrium? This is what the KEYNESIAN CROSS explains. (Figure 10-4).
- Let  $E$  denote planned expenditure. Suppose  $Y > E$ . That is, suppose firms are producing more than the private sector and the government plan to purchase. Firms are forced to accumulate inventories. When this happens, firms will reduce production and that reduces  $Y$ .
- Suppose  $Y < E$ . That is, suppose firms are producing less than the private sector and the government want to purchase. Firms will run down their inventories. When this happens, firms will increase production and that increases  $Y$ .
- The Keynesian cross shows how  $Y$  determined for fixed  $I$ ,  $G$  and  $T$ . Suppose any of these variables change,  $Y$  will change.

- Example 1

Suppose  $G = 10$ ,  $T = 10$ .  $C(Y - T) = 20 + 0.5(Y - T)$ ,  $I(r) = 30 - 50r$  and  $r = 0.1$ . Compute the equilibrium  $Y$ .

Substitute  $G = 10$ ,  $T = 10$ .  $C(Y - T) = 20 + 0.5(Y - T)$ ,  $I(r) = 30 - 50r$ ,  $r = 0.1$  into the equilibrium condition to obtain

$$Y = 20 + 0.5(Y - 10) + 30 - 50 * 0.1 + 10$$

so

$$0.5Y = 20 - 5 + 30 - 5 + 10 = 50$$

and  $Y^* = 100$ .

- Consider now the following more general case. Suppose  $C(Y - T) = M(Y - T)$ , where  $M$  is the constant  $MPC$ .  $0 < M < 1$ . Suppose the investment function  $I(r)$  and  $G$  and  $T$  are left unspecified.
- Substitute the above information into the equilibrium condition  $Y = C(Y - T) + I(r) + G$  to obtain

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

which implies

$$Y = MY - MT + I(r) + G$$

or

$$(1 - M)Y = -MT + I(r) + G$$

or

$$Y^* = \frac{-MT + I(r) + G}{1 - M}$$

- The above equation makes the following predictions:
  - (1) An increase in  $G$  implies an increase in  $Y^*$ .
  - (2) An increase in  $T$  implies a decrease in  $Y^*$ .
  - (3) An increase in  $r$  implies a decrease in  $Y^*$ .
- What happens if the government reduces  $G$ ?  
 What happens if the government reduces  $T$ ?  
 What happens if the Fed reduces  $r$ ?

- **Example 2** Suppose  $G = 10$ ,  $T = 10$ .  $C(Y - T) = 20 + 0.5(Y - T)$ ,  $I(r) = 30 - 50r$  and  $r = 0.1$ .
  - (1) Suppose now the Fed decides to cut interest rate by one percent. Will GDP increase or decrease? By how many percentage points? (hints) With  $r = 0.1$ ,  $Y^* = 100$ . With  $r = 0.09$ ,  $Y^* = 101$ . So GDP goes up by one percent.
  - (2) Suppose the Fed wants to pursue an interest rate policy that implements the following (full-employment) policy objective:  $Y^* = \bar{Y}$  and  $\bar{Y} = 102$ . How should the Fed set its interest rate target.

## 45 Government-Purchases Multiplier (Mankiw 10-1)

- We now know that an increase in government purchases ( $G$ ) can cause the equilibrium  $Y^*$  to increase. We now ask a more specific question. Suppose we increase  $G$  by one unit.  $Y^*$  will increase by how many units?
- To prepare for the analysis. Suppose variable  $y$  depends on variable  $x$  in the following way:  $y = 2 + 3x$ . Now here if we increase  $x$  by 1 unit, then  $y$  will increase by 3 units.
- Suppose instead  $y = 2 + Mx$  where  $M$  is some unknown constant. Then an increase in  $x$  by 1 unit will cause  $y$  to increase by  $M$  units. More generally, an increase in  $x$  by  $\Delta x$  units will increase  $y$  by  $M \times \Delta x$  units.
- We now go back to our model. Suppose the consumption function is  $C(Y - T) = 25 + M(Y - T)$ , where again  $M$  is the constant  $MPC$ .  $0 < M < 1$ . Suppose the investment function  $I(r)$  and  $G$  and  $T$  are left unspecified.
- Substitute the above information into the equilibrium condition

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

to obtain

$$Y = 25 + M(Y - T) + I(r) + G$$

which implies

$$Y = 25 + MY - MT + I(r) + G$$

or

$$(1 - M)Y = 25 - MT + I(r) + G$$

or

$$Y^* = \frac{25 - MT + I(r) + G}{1 - M}$$

or

$$Y^* = \frac{25 - MT + I(r)}{1 - M} + \frac{G}{1 - M}$$

- The above equation shows that an increase in  $G$  by one unit will cause  $Y^*$  to increase by  $\frac{1}{1-M}$  units. We call  $\frac{1}{1-M}$  the government-purchases multiplier.

- Note that since  $M < 1$ , the government-purchases multiplier is greater than one. For example, suppose  $M = 0.8$ , then the government-purchases multiplier is equal to 5. Thus for example if the government increases its  $G$  by 10 billion, then GDP will increase by  $5 \times 10$  billion.

implies an increase in  $Y^*$ .

(2) An increase in  $T$  implies a decrease in  $Y^*$ .

(3) An increase in  $r$  implies a decrease in  $Y^*$ .

- What happens if the government reduces  $G$ ?

What happens if the government reduces  $T$ ?

What happens if the Fed reduces  $r$ ?

- **Example 2** Suppose  $G = 10$ ,  $T = 10$ .  $C(Y - T) = 20 + 0.5(Y - T)$ ,  $I(r) = 30 - 50r$  and  $r = 0.1$ . Suppose now the Fed decides to cut interest rate by one percent. Will GDP increase or decrease? By how many percentage points?

(hints) With  $r = 0.1$ ,  $Y^* = 100$ . With  $r = 0.09$ ,  $Y^* = 101$ . So GDP goes up by one percent.

## 46 Case Study: Cutting Taxes to Stimulate the Economy

In 1961, John F. Kennedy became president of the United States. FKK brought to Washington a group of bright young economists to work on his Council of Economic Advisers. These economists were educated in the school of Keynesian economics.

One of .... (see Mankiw page 266 (a very nice page))

## 47 The IS curve

If both  $r$  and  $Y$  are treated as variables, not constants. Then  $Y = C(Y - T) + I(r) + G$  describes a relationship between  $r$  and  $Y$ . This relationship is called the IS curve. There  $I$  means investment  $S$  means saving.

## 48 A Loanable-Funds Interpretation of the IS equation

The equilibrium condition  $Y = C(Y - T) + I(r) + G$  can be rewritten as

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

- Remember in the model of  $Y = C(Y - T) + I(r) + G$ , we have either assumed  $Y$  is fixed and then used the model to determine the endogenous variable  $r$ , or we have assumed  $r$  is fixed and used the model to determine  $Y$  as the endogenous variable.

But both  $Y$  and  $r$  are important macroeconomic variables that economists want to explain and make predictions about. It is thus desirable to treat both  $Y$  and  $r$  as endogenous variables. The goal here is to build a model that does exactly that.

- Suppose we now treat both  $Y$  and  $r$  as our model's endogenous variables. Then the equation

$$Y = C(Y - T) + I(r) + G \tag{6}$$

is called the *IS* equation or *IS* curve.

- The *IS* equation provides a link between  $r$  and  $Y$ , but it is not enough for determining both  $r$  and  $Y$ . All we need is one more equation that links  $r$  and  $Y$  together. We look into the money market to find that missing equation.

## 49 Money

- What is Money? Economists use the term *money* to mean specifically the stock of assets that can be readily used as a means of payment to make transactions.
- Money is the stock of the most *liquid* assets. Liquid in the sense that it can be converted into any other type of asset *directly* and easily. In this sense, liquidity is convertability.

This property of convertability is a unique property money has as a special type of asset. Imagine one needs to convert a real estate property into airline tickets. What one in most situations must do is to sell the estate for cash, then sell cash to buy airline tickets. In the process of this transaction, money is used as a *medium of exchange* - exchange of the estate for tickets.

Remark 1. How to measure *liquidity* (of a given type of asset)? How close is a given asset to money? Or, how easily is it to convert a stock of a given type of asset into a stock of any other asset? How easy is it to convert a given type of asset into money (cash)?

Remark 2. Some assets are more liquid than others. Money is more liquid than bonds and equities. Bonds, in turn, are liquid than land. And so on.

Remark 3. (i) Money is easy to sell. (ii) Most transactions involve buying and selling money, using.

- **The measure of the quantity of money** usually includes currency and demand deposits.

Currency is the sum of outstanding paper money and coins. Most day-to-day transactions use currency as the medium of change.

Demand deposits represent the funds people hold in their checking account. Assets in a checking account are almost as convenient as currency.

Money, once defined as currency and checking deposits, is the type of asset that does not earn interest for its holder.

The interest rate, denoted  $r$ , then measures the opportunity cost of holding money (instead of other interest bearing assets).

Question: What is the opportunity cost of holding an interest bearing asset relative to money?

More broadly defined measures of money include for instance saving deposits, time deposits, and Treasury securities, assets that are close to money - high in liquidity but low in return.

## 50 The Demand for Money

- Let  $M$  denote the amount of money balances. Let  $M^d$  denote the demand for (nominal) money balances. Let  $M^s$  denote the supply of (nominal) money balances. Let  $P$  denote the price level.

Note in the model we are developing, both  $M^s$  and  $P$  will be treated as exogenous variables. In particular,  $M^s$  will be treated as a policy instrument for the Federal Reserve Bank for conducting monetary policy.

- A transactions theory of money demand:

$$M^d = P \times L(r, Y)$$

where  $r$  is the interest rate,  $Y$  is the GDP or national income, and the function  $L$  is called the money demand function.

- This money demand function states that the demand for money varies proportionally with the price level. That is, if the level of price changes by a certain percent, then the demand for money will change by the same percent.
- The demand for money decreases as  $r$  increases. That is, holding  $Y$  constant, the money demand function  $L(r, Y)$  is downward sloping in  $r$ . The idea is that the interest rate is the opportunity cost of holding money: it is what you forgo by holding some of your financial assets as money.
- On the other hand, an increase in  $Y$  causes the demand for money to also increase. The idea here is that when  $Y$  increases, more buying and selling will take place that requires the use of money to make payments.

- The money demand equation can also be written as:

$$\frac{M^d}{P} = L(r, Y) \quad (7)$$

where  $\frac{M^d}{P}$  is called the demand for real money balances.

## 51 Money Market Equilibrium

- When the money market is in equilibrium, the demand for money must be equal to the supply of money:

$$M^s = M^d$$

or,

$$M^s = P \times L(r, Y)$$

or

$$\frac{M^s}{P} = L(r, Y) \tag{8}$$

The above equation is called the equilibrium condition for the money market. It is also called the *LM* equation or *LM* curve.

- Example1 Let

$$L(r, Y) = 100 - r + 0.5Y$$

Let  $M = 100$  and  $P = 1$ . Then the  $LM$  equation is

$$100/1 = 100 - r + 0.5Y$$

or

$$r = 0.5Y$$

This equation says in order for the money market to clear, interest rate must increase as  $Y$  increases.

- Suppose again  $L(r, Y) = 100 - r + 0.5Y$  and  $P = 1$ . But we leave  $M^s$  unspecified. The the  $IS$  curve is

$$M^s = 100 - r + 0.5Y$$

which in turn implies

$$r = 100 - M^s + 0.5Y$$

This shows that, holding  $Y$  fixed, an increase in money supply reduces the interest rate.

## 52 The $IS - LM$ Analysis

- We now put the  $IS$  and  $LM$  equations together to obtain a system of two equations with two unknowns:

$$IS : \quad Y = C(Y - T) + I(r) + G$$

$$LM : \quad \frac{M^s}{P} = L(r, Y)$$

where  $T, G, M^s$  and  $P$  are exogenous variables.

### Example1

Let  $T = G = 0$ . Let  $C(Y - T) = 0.5(Y - T)$ . Let  $I(r) = 100 - 10r$ . Let  $P = 1$  and  $L(r, Y) = Y - 10r$ . Let  $M^s$  be left unspecified.

Then the the IS equation is

$$Y = 0.5Y + 100 - 10r$$

or

$$Y = 200 - 20r$$

and the LM equation is

$$M^s = Y - 10r$$

Substitute the IS equation into the LM equation to get

$$M^s = 200 - 20r - 10r = 200 - 30r$$

and so

$$r^* = (200 - M^s)/30$$

and

$$Y^* = 300 - 20 * (200 - M^s)/30.$$

Clearly, as  $M^s$  increases,  $Y^*$  increases and  $r^*$  decreases.

Suppose initially  $M^s = 100$ . Suppose there is now a productivity slowdown which shifts the investment function to

$$I(r) = 90 - 10r,$$

which, in turn, drives the economy into a “recession”.

Now as an economist you know several ways through which you can pull the economy back from the recession and restore the initial  $Y^*$ .

(1) Suppose you want to pursue an expansionary monetary policy to offset the effect of the lower investment. By how many percentage points should increase  $M^s$ ?

(2) What are other policy changes you can pursue to achieve the same objective?

We now take a step further to consider the more general situation where all of the three policy instruments,  $T$ ,  $G$ , and  $M^s$  are left unspecified. This will allow us to consider both the fiscal and the monetary policies in one comprehensive model.

Let  $C(Y - T) = C_0 + m(Y - T)$ . Let  $I(r) = I_0 - 10r$ . Let  $P = 1$  and  $L(r, Y) = Y - 10r$ . Let  $T, G$ , and  $M^s$  be left unspecified. Note here  $0 < m < 1$  is the consumer's constant marginal propensity to consume.

The IS equation is

$$Y = C_0 + I_0 + m(Y - T) - 10r + G$$

or

$$(1 - m)Y = C_0 + I_0 - mT - 10r + G$$

The LM equation is

$$M^s = Y - 10r$$

From the LM equation we have  $Y = M^s + 10r$ . Substitute this into the IS equation to get

$$(1 - m)(M^s + 10r) = C_0 + I_0 - mT - 10r + G$$

or

$$(1 - m)M^s + 10(1 - m)r = C_0 + I_0 - mT - 10r + G$$

and so

$$[10(1 - m) + 10]r = C_0 + I_0 - mT + G - (1 - m)M^s$$

and so

$$r^* = \frac{C_0 + I_0 - mT + G - (1 - m)M^s}{20 - 10m} \quad (9)$$

Substitute the above into the LM equation to obtain

$$Y^* = M^s + 10r^* = M^s + 10 \frac{C_0 + I_0 - mT + G - (1 - m)M^s}{20 - 10m}$$

or

$$Y^* = \frac{M^s - mT + G + C_0 + I_0}{2 - m} \quad (10)$$

- Clearly, as  $M^s$  increases,  $Y^*$  increases and  $r^*$  decreases. As  $G$  increases,  $Y^*$  increases and  $r^*$  increases. As  $T$  increases,  $Y^*$  decreases and  $r^*$  decreases.
- The above equation shows that an increase in  $G$  by one unit will cause  $Y^*$  to increase by  $\frac{1}{2-m}$  units. Thus here  $\frac{1}{1-m}$  is the government-purchases multiplier.
- Note that since  $M < 1$ , now the government-purchases multiplier is less than one.

**Example 3(classwork)** Suppose  $G = 10$ ,  $T = 10$ .  $C(Y - T) = 0.5(Y - T)$ ,  $I(r) = 100 - 10r$ . Suppose  $M^s = 100$ ,  $P = 1$  and  $L(r, Y) = Y - 10r$ . Suppose now the Fed decides to cut interest rate by one percentage point, should the Fed increase money supply by how many units? Will GDP increase or decrease? By how many percentage points?

## 53 Fiscal and Monetary Policy Design

The central bank sees inflation rising in the future. It then wants to tighten up monetary policy to fight that. But a tight monetary policy is likely to raise interest rate and that in turn may have a negative effect on the stock market.

Can you design a monetary and fiscal policy combination to slow down the economy while not raising the interest rate?

## 54 Creating a Recession

Suppose you given a toy economy to play with. Suppose this toy economy is described by the equations you are familiar with. How can you create a recession in this economy?

## 55 The Great Depression

See Table 11-2 for the statistics regarding the great depression. What caused the great depression?

**Theory 1** A downward shift in the consumption function caused the contractionary shift in the IS curve. The stock market crash of 1929 may have been partly responsible for this shift: by reducing wealth and increasing uncertainty about the future prospects of the U.S. economy, the crash may have induced consumers to save more of their income rather than spending it.

**Theory 2** The great depression was caused by the large drop in investment in housing. Some economists believe that the residential investment boom of the 1920s was excessive and that once this overbuilding became apparent, the demand for residential investment declined drastically. Another possible explanation for the fall in residential investment is the reduction in immigration in the 1930s: a more slowly growing population demands less new housing.

**Theory 3** Many banks failed in the early 1930s, in part because of inadequate bank regulation, and these bank failures may have exacerbated the fall in investment spending. Banks play the crucial role of getting the funds available for investment to those households and firms that can best use them. The closing of many banks in the early 1930s may have prevented some businesses from getting the funds they needed for capital investment and, therefore, may have led to a further contractionary shift in the investment function.

**Theory 4** In addition, the fiscal policy of the 1930s caused a contractionary shift in the IS curve. Politicians at that time were more concerned with balancing the budget than with using fiscal policy to keep production and employment at their natural rates. The Revenue Act of 1932 increased various taxes, especially those falling on lower-

and middle-income consumers.

**Theory 5** The money supply fell 25 percent from 1929 to 1933, during which time the unemployment rate rose from 3.2 percent to 25.2 percent. Friedman and Schwartz argue that contractions in the money supply have caused most economic downturns and that the Great Depression is a particularly vivid example.

A problem for this hypothesis is the behavior of interest rates. If a contractionary shift in the LM curve triggered the Depression, we should have observed higher interest rates. Yet nominal interest rates fell continuously from 1929 to 1933.

**Theory 6** From 1929 to 1933 the price level fell 25 percent. Many economists argue that the deflation may have turned what in 1931 was a typical economic downturn into an unprecedented period of high unemployment and depressed income.

## 56 The Effects of Deflation

**Effect 1** For any given supply of money  $M$ , a lower price level implies higher real money balances  $M/P$ . An increase in real money balances causes an expansionary shift in the LM curve, which leads to higher income.

**Effect 2** Another channel through which falling prices expand income is called the **Pigou effect**. As prices fall and real money balances rise, consumers should feel wealthier and spend more. This increase in consumer spending should cause an expansionary shift in the IS curve, also leading to higher income.

**Effect 3: The debt-deflation theory** An unexpected deflation makes debtors poorer and creditors richer. Debtors thus spend less and creditors spend more. If these two groups have equal spending propensities, there is no aggregate impact. But it seems reasonable to assume that debtors have higher propensities to spend than creditors perhaps that is why the debtors are in debt in the first place. In this case, debtors reduce their spending by more than creditors raise theirs. The net effect is a reduction in spending.

**Effect 4** When firms come to expect deflation, they become reluctant to borrow to buy investment goods because they believe they will have to repay these loans later in more valuable dollars. The fall in investment depresses planned expenditure, which in turn depresses income.

## 57 The Japanese Slump

During the 1990s, after many years of rapid growth and enviable prosperity, the Japanese economy experienced a prolonged downturn. Real GDP grew at an average rate of only 1.3 percent over the decade, compared with 4.3 percent over the previous twenty years. The unemployment rate, which had historically been very low in Japan, rose from 2.1 percent in 1990 to 4.7 percent in 1999. In August 2001, unemployment hit 5.0 percent, the highest rate since 1953.

Although the Japanese slump of the 1990s is not even close in magnitude to the Great Depression of the 1930s, the episodes are similar in several ways.

First, both episodes are traced in part to a large decline in stock prices. In Japan, stock prices at the end of the 1990s were less than half the peak level they had reached about a decade earlier. Like the stock market, Japanese land prices had also skyrocketed in the 1980s before crashing in the 1990s.

Second, during both episodes, banks ran into trouble and exacerbated the slump in economic activity. Japanese banks in the 1990s had made many loans that were backed by stock or land. When the value of this collateral fell, borrowers started defaulting on their loans. These defaults on the old loans reduced the banks ability to make new loans. The resulting credit crunch made it harder for firms to finance investment projects and, thus, depressed investment spending.

Third, both episodes saw a fall in economic activity coincide with very low interest rates. This fact suggests that the cause of the slump was primarily a contractionary shift in the IS curve, because such a shift reduces both income and the interest rate. The obvious suspects to explain the IS shift are the crashes in stock and land prices and the problems in the banking system.

Finally, the policy debate in Japan mirrored the debate over the Great Depression. Some economists recommended that the Japanese government pass large tax cuts to encourage more consumer spending. Although this advice was followed to some extent, Japanese policymakers were reluctant to enact very large tax cuts because, like the U.S. policymakers in the 1930s, they wanted to avoid budget deficits. In Japan, this is in part because the government was facing a large unfounded pension liability and a rapidly aging population.

Other economists recommended that the Bank of Japan expand the money supply more rapidly. Even if nominal interest rates could not go much lower, they perhaps more rapid money growth could raise expected inflation, lower real interest rates, and stimulate investment spending. Thus, although economists differed about whether fiscal or monetary policy was more likely to be effective, there was wide agreement that the solution to Japans slump, like the solution to the Great Depression, rested in more aggressive expansion of aggregate demand.

## 58 The Liquidity Trap

In Japan in the 1990s and the United States in the 1930s, interest rates reached very low levels. As Table 11-2 shows, U.S. interest rates were well under 1 percent throughout the second half of the 1930s. The same was true in Japan during the second half of the 1990s. In 1999, Japanese short-term interest rates fell to about one-tenth of 1 percent.

Some economists describe this situation as a liquidity trap. According to the IS-LM model, expansionary monetary policy works by reducing interest rates and stimulating investment spending. But if interest rates have already fallen almost to zero, then perhaps monetary policy is no longer effective.

Other economists are skeptical about this argument. One response is that expansionary monetary policy might raise inflation expectations. Even if nominal interest rates cannot fall any further, higher expected inflation can lower real interest rates by making them negative, which would stimulate investment spending. A second response is that monetary expansion would cause the currency to lose value in the market for foreign-currency exchange. This depreciation would make the nation's goods cheaper abroad, stimulating export demand.

# Chapter 6

## The Open Economy

### 59 The open Economy

So far we have studied a closed economy. Let's now open the economy up for international trade.

Remember the GDP can be divided into the following components:

$$Y = C^d + I^d + G^d + EX$$

where  $C^d$  is (domestic) consumption expenditure on domestic goods and services,  $I^d$  is (domestic) investment expenditure on domestic goods and services,  $G^d$  is (domestic) government purchases of domestic goods and services.  $EX$  is (total) exports of domestic goods and services.

$C^d + I^d + G^d$  is domestic spending on domestic goods and services.  $EX$  is foreign spending on domestic goods and services.

$C^f$  is (domestic) consumption expenditure on foreign goods and services.  $I^f$  is (domestic) investment expenditure on foreign goods and services,  $G^f$  is (domestic) government purchases of foreign goods and services.

$$IM = C^f + I^f + G^f$$

is total imports, or total domestic spending on foreign goods and services.

$$C = C^d + C^f$$

$$\begin{aligned}
 I &= I^d + I^f \\
 G &= G^d + G^f
 \end{aligned}$$

Substitute the above into  $Y = C^d + I^d + G^d + EX$  to obtain

$$Y = C + I + G + EX - (C_f + I^f + G^f)$$

or

$$Y = C + I + G + EX - IM$$

or

$$Y = C + I + G + NX \tag{11}$$

where

$$NX = EX - IM$$

is net exports, or trade balance.

The equation  $Y = C + I + G + NX$  can be rewritten as

$$NX = Y - (C + I + G) \tag{12}$$

That is, net exports is equal to output minus domestic spending.

If the economy produces more than it spends, then net exports is positive (Trade surplus). Otherwise it's negative (trade deficit). When  $NX = 0$ , the economy is said to have balanced trade.

## 60 International Capital Flows and the Trade Balance

Let  $S = Y - C - G$  denote national saving (it is equal to the sum of public saving  $T - G$  and private saving  $Y - T - G$ ). Then the equation  $Y = C + I + G + NX$  can be rewritten as

$$S - I = NX$$

That is, the economy's net exports (trade balance) must always be equal to the difference between its saving and its investment.

$S - I$  is called net capital outflow.

That is, if the domestic economy saves more than it invests, then the surplus flows to the foreign countries.

If our investment exceeds saving, then the net capital flow is negative. That is, we must borrow from foreign countries to finance our investment.

In other words,

$$\text{Net Capital Outflow} = \text{Trade balance}$$

One way to think about the above equation is this: When  $S > I$ , we are saving more than we invest. What's saved but not invested is used to make loans to foreigners. These loans enables the foreigners to buy more goods and services from us than we buy from them. Eventually, the loans will become goods and services exported to foreign countries.

On the other hand, if Our investment exceeds our saving, the extra investment must be financed by borropwing from abroad. These for-

eign loans enables us import more goods and services than we export. That is, we are running a trade deficit.

International flow of capital may take many forms. In other words, there are many ways in which international lending and borrowing can take place. When the US runs a trade deficit with Japan, the capital flow from Japan to the US could take the form of a financial loan made to a US company by a Japanese bank, or the Japanese buying the debt issued by American corporations, or the Japanese buying other types of US assets (equity, treasury bills, houses).

## 61 A Small Open Economy

Consider first a small open economy with perfect capital mobility.

*Small* means the economy is a small and negligible part of the world financial market and it has no way to affect the determination of the world interest rate.

By *perfect market mobility* we mean that residents of the country have full access to world financial markets. In particular, the government does not interfere with international lending and borrowing.

Let  $r^*$  denote the world interest rate (market rate in the world financial markets). This world interest rate is assumed to be exogenously fixed because the economy is sufficiently small relative to the world market that it can borrow or lend as much as it wants in the world financial markets without affecting the world interest rate.

Because of perfect market mobility, residents of the small open economy need never borrow at any interest rate above  $r^*$ , they need never lend at a rate that is lower than  $r^*$  either. So, in our small open economy,

$$r = r^*. \tag{13}$$

More specifically, suppose  $r > r^*$ ; then domestic borrower will borrow abroad

## 62 Policies influence trade balance in a small open economy

Now as we did for the closed economy, let's first assume the economy's output  $Y$  is fixed. Assume  $C = C(Y - T)$  and  $I = I(r)$ . Because  $r = r^*$ , so  $I = I(r^*)$ .

So the economy's net exports must be equal to

$$NX = [Y - C(Y - T) - G] - I(r^*)$$

The above equation can be used to consider how policies influence the trade balance, without being concerned about their effects on the interest rate.

For example, an increase in  $G$  reduces trade surplus and increases trade deficit.

## 63 The U.S. Trade Deficit

After 1975, the US ran large trade deficits. In 2007, the trade deficit was 708 billion, 5.1 of U.S. GDP.

As the equation  $S - I = NX$  requires, this trade deficit had to be financed by borrowing from abroad (i.e., by selling U.S. assets abroad). Thus, during this period, the U.S. went from being the world's largest creditor to the largest debtor.

What caused the U.S. trade deficit?

(i) Expansionary fiscal policy in the 1980s - the Regan years over which personal taxes were cut substantially for three years (1981-84) which, according to our model, increased personal consumption but reduced national saving ( $S$ ), thereby reducing trade balance.

A hallmark of the Regan years was the *twin deficits*.

(ii) In the late 1990s, rapid productivity growth raised incomes in tax revenues, moved the U.S. federal budget from deficit to surplus, which in turn caused national saving to rise. Meanwhile, the IT boom caused an expansionary shift in the U.S. investment function, and the investment boom was even a stronger force that pushed the trade balance toward deficit.

(iii) In the early 2000s Bush years, tax cuts and the war on terror reduced national saving again, trade deficits reached historic highs.

(iv) After 2005, housing prices started to decline, led to a substantial decline in residential investment. Trade balance improved.

## 64 The nominal exchange rate

The nominal exchange rate is the relative price of the currency of two countries.

Suppose the exchange rate between the US dollar and the Japanese yen is 120 yen per dollar. Then you can use 1 dollar to buy 120 yen, or you can pay 120 yen to buy 1 dollar.

When people refer to the exchange rate, they usually mean the nominal exchange rate.

We use  $e$  to denote the nominal exchange rate.

$$1 \text{ dollar} = e \text{ yen}$$

$$1 \text{ domestic currency} = e \text{ foreign currency}$$

That, the nominal exchange rate is the price of domestic currency in units of a foreign currency.

## 65 The real exchange rate

The real exchange rate is the relative price of the goods of the two countries. Suppose there is only one good, cars, that the two economy produce and the American cars and Japanese cars are of the same quality. Then the real exchange rate is the price of one US (domestic) car in units of Japanese (foreign) cars. In other words, in order to buy one US car, how many US cars I must give up.

That is, instead of asking one unit of domestic currency is equal to how many units of foreign currency, I now ask one domestic car is equal to how many foreign cars.

We use  $\epsilon$  to denote the real exchange rate.

For simplicity, let's suppose the two countries produce cars only, and the american cars and the Japanese cars are of the same quality.

Let  $P$  denote the price of a car in the US (the domestic country),  $P^*$  the price of a car in Japan.

The question is: one US car is equal to how many Japanese cars?

$$\epsilon = 1 \times P \times e/P^* = e \times (P/P^*)$$

That is, I sell 1 US car to get  $1 \times P$  US dollars, I then exchange them for  $1 \times P \times e$  Japanese yen, and I then use these yen to buy  $1 \times P \times e/P^*$  Japanese cars.

The real exchange rate is also called the terms of trade.

## 66 The Mundell-Fleming Model

Consider again a small open economy with perfect capital mobility:

$$r = r^*, \quad (14)$$

where remember  $r$  is the interest rate in the domestic country,  $r^*$  is the world interest rate.

Assume the goods market is described by the following IS equation:

$$Y = C(Y - T) + I(r^*) + G + NX(e). \quad (15)$$

The above equation assume that the demand for net exports depends on the exchange rate. Naturally,  $NX$  decreases as  $e$  increases.

Equation (15), the IS curve that describes a relationship between  $Y$  and  $e$ , slopes downward. Figure 12-1(a).

The LM equation now reads

$$M/P = L(r^*, Y). \quad (16)$$

The M-F model is designed to analyze short-term fluctuations, the price levels  $P$  and  $P^*$  is assumed to be exogenously fixed.

We now use this model for policy analysis.

## 67 The System of Floating Exchange Rates

Under a system of floating exchange rates, the exchange rate is set by market forces and is allowed to fluctuate in response to changing economic conditions.

The floating exchange rate system is the system relevant to most major economies today.

**An Example** Suppose  $C(Y - T) = m * (Y - T)$ ,  $I(r) = I_0 - 100r$ ,  $r^* = 0.1$ ,  $L(r, Y) = Y - 100r$ ,  $NX(e) = NX_0 - 10e$ .  $P$  and  $r^*$  are unknown constants. Solve for the equilibrium  $Y$  and  $e$ .

By (15) and (16), the IS-LM equations are:

$$IS : Y = m * (Y - T) + I_0 - 100r^* + G + NX_0 - 10e. \quad (17)$$

$$LM : M^s/P = Y - 100r^*. \quad (18)$$

Solving these equations to obtain

$$Y^* = M^s/P + 100r^*, \quad (19)$$

$$e^* = \frac{1}{10} \left\{ -(1 - m) \left( \frac{M^s}{P} + 100r^* \right) - mT + I_0 - 100r^* + G + NX_0 \right\}.$$

Clearly then

$$\begin{aligned} G \uparrow &\rightarrow e^* \uparrow, NX(e^*) \downarrow, \\ M^s \uparrow &\rightarrow e^* \downarrow, NX(e^*) \uparrow, \\ NX_0 \uparrow &\rightarrow e^* \uparrow, NX(e^*) \downarrow. \end{aligned}$$

## 68 Policies under Floating Exchange Rates

Suppose the government stimulates domestic spending by increasing government purchases or by cutting taxes. This shifts the IS curve to the right and, as a result, the exchange rate appreciates, whereas the level of income remains the same.

Suppose the central bank increases the money supply. Because the price level is assumed to be fixed, this increases the real money balances, shifting the LM curve to the right. exchange rate is lower, income higher.

Suppose the government pursues a trade policy to reduce the demand for imported goods (say by imposing an import quota or a tariff). This shifts the NX curve to to right (by reducing imports), which in turn shifts the IS curve to the right. The exchange rate will appreciate but income remains the same. Notice  $NX(e) = Y - C(Y - T) - I(r^*) - G$  remains the same. So restricting trade don't necessarily improves the balance of trade.

## 69 The Fixed Exchange Rate System

Under a fixed exchange rate, the central bank announces a value for the exchange rate and then stands ready to buy and sell the domestic currency to keep the exchange rate at its announced level.

In the 1950s and 1960s, most of the world's major economies, including that of the United States, operated within the Bretton Woods system - an international monetary system under which most governments agreed to fix exchange rates. The world abandoned this system in the early 1970s, and most exchange rates were then allowed to float.

The fixed exchange rate system is characterized by

$$e = \bar{e}, \quad (20)$$

where  $\bar{e}$  is an exogenously fixed exchange rate. And the IS-LM equations are:

$$Y = C(Y - T) + I(r^*) + G + NX(\bar{e}). \quad (21)$$

$$M^s/P = L(r^*, Y). \quad (22)$$

The above two equations determine both  $Y$  and  $M^s$ . Thus the central bank loses control over the country's money supply  $M^s$ .

## **70 The International Gold Standard**

During the late 1800s and early 1900s, most of the world's major economies operated under a gold standard. Each country maintained a reserve of gold and agreed to exchange one unit of its currency for a specified amount of gold. Through the gold system, the world's economies maintained a system of fixed exchange rates.

## 71 Devaluations and Revaluations

A reduction in the  $e$  is called a **devaluation** and an increase in  $e$  is called a **revaluation**.

The international gold standard collapsed during the great depression. During the great depression, some countries, Denmark, Finland, Sweden, UK, devalued their currency by about 50 percent. These countries recovered quickly from the great depression, as the Mundell-Fleming model predicts.