Essentials of Macroeconomics

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1.1 Prices and price level

1.1.1 Price level

Prices are of great importance in macroeconomics as indeed they are in microeconomics. However, in microeconomics we are more interested in prices of individual goods and services and such prices are rarely important for the economy as a whole although there are exceptions (for example, the price of oil). In macroeconomics we are more interested in how prices change *on average*. We define the *price level* as a weighted average of several different prices.

If p_1 is the price of gasoline and p_2 the price of oil, then $10p_1 + p_2$ is a price level. It is a weighted average of two prices with weights 10 and 1. Normally, the price level is defined using many more prices.

The reason for using different weights is that some prices are more important than others for the economy. The price of gasoline, for example, is much more important than the price of paper clips. By using different weights we allow for changes in some prices to have a larger effect on the price level than changes in other prices.

Exactly which prices are included in the price level and the weights they carry may vary. Different choices give rise to different measures of the price level. To visualize the prices and weights that are included, we use the concept "basket" of goods and services.

We may, for example, create a basket that contains all the goods sold by a particular store on a particular day. The price of this basket is then a price level – it will be a weighted average of the prices of the goods sold that day and the weights will be equal to the number of each good sold. Perhaps the basket contains 100 liters of regular milk but only one frozen cake. The price of regular milk will then have a weight of 100 while the price of frozen cake will have a weight of 1. Changes in the price of milk will then have a greater influence on the price level than changes in the price of frozen cake.

Note: in macroeconomics, it is common to use the term "prices" or "price" as short for price level. The expression "prices rise" should be interpreted as "the price level rises" – it does not mean that all prices rise.

1.1.2 Price level and time

We are rarely interested in the value of the price level at a particular point in time. What we are interested in is the *percentage change* in the price level between two points in time.

We calculate the percentage change by first creating a basket of goods and services. At regular intervals (usually once a month on the first day of the month) we measure all the prices of the contents of the basket (typically as an average of the market) and calculate the price level. In this way, we will end up with a *time series* of price levels – one value for each month.

Using this time series we can study how the price level evolves over time. If all prices rose by 2% during one month, the price level would rise by exactly 2%. If one of the prices rose by 2% while the other prices remained unchanged, the price level would rise, but by much less than 2%. Exactly how much it would rise would depend on the weight of the changed price.

Imagine that we have created a particular basket of goods and services. We calculate the price level at four different points in time during 2008 without changing the content of the basket (the weights are unchanged). Suppose that we find the following time series for the price level:

Point in time	Jan 1, 2008	Feb 1, 2008	March 1, 2008	April 1, 2008
Price level	60 770	62 400	62 850	62 850

1.1.3 Price index

Since we are only interested in the percentage change of the price level and not the particular value, we can divide each price level by a given constant so that the numbers are easier to deal with. When we divide a series of price levels by a constant we end up with what is called a time series of *price indexes*.

Using the same basket as above, if we divide the entire series by 607.70 we get the following time series of price indexes:

Point in time	Jan 1, 2008	Feb 1, 2008	March 1, 2008	April 1, 2008
Price index	100	102.68	103.42	103.42

The reason for choosing 607.70 is that we want the index to be equal to 100 for the first point in time. The advantage of having an index that starts with 100 is that we will have a clearer picture of the evolution of prices. We may, for example, immediately conclude that prices rose by 2.68% on average in January and by 3.42% during the three months January to March.

Note that the percentage change of the original price level and the percentage change of the price index is the same. The percentage change will not depend on which point in time we select as our "base" (giving the price index a value of 100). Using the price index, the percentage change during January is (62400 – 60770)/60770 = 2,68% which is exactly the same as the percentage change of the price index.

1.1.4 Consumer Price Index, CPI

CPI is a price index of a particular basket called the CPI-basket. The CPI-basket contains basically all the goods and service consumed in a country – food, gas, medicine, haircuts, transportation, house rent and so on. The composition of the CPI basket is determined by the value of what is consumed in the country – the larger the value of total consumption of a good or service, the larger the weight in the basket. For example, if we spend twice as much on apples as on pears, apples will have twice the weight in the basket. The exact details of the composition of the basket and how the CPI is calculated are complicated and vary somewhat between countries. Figure 1 displays CPI for Germany after the reunification starting at January 1991. This data has 2005 as the reference year. This means that the CPI is constructed in such a way that CPI is exactly equal to 100 on average during 2005.

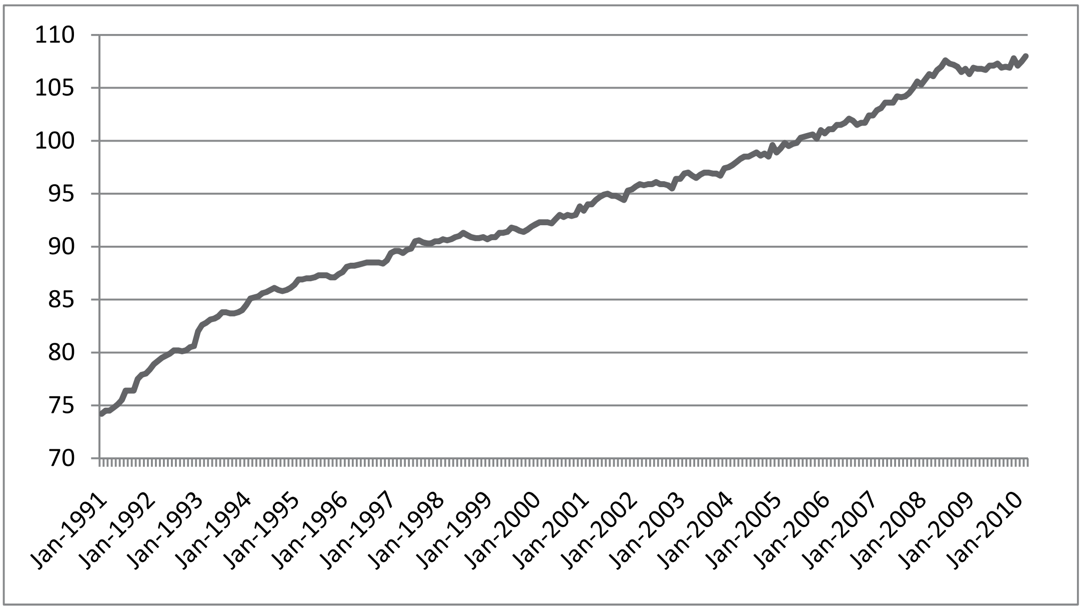


Figure 1.1 Consumer price index (CPI) for Germany 1991–2010. Source: OECD.

1.1.5 Problems with CPI

To illustrate the problems involved in calculating the CPI we consider MP3 players. If you measure the average price of MP3 players at two points in time, say one year apart, you may find that the average price has not changed.

However, this is not the whole story since the products on the market will have changed. Typically, the products at the later measurement are more advanced than the products at the first measurement. If you were to compare prices of MP3 players with the same performance, you would probably find that prices have fallen. Without adjusting for changes in performance and quality, you will usually overestimate the rise in the price index.

1.2 Inflation

1.2.1 Definition

The inflation between two points in time is defined as the percentage increase of the price index between these two points in time.

Comments:

- Price index is calculated at a particular *point in time*, inflation over a *time period*, typically one year
- Inflation may just as well be defined as the percentage change in the price level.
- Inflation is independent of which year we use as our base year for our price index.
- You often hear that inflation is the "percentage change in prices" but keep in mind that "prices" is then short for the price level.
- Since the price level may be defined in many different ways (using different goods and different weights in the basket), inflation may be defined in many different ways.
- If the price index decreases between two points in time we say that the inflation is negative or that we have *deflation*.

1.2.2 Inflation in Germany

Once we have monthly data on a price index we can calculate the inflation. In most countries, the percentage change in the price index during one month is small. Therefore, it is more common to calculate the inflation each month based on an entire year. For example, on 1 January 2010, inflation is calculated as the percentage change in the price index between 1 January 2010 and 1 January 2010. On 1 February 2010, inflation is calculated as the percentage change in price index between 1 February 2010 and 1 February 2010 and so on. Figure 1.2 shows Germany as an example.

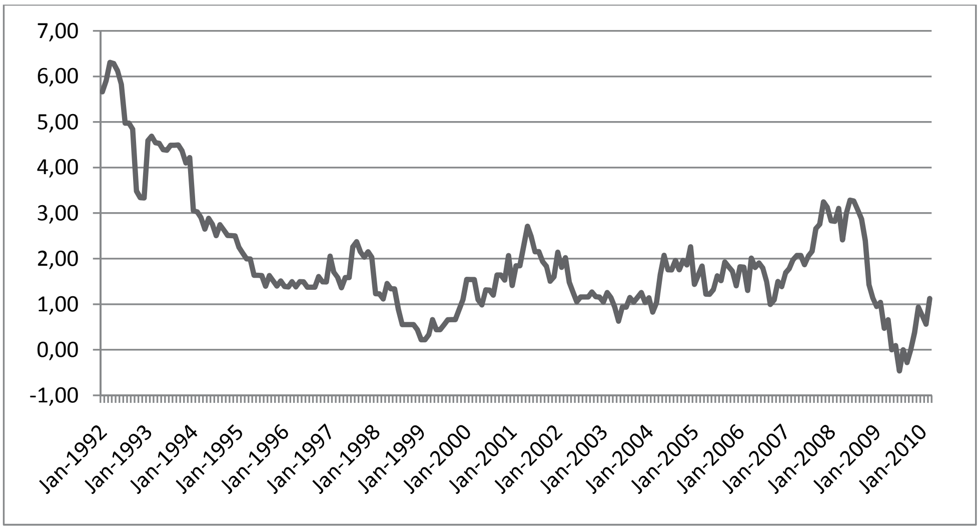


Figure 1.2 Inflation in Germany 1992–2010. Source: OECD.

1.2.3 Inflation in Sweden

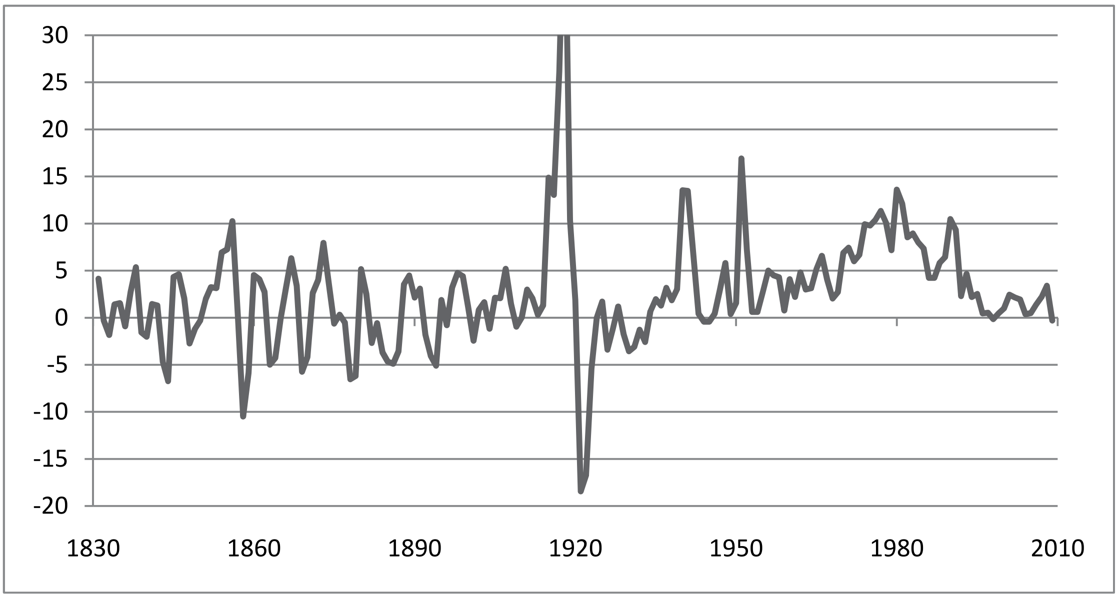


Figure 1.3 Inflation in Sweden 1830–2010. Source: SCB.

Four aspects are interesting when we look at inflation data for Sweden

- During the 1800s, when Sweden was mainly an agricultural society, deflation where almost as common as inflation.
- The "spikes" in 1918–1922 began with a speculative boom right at the end of World War I, which in turn was followed by a deep depression.
- In the period from the end of the Second World War 1945 to the economic crisis of the 1990s, Sweden had continuous inflation with no periods of deflation. Inflation was particularly high during the 1970s and the 1980s.
- From 1992 onwards Sweden has had a low and a relatively constant rate of inflation with regular periods of deflation. A major reason for the low inflation in Sweden, as for most OECD countries, is the priority given to combating inflation. Sweden now has an inflation target aiming to keep inflation to between 1% and 3%.

2 Exchange rate

2.1 Definition

The exchange rate is defined as the price of one unit of currency in terms of another currency. If one euro costs 1.5 USD then 1 USD costs 1/1.5 = 0.667 euro. If the exchange rate is stated in terms of the euro (for example, 1.5 USD/euro) then the euro is called the *base currency* or the *unit currency*.

In most countries, the exchange rate is expressed using the foreign currency as the base currency. For example, in Denmark, the USD exchange rate would be expressed as 4.8 Danish kronor (DKK) per USD while, in the U.S., the same exchange rate would be expressed as 0.208 USD/DKK (or 20.8 USD/100DKK). This way of specifying the exchange rate is called the *direct method* as you can immediately figure out how much you have to pay for one unit of a foreign currency.

In some countries, the exchange rate is expressed using the home currency as the base currency. In the UK for example, the Danish exchange rate would be expressed as 9.2 DKK/GBP. Thus, you have to invert the exchange rate if you want to figure out how much one unit of a foreign currency costs in the UK. This method is called the *indirect method* of specifying the exchange rate and the notation is sometimes called *British notation*.

2.2 Exchange rate systems

Different countries have different exchange rate systems. The most important characteristic of an exchange rate system is to what degree the country is trying to *control the exchange rate*.

- A country may have a *completely flexible exchange rate*. The exchange rate is then determined solely by supply and demand in a free market without intervention of the government or the central bank.
- A country may have a *completely fixed exchange rate* by pegging the exchange rate to another currency or to an average of several currencies. A country may, for example, decide that one unit of its currency will be exchanged for exactly 0.2 euro. One euro will then cost 5 of the domestic currency.
- A country may also have an exchange rate system in between these two extremes, called a "managed float". In this system, the central bank only intervenes under special circumstances when it wants to influence the exchange rate one way or the other.
- A country may also be part of a monetary union where all the countries in the union share the same currency. There is then no exchange rate between the countries in the union. The union must itself select an exchange rate system vis-à-vis other currencies. The largest monetary union is the EMU, the European Monetary Union with its currency the euro. The euro is flexible against other currencies (except those that are pegged to the euro).

The most common exchange rate system in the western world during the previous century was the fixed exchange rate system. Up to the 1930s, most currencies were pegged to the price of gold (the gold standard). After the Second World War a new system was created, the so-called Bretton Woods system, where each currency in the system was pegged to the US dollar (USD). After the collapse of this system in the 1970s, many currencies, for example, the USD, have been flexible.

2.3 Changes in the exchange rate

Suppose that the United States is our home country and that the current euro exchange rate in direct notation is $S_D = 1.5$ (euro/USD). In indirect notation, *SI* = 0.667 (USD/euro). If the euro becomes more expensive in terms of the USD we say that the USD has *depreciated* against the euro (lost in value). This means that *SD* has increased (to say *SD* = 1.6) and that *SI* has fallen (to 0.625). If the euro becomes less expensive we say that the USD has *appreciated* against the euro. In such a case, *SD* will fall and *SI* will increase. Of course, when the USD depreciates against the euro, the euro appreciates against the USD.

Remember:

A foreign currency is more expensive ⇔ the domestic currency has depreciated *A foreign currency is less expensive ⇔ the domestic currency has appreciated*

Also keep in mind that when a currency depreciates, *S* will increase if we use the direct notation and decrease if we use indirect notation.

If a country has a fixed exchange rate (say against a particular currency), the government or the central bank may change this fixed exchange rate. Suppose that Hong Kong is our home country and that the Hong Kong dollar (HKD) is fixed against the USD at the exchange rate 7.8 HKD/USD (direct notation). If the central bank in Hong Kong changes this exchange rate to say 8.2 HKD/USD it makes the foreign currency more expensive and the HKD cheaper. In this case we say that the HKD has been *devalued*. However, if the exchange rate is changed to say 8.6 HKD/USD we say that the HKD has been *revalued*.

2.4 The euro against the US dollar

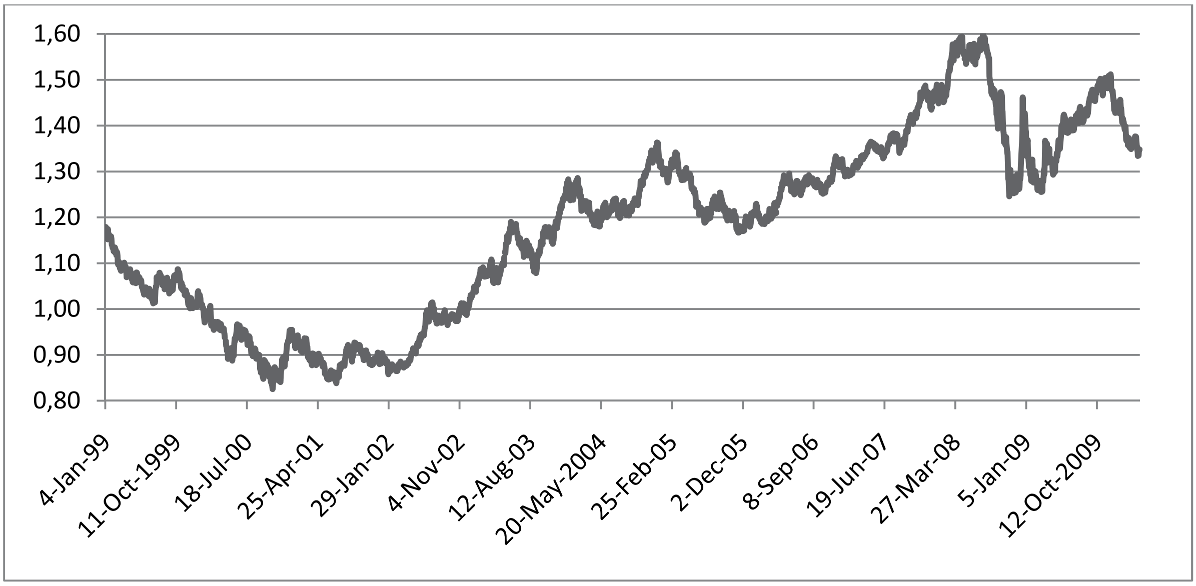


Figure 2.1. The price of one euro in US dollars 1999–2010. Source: IMF

As an example, Figure 2.1 shows the exchange rate between the USD and the euro with the euro as the base currency.

2.5 Effective exchange rate

Suppose that we are interested in the external competitiveness of a country, say Japan. To do this we could look at the evolution of a particular exchange rate, say the exchange rate between the Japanese yen (JPY) and the USD. The problem with this idea is that this exchange rate will reflect the external competitiveness and events in the US as much as in Japan. If we want to isolate Japan without including events in other countries, we look at the *effective* exchange rate instead.

The effective exchange rate is the price of a basket of currencies where each currency is weighted in relation to its importance to the country. Such a price level is then divided by a constant such that its value is exactly 100 at a given point in time. If, for example, the price index is 110 one year after the base year, then the currency has depreciated by an average of 10% against other currencies that year.

3 Gross domestic product

3.1 Definition

Perhaps the most important concept in macroeconomics is Gross Domestic Product (GDP):

Gross Domestic Product (GDP) is defined as the market value of all finished goods and services produced in a country during a certain period of time

Note that we only include finished goods and services – that is, anything that is sold directly to the consumer. Electric power sold to a steel mill is not included while all the electric power sold directly to consumers is included. The reason is simply that we want to avoid "double counting". Consider for example the production of cars. Car producers have parts produced by other firms which in turn have parts delivered by other firms and so on. If we were to count the value of everything produced by a firm, then most parts of a car would be counted several times. This is why only the value of the finished car is used in the calculation of GDP. Note, however, that if a firm buys a robot that it uses in the production of cars, then this robot is counted (if it is produced in the same country). The car producer is then the "final consumer" of the robot – no value is added to it and it is not resold to another firm.

3.2 Real GDP

To be able to make reasonable comparisons of GDP over time, we must adjust for inflation. For example, if prices are doubled over one year, then GDP will double even though exactly the same goods and services are produced as the year before. To eliminate the effect of inflation we divide GDP by a price index and we define *real GDP as GDP divided by a price index*.

It is not very common to use CPI in the construction of real GDP. The reason is that CPI measures the price evolution of consumer goods while GDP includes investment goods as well as consumer goods. Instead, it is common to use a *GDP deflator* as a price index. The GDP deflator measures the price evolution of a basket whose composition is close to the composition of GDP. The difference between the CPI and the GDP deflator is fairly small however. To avoid confusion, GDP that is not adjusted for inflation is often called *nominal GDP*.

3.3 Growth

By (nominal) *GDP-growth* we mean the percentage change in (nominal) GDP over a specific period of time. Real GDP growth is defined as the percentage change in real GDP. The real growth tells us how much the economy has grown during a particular period when the effect of inflation is removed.

3.4 Purchasing power

One problem in using the exchange rate when comparing GDP per capita between countries is that is fluctuates quite a lot. A way of avoiding dependence on the exchange rate is to use *purchasing power*.

3.5 GDP is a flow!

Finally, note that GDP is a flow variable and not a stock variable. By a flow variable we mean a variable that is measured in something *per unit of time*. If you fill a bath tub you may fill it at 40 liters *per minute* – a flow – while the tub itself may contain 200 liters – a stock. In the same way, income is flow (you may make 9 euro per hour) while the amount of money you have in your bank account is a stock (you would never claim that you have 2400 euro "per month" in your account – you have 2400 euro period).

GDP, being a flow, is not a measure of the total wealth of a country but a measure of the "income" of the country during a certain period of time. Sure, if GDP is high, it is quite likely that the total wealth of the country is increasing over time (some wealth is lost to depreciation). Therefore, there is often a connection between what we perceive as a "rich" country and a high GDP per capita.

4 The components of GDP

4.1 The circular flow – simple version

We have defined GDP, the gross domestic product, as the market value of all finished goods and service produced in a country during a specific period of time. We will now look closer at the definition and the components of GDP – something which is necessary if we want to understand macroeconomics.

In order to better figure out the details of GDP we will use the "circular flow model". The main purpose of the circular flow is to show how goods, services and money flow to and from various sectors in the economy. Such a model may be more or less detailed. We will start with the least detailed version and then construct a more complete model to which we will refer throughout the book.

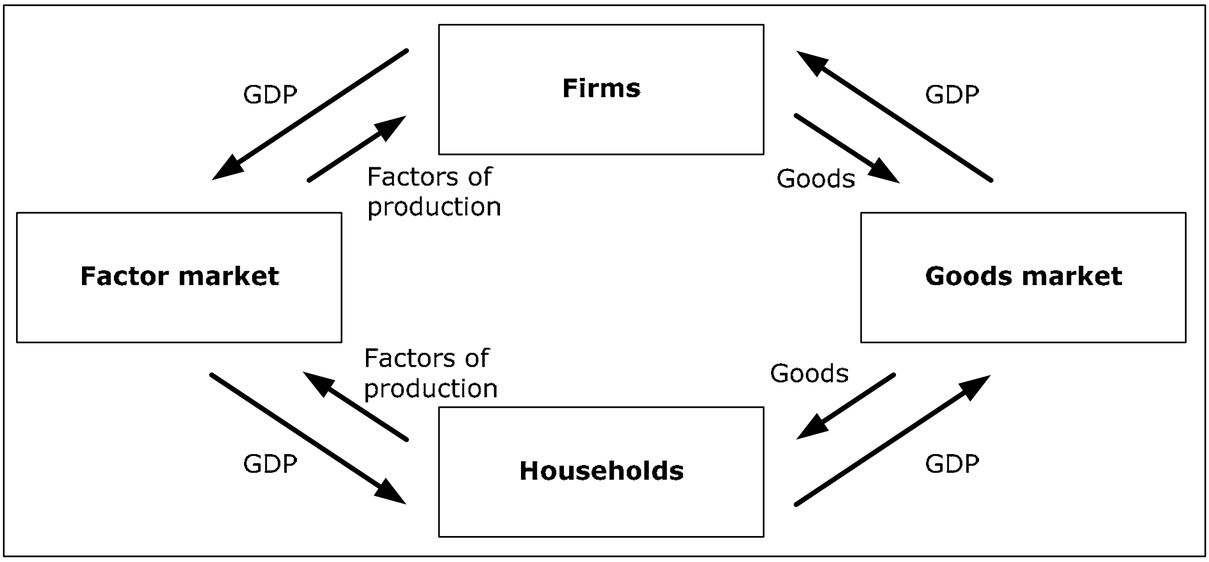


Fig 4.1

In this model goods (and services) flow counter clockwise while money flows clockwise.

- Firms deliver *finished* goods to the goods market (semi-manufactured goods circulate within the box firms). Firms are compensated for the goods and this compensation is equal to GDP.
- Consumers receive goods from the goods market where prices are determined through supply and demand.
- In order to pay for the goods, the consumers deliver factors of production (labor and capital) to the factor markets.
- Firms buy factors of production using the income they receive from the goods market.

Note that the flow of money from firms to the factor markets is exactly the same as the flow of money from the goods market to the firms. If this was not the case, firms as a group would make a profit or a loss. But since all firms are owned by individuals (directly or indirectly through pension funds and other funds), all profits or losses must eventually fall on the consumers. This flow is part of the return on capital, a flow of money to the factor market.

4.2 The circular flow – a more detailed version

We need a more detailed version of the circular flow model in order to understand important issues in macroeconomics. However, even the more detailed version must be a simplified model of the real world. We will only include details that are important for the understanding of macroeconomics at this level. All the details and the exact definitions would use up too much space.

To make the figure less complicated, we start with the firms. Then we draw the circular flow using two parts. In the first part we illustrate how goods flow between various sectors of the economy, while in the second part we show how money flows.

4.3 Modeling a firm and the concept value added

Before we look at the more detailed version of the circular flow, we will illustrate the model of the firm that we will use in this book.

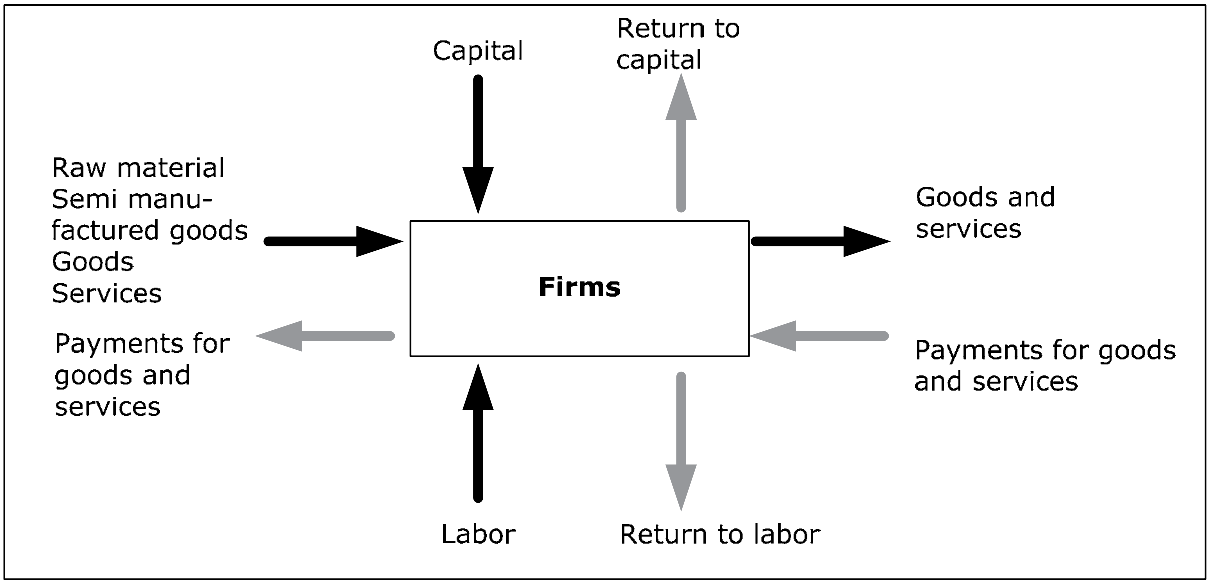


Fig. 4.2: Firms in the circular flow.

A firm in our model is a unit which *adds value to products*. These products may be raw material, semi-manufactured goods, final goods and services. By adding value, we mean that the firm acquires the good, adds value to it and then sells it. A supermarket adds value to a final good by making it more available to consumers and a bakery adds value to flour when it bakes bread.

Firms add value by using factors of production (mostly various forms of labor and capital). We define *value added* as the *difference between the revenue and the cost of the goods*. If a supermarket buys a fish for 4 euro and sells it for 5 euro, it has added 1 euro of value to the fish.

From the diagram we see that the *value added in a firm must be equal to the compensation to the factors of production*. This must be the case since the net flow of money for a firm must be zero (remember that profits become return to capital – a compensation to the owners of the firm).

4.4 Firms in the circular flow

We divide all firms into three categories: *FR* consists of all firms that acquire raw material (iron ore, farm products and so on), *FH* all those that produce semi-manufactured goods (steel, pulp and so on) and *FF* all firms producing finished goods (software, cars and so on). We use the symbol *Y* for GDP. All of *Y* will go to the firms in the *FF* box. However, if we sum the value added from *all* firms, we will get exactly *Y*. This is why:

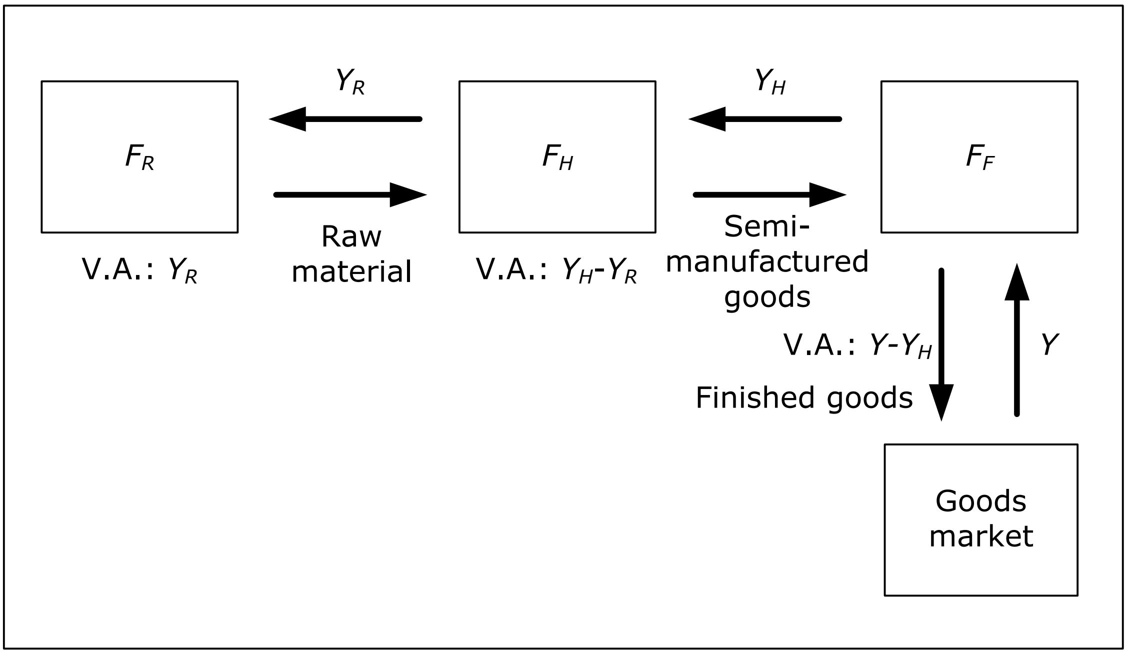


Fig. 4.3: Goods in the circular flow.

- If *YR* is the total value of all goods going from *FR* to *FH*, then the total value added from all firms in the *FR* box is equal to *YR* (they do not purchase any goods to which they add value).
- In the same way, if the total value of all goods going from *FH* to *FF* is given by *YH*, then the total value added from all firms in the *FH* box is *YH* – *YR*.
- In the same way, the total value added for all firms in the *FF* box will be equal to *Y* – *YH*. If we sum all the value added from all firms, we get *YR* + (*YH* – *YR*) + (*Y* – *YH*) = *Y*.
- This result is independent of how many "levels" or boxes we have in the production process. Instead of three levels, we could have any number of levels and the result would still hold. Also, a particular firm may be producing in several of the boxes.

Since the value added in each firm is equal to the return to the factors of production, the total return to the factor market must be equal to the sum of value added from all firms, which is equal to *Y*.

The total return to the factor market =
Sum of all value added =
GDP

4.5 Circular flow – circulation of goods

Figure 4.4 shows a more developed version of the circular flow. In this figure we see how goods flow through the various sectors of the economy.

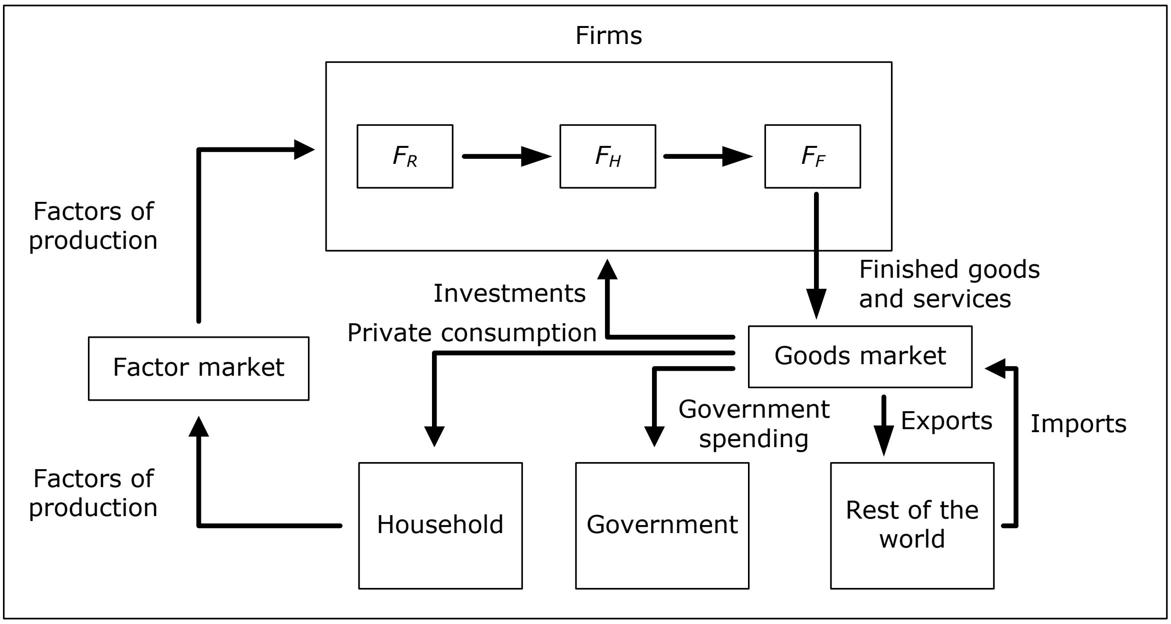


Fig. 4.4: Money in the circular flow.

- In addition to the private sector we now include the Government and the Rest of the World in this model.
- Finished goods in the goods market are divided into four categories: private consumption going to the private sector, public consumption for the government (health care, education, defense and so on), investment going to firms and export to the rest of the world. To this flow we must now add imports from the rest of the world.

4.6 Circular flow – circulation of money

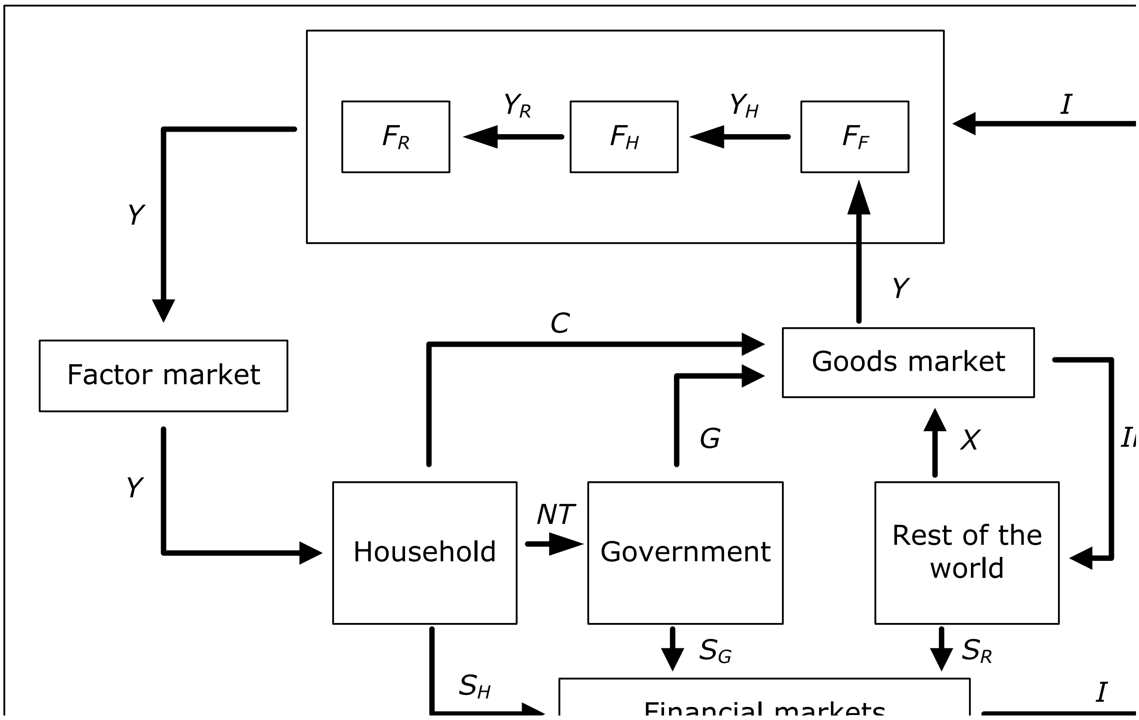


Fig. 4.5

4.7 Private sector in the circular flow

- The private sector total income is called the *national income*. Since the private sector receives the entire return from the factors of production, the national income is equal to the GDP and we can use the symbol Y for national income as well. Note that in a more detailed analysis of the components of GDP, including for example depreciation and factor income from abroad, it is no longer the case that national income is exactly the same as GDP, but they will often be close to each other.
- The private sector pays taxes to the government. Here we must include all taxes, income taxes, value added taxes, selective purchase taxes and payroll taxes (which are ultimately paid by the private sector since it owns the firms).
- Part of these taxes will be returned to the private sector in the form of pensions, child allowances, sickness benefit, unemployment benefits and so on. All these are examples of *transfers* from the government.

- *Net tax* is then defined as taxes minus transfers and is denoted by NT.
- National income minus net tax is called *disposable income* or personal disposable income and is denoted by $YDisp$ where $YDisp = Y - NT$.
- Total consumption by the private sector is denoted by C. C need not be equal to disposable income as the private sector can save and borrow. We define the *private sectors savings* as $SH = YDisp - C$ (H for household). If $C > YDisp$ then $SH < 0$, which implies that the private sector (in the aggregate) is borrowing money.

4.8 The Government, Rest of the World and the financial markets

- The total expenditure of the government may be divided into two parts: transfers to the private sector and consumption.
- *Government expenditure* is the total expenditure by the government on goods and services. Note that the salary paid to an officer in the army is included in the government expenditure while the pension to the same officer is part of the transfers. We denote government expenditure by G.
- Government revenue is from taxes paid by the private sector. Since part of the taxes is returned through transfers, the government has NT available for consumption.
- We say that the government has a *balanced budget* if $G = NT$. We also define government savings as $SG = NT - G$.
- The total value of all exports to the rest of the world is denoted by X, while the total value of all imports from the rest of the world is denoted by Im. If $Im > X$ then the value of all goods and services received from the rest of the world is larger than the value of goods and services that we send to them. The difference, $SR = Im - X$ is *rest of the world savings* and this is also the amount we borrow from the rest of the world, which must eventually be paid back by exporting more than we import.
- Firms borrow money from the financial markets in order to finance *investments*, denoted by I. Investments are financed by private sector savings, government savings and rest of the world savings, $I = SH + SG + SR$. Note that SH , SG and/or SR may be negative.

4.9 Components of GDP

- By considering all arrows to and from the goods market we see that $Y + Im = C + I + G + X$. The left hand side is the value of all finished goods flowing into the goods market and the right hand side decomposes all goods into four categories. Note that this is simply an accounting identity and it must always hold.
- Moving Im to the right hand side we have $Y = C + I + G + X - Im$. $X - Im$ is called *net exports*, NX and $NX = -SR$. Note that net exports is equal to the amount that the rest of the world *borrows* from our country. Thus, we can write $Y = C + I + G + NX$ where C, I, G, NX are called the components of GDP.

- We have another accounting identity from the financial markets: $SH + SG + SR = I$. Using $SH = YDisp - C = Y - NT - C$, $SG = NT - G$ and $SR = Im - X$ we get $Y - NT - C + NT - G + Im - X = I$, which is equivalent to the accounting identity from the goods market. Thus, if the accounting identity from the financial markets holds, the identity from the goods market must hold and vice versa. But the most important relationship to remember is

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

4.10 Four different measures of GDP

Using the circular flow model we see that there are four equivalent ways of measuring GDP:

- Using the definition: the market value of all finished goods (expenditure method)
- As the sum of all value added from all firms (value added method)
- As the sum of consumption (private and government), investment and net exports (components method)
- As the sum of all returns from the factor markets: wages, return on capital and so on (income method)

4.11 Capital

By *capital* we typically mean manufactured goods that are used to produce other goods and services but are not used up in the production process (such as machines and computers). Sometimes we use the term *fixed capital* instead of capital to distinguish capital from *financial capital*, which consists of bank deposits, stocks, bonds and other assets. Fixed capital is sometimes divided into physical capital and immaterial capital such as individual capital (talent, skills, knowledge) and social capital.

4.12 Investment

When we use the word investment, we typically mean "*gross investment*". Basically, gross investment consists of all finished goods that we have produced but not consumed. The important parts of gross investment are *gross fixed investment* and *changes in inventories*.

Gross fixed investment is the total amount of investment in fixed capital. If a firm produces more than it sells in a particular period of time, its inventory will increase. This will be counted as a positive investment. In the same way, we will have a negative inventory investment whenever inventories decrease.

By *net investments* we mean gross investments minus depreciation such that the actual increase in the amount of capital between two periods in time is equal to the net investment during this period. Keep in mind that while capital is a stock, investment is a flow. We may talk about a firm's total amount of capital at a particular point in time and a firm's total investment over a period of time.

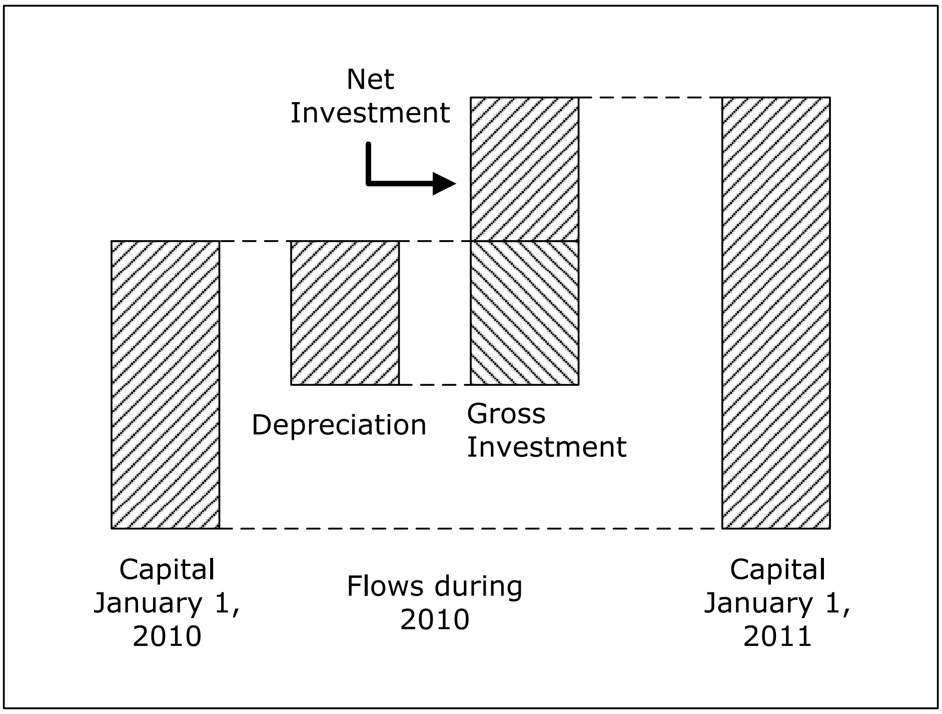


Fig. 4.6

4.13 Components of GDP in numbers 200x

BNP *Y*	2 673
Privat konsumtion *C*	1 283
Investeringar *I*	456
Offentlig konsumtion *G*	728
Import *Im*	1 093
Export *X*	1 299
Nettoexport NX	206
C + I + G + NX	2 673

Table 4.1

5 The Labor Market

5.1 Introduction

An important macroeconomic variable is the total amount of labor that is used in a certain time period. The amount of labor and the amount of capital are important explanatory variables for total production and GDP. Another reason for the importance of the amount of labor is that it is related to the unemployment rate – a macroeconomic variable which is clearly important.

5.2 Uneployment classification

Economists sometimes distinguish between different types of unemployment. There are many different ways of classifying unemployment but the following is quite common.

- *Frictional unemployment*. Individuals that are temporarily unemployed while transiting between jobs or just entering the labour market. This kind is typically short in duration but always present in a market economy.
- *Structural unemployment*. Individuals that are unemployed because their skills are no longer in demand where they live. This kind typically leads to longer spells and may require the unemployed to acquire training or to move.
- *Cyclical unemployment*. Unemployment due to a recession.
- *Classical unemployment*. Unemployment due to real wages being too high (for example through minimum wage laws).

All unemployed individuals are assumed to belong to exactly one of these categories, so that if we sum the unemployment from each category we will get the total unemployment. We define the unemployment *rate* for the above categories e.g. we define the frictional unemployment rate as the frictional unemployment divided by the total labor force, and similarly for the other categories.

Obviously, it is often difficult to determine exactly which category an unemployed individual belongs to and official measures of the unemployment in each category do not exist.

Notwithstanding, this classification is very useful in economics. If unemployment increases in a particular city due to a firm relocating production, it is structural unemployment that increases (initially, part of it is frictional), and if unemployment increases due to a recession, it is the cyclical unemployment that has increased. Knowing what type of unemployment is currently present is important when considering what type of measures to take to lower unemployment.

5.3 Full employment

The *natural rate of unemployment* is defined as the sum of the rates of frictional, structural, and classical unemployment (excluding cyclical unemployment). The natural rate of unemployment is sometimes called *voluntary unemployment* and is assumed to be much more stable than the total unemployment rate.

Since the cyclical unemployment is zero in a boom, the natural rate of unemployment is equal to the observed unemployment rate in a boom. In a recession, the observed unemployment rate exceeds the natural rate by the cyclical unemployment rate.

We say that we have *full employment* when the unemployment rate is equal to the natural rate (and cyclical unemployment is zero). Remember that full employment does not imply that the unemployment rate is zero.

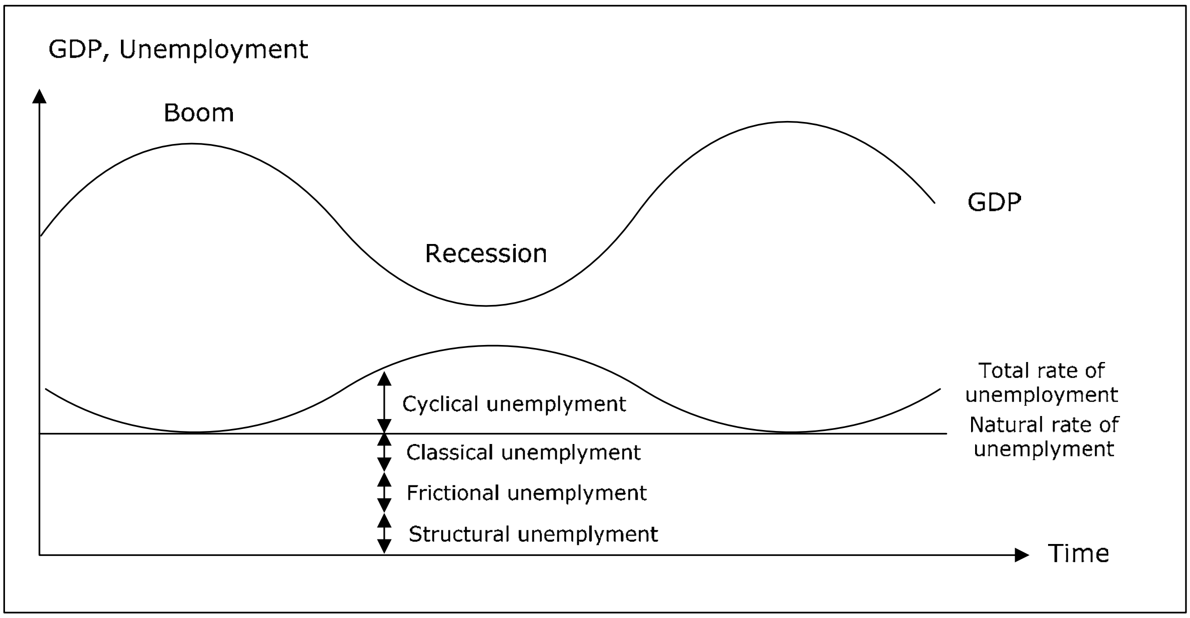


Figure 5.3: Different kinds of unemployment.

5.4 Wages

5.4.1 Nominal wages

The *nominal wage* is the wage per unit of time in the currency used in the country – what we typically just call wage. When we refer to wage in macroeconomics we almost always mean gross wage, that is, the wage before income taxes but after employment taxes paid by the employer. Wage is a flow that we typically measure in units of currency per hour.

5.4.2 Wages and income

Remember that by wage we typically mean what you receive for working one hour, while income is the total revenue from all sources over a longer time period (such as a month). Your income depends on the wage but also on the number of hours you work. An individual may have a very high wage but a low income (say $1000 per hour but only working 1 hour per month) or a low wage but a high income (for example by owning stocks or bonds). Do not confuse wage with income.

5.4.3 Nominal wage level

In macroeconomics, we are normally not interested in the wage for a particular individual but in the average wage for all employed individuals. This average is called the *wage level* but since we typically only care about the wage level, we will almost always use wage when we actually mean the wage level. Thus, a statement such as "wages increase" should not be interpreted as all wages increasing, but rather that the average is increasing.

5.4.4 Real wage

Consider the following scenario. You work full time and during January 2008 you make 2000 euro after tax. A particular basket of goods and services costs 100 euro in January, which means that your salary will buy you 20 such baskets.

In February, you receive a 10% wage increase and you make 2200 euro after tax. Does this imply that you can buy 10% more baskets – that is 22 – in February? Well, not necessarily.

The number of baskets that you can buy in February depends on the possible changes in prices as well. If the price of a basket increases by 3% to 103 euro your 2200 will buy you 2200/103 = 21.36 baskets of 7% more than in January. Even though your wage has increased by 10%, you can only increase your consumption of baskets by 7%. We say that the real wage has increased by 7%.

Formally, we define the real wage as the nominal wage divided by a price index (typically CPI). In the example above, your real wage was 20 in January and 21.36 in February if we use the price of the basket as a price index. Remember that the nominal wage will tell you your wage in units of currency, while the real wage will tell you your wage in baskets of goods and services and this is more important to us.

Therefore, we care about increases in real wages, not in nominal wages. If you found out that Ken, who works in another country, got a 50% increase in his wage each year, you may initially be quite happy for Ken. If you then found out that inflation in the country where Ken works is 70%, you should actually feel sorry for him. His real wage is 1.5/1.7 = 88% of his real wage the year before – a real wage cut by 12%.

6 Money and banks

6.1 Money

6.1.1 Money, definition

Before discussing macroeconomic models we must define what we mean by money. Money has a long and interesting history and an understanding of how we came to use money is useful for any macroeconomist. Unfortunately, there is not enough space to describe how money was "invented" and how it evolved over time. There are, however, many excellent descriptions on the Internet.

"Money" in economics is actually not as simple to understand as you may think and many use the term money in a way inconsistent with how it is defined in economics. Money is defined as *any commodity or token that is generally accepted as payment of goods and services.*

6.1.2 Two types of money

In most countries, one can identify two "types of money":

- Currency and coins
- Bank deposits

The total value of all the money in a country at a given point in time is called the *money supply* and this is an important macroeconomic variable. The reason for the importance of the money supply is that it measures how much is available for immediate consumption. There is an important relationship between the supply of money and inflation, which will be investigated later on in the book.

6.1.3 What is money and what is not money

If you are trying to determine if something is money, simply consider whether it would be accepted in most stores as payment. You then realize that stocks, bonds, gold or foreign currency are not money. These must first be exchanged for the national currency before you can use them for consumption. Note that in some cases, foreign currency will be money. For example, in some border towns, the currency of the bordering country may be accepted virtually everywhere.

You also realize that some bank deposits *are* money. If you have money in an account in a bank and a debit card, you can pay for goods and service using the card in most places. Funds are withdrawn directly from your account when you make the purchase, which makes the deposits as good as cash in your pocket. Counting deposits as money is also consistent with the idea that money measures how much is available for immediate consumption.

Not all deposits can be counted as money. With most savings accounts, you cannot connect the account to a debit card and these deposits should not be counted as money. We also note that what is money has nothing to do with the commodity or token itself:

- USD is money in the United States but not in the UK.
- Gold is not money but gold was money in some countries in the middle ages. Historically, such diverse commodities as cigarettes and sharks' teeth have been used as money in some places.
- A national currency may suddenly cease to be money in a country. This may happen if inflation is so high that people shift to another foreign currency.

6.1.4 Money, wealth and income

Money is not the same as wealth. An individual may be very wealthy but have no money (for example by owning stocks and real estate). Another individual may have a lot of money but no wealth. This would be the case if an individual with no wealth borrows money from a bank. She will have money (for example in the form of a deposit in the bank) but no wealth since this deposit exactly matches the outstanding debt. Be careful with this distinction: do not say "Anna has a lot of money" if you mean that Anna is wealthy.

Money is not the same as income and income is not the same as wealth. Income is a flow (for example is currency units per month) while money or wealth is a stock (measured at a particular point in time). Again, it is very possible to have a high income but no money and no wealth, or to be very wealthy and have a lot of money but no income. This is another distinction to be careful with. Do not say that "Sam makes a lot of money" if you mean that Sam has a high income. Money has a very precise definition in economics!

6.1.5 Economic functions of money

Money is generally considered to have three economic functions:

- *A medium of exchange*. This is its most important role. Without money we would live in a *barter economy* where we would have to trade goods and services for other goods and services. If I had fish but wanted bread, I would need to find someone who was in the precise opposite situation. In a monetary economy I can trade fish for money with one individual and money for bread with another. Money solves what is called *the double coincidence of wants*.
- *A unit of account*. In a monetary economy, all prices may be expressed in monetary units which everyone may relate to. Without money, prices must be expressed in units of other goods and comparing prices are more difficult. You may find that a grilled chicken costs 2 kilos of cod in one place and 4 kilos of strawberries in another. Finding the cheapest grilled chicken is not easy.
- *Store of value*. If you are a fisherman and have a temporary surplus of fish that you want to store for the future, storing the fish might not be a great idea. Money, on the other hand, stores well. Other commodities, such as gold, have this feature as well.

6.2 Central banks

6.2.1 Introduction

A central bank is a public authority that is responsible for monetary policy for a country or a group of countries. Two important central banks are the European Central Bank (for countries that are members in the European Monetary Union) and the Federal Reserve of the United States.

Central banks have a monopoly on issuing the national currency, and the primary responsibility of a central bank is to maintain a stable national currency for a country (or a stable common currency for a currency union). Stability is sometimes specified in terms of inflation and /or growth rate in the money supply.

Other important responsibilities include providing banking services to commercial banks and the government and regulating financial markets and institutions. In this sense, a central bank is the "bankers' bank" – other banks can borrow from or lend money to the central bank. Therefore, all banks in a country have an account in the central bank. When a commercial bank orders currency from the central bank, the corresponding amount is withdrawn from this account. This account is also used for transfers between commercial banks. Central banks also manage the country's foreign exchange and gold reserves.

6.2.2 Monetary base

The monetary base is defined as the total value of all currency (banknotes and coins) outside the central bank and commercial banks' (net) reserves with the central bank. The monetary base is a *debt* in the balance sheet of the central bank. Its assets are mostly comprised of the foreign exchange and gold reserves and bonds issued by the national government. Currency inside the central bank has no value – it is comparable to an "I owe you" written by yourself and held by yourself.

Since the central bank has a monopoly on issuing currency, it is in complete control of the monetary base. In section 7.4.2 we will describe exactly how they change the monetary base. However, the central bank does not completely control the money supply. This is due to the second component of the money supply – bank deposits – which it cannot control. Fortunately, it has methods of influencing the total money supply and these methods will be discussed in chapter 7.

In many countries, the central bank imposes *reserve requirements*. This means that commercial banks are obliged to hold a certain percentage of deposits as reserves either as currency in their vaults or as a deposit at the central bank. Reserve requirements are usually rather small (typically between 0% and 10%) which means that the monetary base is quite close to the value of all currency outside the central bank.

6.3 Commercial banks

6.3.1 Currency inside banks is not money

The fact that currency inside commercial banks is not money may strike you as odd, but it is an important principle. The 100 dollar bill in the ATM will become money only at the instant you withdraw it. The reason is this. We want the money supply to measure how much is available for immediate consumption. But currency inside a bank cannot be used for consumption and this is why it is not counted in the money supply. Cash in the bank is not money, but the binary bits in the bank's computer system representing the balance in your checking account are!

An example may also illustrate this important fact:

- Eric has 100 euro – this amount is obviously part of the money supply as it is immediately available for consumption.
- Eric deposits 100 euro into his checking account. He still has 100 euro available for immediate consumption using his debit card and the money supply should not be changed by this deposit (it is not – deposits are included in the money supply).
- Eric's bank now has 100 euro more than before deposit. *If* we count currency inside the bank as money, the money supply would have *increased* by 100 euro by his deposit. This does not make sense as the amount available for immediate consumption has not changed.
- In the same way, withdrawing money from the ATM does not affect the money supply. When you withdraw money, currency outside banks increases while your checking balance decreases by the same amount.

Even though currency inside a bank is not money, it is still part of the monetary base. 100 euro inside the bank is obviously still worth 100 euro to the bank even though we do not include it in the money supply.

6.3.2 How commercial banks "create money"

Commercial banks obviously cannot influence the amount of currency in the economy or the monetary base, since they are not allowed to print money. They can, however, influence the money supply through the second component of the money supply – the deposits. A bank will increase the money supply simply by lending money to a customer. In the same way, when a loan is repaid or amortized, the money supply decreases.

It may sound odd that the money supply increases by 1 million the same instant a bank agrees to lend this amount. The bank has created money but no wealth (keep in mind that these are different concepts). The bank has simply converted one asset (cash) into another (the promise of repayment), while there is no change in the individual's net wealth. However, after the loan, there is an additional one million available for immediate consumption. It makes no difference if the borrower keeps the money in her account or withdraws them in the form of currency.

If, for example, the borrower uses the money to buy an apartment, the funds are transferred to the seller of the apartment. This will not affect the money supply – now it is the seller of the apartment that has a million available for consumption. If the seller uses the funds to repay the loan he got when he bought the apartment, the money supply will again decrease.

6.3.3 How much money can banks create?

Does this mean that banks can create an unlimited amount of money? The answer is no – that would require them to lend an unlimited amount of money and that is not possible.

Banks use deposits to create new loans but there is an important difference between deposits and loans. When individuals deposit money in a bank, they can withdraw the money whenever they like. A bank, on the other hand, has no right to cancel a loan and get their money back whenever they like. Banks therefore need *reserves* so that they can deal with large withdrawals. A bank with small reserves will therefore be less inclined to lend money.

6.3.4 The multiplier effect

Deposits and loans in banks give rise to an important *multiplier effect*. We use a simple example to illustrate this effect. Consider the bank K-bank with total deposits of 10,000 (millions or whatever). K-bank is aiming for a reserve ratio of 10% of deposits. At the moment it has lent 9,000 and has 1,000 in reserve – exactly meeting their desired reserve ratio.

Emma makes a deposit:

Emma has 1,000 in her mattress and decides to deposit it in K-bank. The deposit will not affect the money supply but K-bank now has 11,000 in deposits, 9,000 in loans and 2,000 in reserves.

K-bank lends money:

With deposits equal to 11,000, K-bank wants reserves to be 1,100, not 2,000. The bank therefore wants to lend 900, that is, 90% of the amount Emma deposited. The bank now lends 900 to Ashton.

Ashton borrows money:

At the same moment K-bank lends 900 to Ashton, the money supply increases by 900. Emma's decision to transfer 1,000 from the mattress to the bank has the effect of increasing the money supply by 900. There are three ways Ashton can use the funds borrowed from K-bank. He can withdraw the funds in cash and keep the cash, he can keep them in his account at K-bank or he can spend them (or a combination of all three).

Ashton withdraws the money:

If Ashton withdraws the funds in cash, K-bank will have 11,000 in deposits, 9,900 in loans and 1,100 in reserves. Thus, it will prefer not to lend any money until deposits increase.

Ashton keeps the funds in his account:

If Ashton decides to keep his funds with K-bank the deposits will increase by 900 the same instant it lends Ashton the money. K-bank will now have 11,900 in deposits, 9,900 in loans and 2,000 in reserves.

K-bank lends money again:

In the case where Ashton keeps his funds in his account at K-bank, the bank will want to increase lending further. In the next step, it will want to lend 90% of 900 or 810. When it lends 810, money supply will increase by 900 + 810 = 1,710 because of the deposit made by Emma. If the second borrower also decides to keep the funds in the bank, the bank can lend money a third time. In the third step it will lend 90% of 810 or 729. Note that the amount in each step will be smaller and smaller and if you add them, you will always end up with a finite amount (see exercises).

…and we have a multiplier effect:

If all or some of the borrowers keep the borrowed funds in the bank, a deposit will generate an *increase in the money supply which is larger than the initial deposit* and this is what we call the multiplier effect. Remember that this effect is not guaranteed – had Ashton withdrawn the borrowed funds in cash, he would have broken the chain and the increase in money supply would have been equal to the deposit.

Ashton spends the money:

We had a third possibility: Ashton may spend the borrowed funds. Let's say that Ashton buys a stamp collection from Brittney for 900. If Brittney uses the same bank as Ashton, the funds will simply be transferred to Brittney's account. However, to K-bank, this makes no difference. K-bank will still want to increase its lending.

…will not disturb the multiplier effect:

If Brittney has a different bank, funds will be transferred from K-bank to Brittney's bank. In this case, K-bank will not be interested in lending any more money. However, in this case, deposits have increased in Brittney's bank and *the multiplier effect continues in her bank*. The only way the chain of the multiplier effect may be broken is if someone withdraws funds in cash and keeps the cash (if the cash is spent and it goes into an account – the multiplier effect will take off again). If some of the funds are withdrawn, the multiplier effect is weakened but not broken.

7 Interest rate

7.1 Introduction

When you borrow money, you usually have to pay a fee for the loan. This fee is often called interest, particularly if the fee is proportional to the amount you borrow. The interest rate is commonly expressed as a percentage of the size of the loan per unit of time, typically per year. If the interest rate is 10% per year, you must, for example, pay 1,000 per year if you borrow 10,000.

The interest rate may be fixed or floating. If it is fixed, you will pay the same percentage for the entire duration of the loan. With a floating interest rate, the interest rate will change regularly depending on market conditions.

The Interest rate for a specific loan depends on the general level of interest rates as well as the specifics of the loan. Factors such as risk (the probability that the loan will not be repaid), duration of the loan and whether you select a fixed or a floating rate will influence the interest rate.

7.2 Market interest rates

The most important interest rates from a macroeconomic perspective are interest rates that the government pays on the loans they use to finance the national debt. The government borrows money by issuing government bonds. All such bonds have a fixed nominal amount and a given maturity date. The government promises to pay exactly the nominal amount (also called the principal or the face amount) to the holder at the maturity date. Some bonds also promise regular payments, so-called coupon payments, at regular intervals, the coupon dates.

In most countries you will find many types of government bonds. An important distinction is the duration of the bond, that is, the difference between the maturity date and the date when the bond was issued. For example, in the United States, government bonds maturing in one year or less are called Treasury bills.

Typically, bonds with a maturity of a year or shorter have no coupons. Instead, they are sold below the nominal amount at what is called the *issue price*. The issue price for a bond without coupons must be below the nominal amount. For example, if you pay 23,500 for a bond with a nominal amount of 25,000 maturing in one year, your interest rate is (25 000 – 23 500)/23 500 = 6.38%.

In most countries, you also find government bonds with longer maturity. For example, in the United States you have Treasury notes (two to ten years) and Treasury bonds (10 years or longer). Government bonds with longer maturity typically make coupon payments. You will also find other types of bonds

7.2.1 Relationship between the interest rate and the bond price

Note that the higher the issue price, the lower the interest rate. In the same way, when the price of a government bond increases, the interest rate falls and vice versa. The price of a government bond is normally determined by supply and demand which means that you can understand movements in these interest rates by analyzing the market. For example, if the government needs to borrow more money, supply increases, bond prices fall and interest rates increase.

7.2.2 Calculating interest rates on a yearly basis

If the maturity is different from one year, the interest rate is usually recalculated to a corresponding one year rate. For example, consider a bond which matures in six months, has a nominal amount of 25,000 and a current price of 24,200 (no coupons). The six month interest rate is then 800/24,200 = 3.3%. If we want to express this rate as a yearly rate we imagine that we make this investment twice. Our return would then be 1.033·1.033 = 1.067 or 6.7%. Note that if the interest rate is fairly low, then the yearly interest rate is approximately two times the six month interest rate. In the same way, the monthly interest rate is approximately one twelfth of the yearly interest rate.

Keep in mind that the six month interest rate, recalculated to a yearly rate, will typically not be equal to the one year interest rate. For example, suppose that we expect interest rates to increase. In such a case, the yearly interest rate would be an average of the current six month rate and the six month rate six months from now, which is expected to be higher. Hence, the one year rate would be higher than the current six month rate. In the same way, if we expect interest rates to fall, then shorter interest rates will be higher than longer interest rates.

This means that we have many different market rates in a country – rates depending on maturity. Even though rates with different maturity (all recalculated to a yearly rate) need not be exactly equal, they cannot be too different either. This is particularly true for rates with similar maturity. The seven month rate cannot deviate far from the six month rate since they are fairly close substitutes.

7.2.3 The yield curve

The yield curve is a graph of interest rates of different maturity (recalculated to yearly rates) at a particular point in time. It is common for the yield curve to slope upwards (interest rates with longer maturity are generally higher than those with a shorter maturity). The reason for this is that there is a higher demand for loans with longer maturity due to the reduced uncertainty. Many borrowers are prepared to pay a premium to avoid fluctuations in the interest rates.

As discussed above, if the market expects higher interest rates, then the slope of the yield curve will increase. Although not very common, the slope may be negative if the market expects the interest rates to fall more than the premium on longer rates.

7.2.4 Other interest rates

There are many other interest rates in a society. For example, you will earn interest when you deposit money in a bank account and you will pay interest when you borrow money. These interest rates will depend on the specifics of the deposit and the perceived risk when you borrow money. However, all interest rates are correlated with the market interest rates. When you borrow money, you typically pay a higher interest rate compared to government bonds, and when you lend money, you will receive a lower rate.

7.3 Overnight interest rates

7.3.1 The market for overnight loans

Overnight interest rates are rates for loans over a single night – these are the shortest of all interest rates. During the day, banks normally have access to interest free loans from the central bank. At the end of the day, all such loans must be cleared with the central bank. For this reason, there is a market for loans overnight between banks and the overnight interest rate is determined by supply and demand in this market.

7.3.2 Central bank overnight interest rate

The overnight interest rate is an important interest rate for a central bank and it has methods of influencing this rate. In most countries, the central bank signals what it would like the overnight rate to be. For example, in the United States, this rate is the federal funds rate. If the overnight rate steers away from the federal funds rate, the Federal Reserve will take action to steer it back towards the federal funds rate.

In addition to signaling a desired overnight interest rate, most central banks have "standing facilities" for overnight loans. For example, the ECB has a "deposit facility" and a "marginal lending facility" that member banks can use for deposits and for lending overnight. The overnight interest rate must therefore be in between the deposit rate and the marginal lending rate. Typically, the overnight rate is far from the deposit and lending rates and standing facilities are rarely used.

7.4 Monetary policy

7.4.1 Central bank and monetary policy

By monetary policy we mean the policy directed at controlling the money supply and the interest rates. In most countries, the central bank is responsible for monetary policy. It usually has complete or nearly complete control over:

- Overnight interest rates
- The monetary base

It also has *some* control over:

- Interest rates with longer maturity. Since loans with longer maturities are substitutes for overnight loans, the central bank also hassome control over longer interest rates. The control is larger for shorter rates. This relationship is discussed further in 7.4.4.
- Money supply. The monetary base is only a small part of the total money supply but, through the multiplier effect, the central bank's control over the money supply is magnified. This is examined in 7.4.2.
- Inflation. For many central banks, this is the variable they are mostly interested in controlling. For all central banks, it is an important variable. Exactly how the central bank affects inflation by controlling the overnight interest rate and monetary base is one of the most important issues in macroeconomic theory and will be discussed throughout the book.

As we shall see in the next section, it is not possible to choose the overnight interest rate and monetary base independently of each other. In most countries, the main focus of the central bank is on controlling the overnight interest rate rather than the monetary base. The next section shows that the central bank must increase the monetary base if it wants to lower the overnight interest rate. When it increases the monetary base, the money supply will increase and we will see a negative correlation between the overnight rate and money supply.

When the overnight interest rate decreases, the money supply increases *When the overnight interest rate increases, the money supply decreases*

The rest of this section describes:

- How the monetary base affects the money supply through the multiplier effect.
- How changes in the overnight rate cause changes in the money supply.
- How the central bank's control over the overnight interest rate affects longer interest rates.
- How the central bank can affect inflation by controlling the overnight interest rate.

7.4.2 Monetary base and the supply of money

It is not possible for the central bank to print and distribute money – that would increase their debt without increasing their assets. Instead, they change the monetary base by *buying and selling financial assets* (usually government bonds) in so-called open market operations.

Let us say that the central bank buys government securities for 100 million. They can pay for these bonds simply by printing new bills to the amount of 100 million. At first this may seem suspicious and "too simple". But remember that outstanding notes count as a liability for the central bank. When it buys the government securities, its assets will increase by exactly the same amount as its liabilities.

Typically, the central bank will not pay cash when it buys government securities. Instead, it will ask the seller's bank to credit the individual's account and will then credit the bank's central bank account. This procedure is equivalent to paying in cash – the monetary base will increase by the same amount in both cases (remember that the banks' assets in the central bank are included in the monetary base).

Since this will lead to an increase in deposits in the banks, the money supply will increase. By the multiplier effect, the *increases in the money supply will be more than 100 million*. This way, the central bank can influence the money supply several-fold by changing the monetary base.

7.4.3 Overnight interest rates targets and money supply

There are many ways to explain the important connection between the overnight interest rate target and the money supply. We will use an example to demonstrate why a decrease in the overnight rate target increases the money supply.

Imagine that the central bank changes the target from 6% to 4%. Before lowering their target, overnight interest rates were at around 6%, say between 5.6% and 6.4%. When the central bank cuts the target to 4%, it signals that it wants to see an overnight rate around 4%.

Remember that central banks normally have standing facilities allowing banks to borrow from the central bank at a rate slightly above the target rate (and to lend at a rate slightly below). If the central bank does nothing except to change the target rate, the banks would immediately use the standing facilities and borrow from the central bank. They were used to borrowing at rates around 6% overnight but can now borrow from the central bank at slightly above 4%. But the central bank does not want the standing facilities to be used – it wants the overnight rate to be close to the target such that the banks lend and borrow from each other in the market. The question then is, how can they influence the overnight market so that banks will want to borrow / lend at around 4%? The answer is by increasing the monetary base and thus the money supply.

When the central bank buys government securities, it purchases from many individuals, companies and institutions. Deposits and reserves in most banks will increase as described in the previous section. Therefore, most banks will want to lend overnight and this will drive down the overnight interest rate.

To summarize: When the Central Bank cuts the target rate, they must simultaneously increase the monetary base by buying government securities. The growth of the monetary base creates a surplus in the banks, the supply of funds overnight increases, the demand falls and the overnight rate falls. Although the monetary base represents a small portion of the money supply, a change in the monetary base is magnified by the multiplier effect.

7.4.4 Overnight rates and interest rates with longer maturity

By controlling overnight interest rates, the central bank will affect the interest rates with longer maturity. The reason for this is that interest rates with similar maturity cannot be too different. If, for example, the central bank increases the target rate (move intercept on the yield curve upwards), then interest rates with short maturity will very likely increase but longer interest rates may also increase.

Let's say that the central bank increases the target rate. When the target rate increases, the central bank needs to raise the overnight interest rate which may be accomplished by selling government securities. The central bank will then debit the commercial banks' central bank accounts and the banks will debit the accounts of the buyers of the securities. The reserves will now be too small, and this will create an upward pressure on the overnight interest rate. To create a long-term balance, banks will want to increase their deposits and reduce their lending. They can achieve this by raising bank interest rates.

Another way to explain why banks raise their interest rates is as follows. With higher overnight interest rates, it is more expensive for banks to end the day with a deficit. To reduce the risk of having to borrow overnight, they can increase their reserves by increasing deposits and reducing loans, which they again accomplish by raising the interest rates.

Market interest rates are affected as well. First, when the central bank sells government securities, the price of these securities will fall and the interest rate will increase. Second, government securities are close substitutes for bank deposits, and when one of these rates changes, the other follows suit.

7.4.5 Overnight target rates and inflation

One of the main targets of every central bank is a low and stable inflation. It's main control variable is the overnight interest rate target, and the mechanism that allows the target to affect inflation is called the *transmission mechanism*. A brief description of the transmission mechanism looks like this:

1. When the central bank target rate increases, other interest rates in the economy will increase (and the money supply will decrease, but that is not important here).
2. With higher interest rates, it is more expensive to borrow and more advantageous to save. Therefore, consumption and investment will decrease (we say that the central bank "cools off" the economy).
3. As consumption and investment fall, GDP is reduced and unemployment will rise. This will cause inflation and the growth rate in wages to fall. The exact details in this mechanism will be discussed in the following chapters.

7.5 The real interest rate

7.5.1 Interest rates and inflation

Suppose you have 1 million on 1st January 2008. A basket of goods and services similar to the CPI basket costs 100,000. You can then buy exactly 10 such baskets on 1st January 2008.

Say that you can invest your million at a 10% interest rate. On 1st January 2009 you will then have 1.1 million. 1.1 million may not be enough for 11 baskets as prices may have changed. Say that inflation was 4% in 2008. The price of a basket has then increased to 100,000 * 1.04 = 104,000 and you can buy 1,100/104 = 10.58 baskets, which is 5.8% more than last year. Even though your wealth has increased by 10% (in whatever currency you use), your *real* wealth (in baskets) has only increased by 5.8% and we say that the real interest rate is 5.8%.

7.5.2 Nominal and real interest rates

To distinguish the real interest rate from the "normal" interest rate, the latter is called the *nominal interest rate*. The nominal interest rate shows the growth of your money while the real rate shows the growth of what your money can buy.

7.5.3 Expected inflation

Note that it is changes in prices during 2008 which matter for the high real interest rate (the time period when your deposit is earning interest). This means that you can never know how high the real rate is actually going to be when you start to save on 1st January 2008, even if you know the nominal interest rate exactly. Crucial to the determination of the real rate is *the expected inflation* – the inflation expected in the year you save.

7.5.4 Relation between nominal interest rate, real interest rate and inflation

If we denote the nominal interest rate by R, the real rate by r and the expected inflation by π^e then the real interest rate is defined by:

$$r = R - \pi^e \text{ or } R = r + \pi^e$$

Many textbooks use actual inflation (as measured during the previous period) instead of expected inflation in the definition of the real interest rate. Such a definition is not entirely incorrect (although the correct definition uses expected inflation), as expected inflation is often close to the current observed inflation.

8 Macroeconomic models

8.1 Introduction

We have now reached the second part of this book. The first 7 chapters was a description of the macroeconomic variables and institutions. In the second part, we will analyze how these variables fit together and present models that explain the main macroeconomic variables.

Using these models we can, for example, analyze what happens when the government increases consumption, when the central bank increases the target interest rate and when domestically produced goods do well in foreign markets. We can also understand important observations of the economy, such as cyclical fluctuations in growth, correlation between unemployment and inflation and the relationship between interest rates and foreign exchange rates.

Macroeconomics is not an exact science such as physics. No one knows exactly how the macroeconomic variables are related. Instead, there exist a number of models that try to explain various observations and relationships between macroeconomic variables. Unfortunately, not all of these models consistent – one model may predict that unemployment will fall if the central bank lowers the target interest rate while another may claim that such a change will not affect unemployment.

This type of problem is something you have to get used to and accept. Economics is not a subject where you can perform an experiment to find out what is really "true". Observed phenomena may have different explanations in different models and different models will lead to different predictions of macroeconomic variables. If you conclude that "An increase in x will lead to an increase in y" you really should not think of this as a property of the real world but rather as the property of a particular model.

One model that is very popular in virtually all basic courses in macroeconomics all over the world is the so-called *neo-classical synthesis*. As the name suggests, this is a combination or a synthesis of two models, namely the classical model and the Keynesian model. In short, the neo-classical synthesis claims that the Keynesian model is correct in the short term while the classical model is correct in the long run. The rest of this book builds up the neo-classical synthesis. Note that there are actually many minor variations of the neoclassical synthesis. I try to present the most common version.

8.2 Common assumptions

All models require a number of assumptions to be able to say anything of interest. In this section we will describe the assumptions that will apply throughout the rest of the book.

8.2.1 Unemployment and hours worked are directly related

In all models we assume a negative relationship between the number of hours worked and unemployment. If the number of hours worked increases, the unemployment will fall and vice versa. This assumption will be true if the workforce is constant and individuals in the labor force either work full time or not at all.

In reality, this relationship need not hold. We may see an increase in the labor force (for example from immigration) that is larger than the increase in employment which would lead to an increase in both hours worked and unemployment but we disregard this possibility.

8.2.2 The central bank has complete control over money supply

This assumption can be justified on the basis of section 7.4.3. Remember that the money supply is equal to the money multiplier times the monetary base. We will assume that the money multiplier is constant and since the monetary base is completely under the control of the central bank, the central bank will control the money supply.

8.2.3 Monetary policy = change in money supply

The central bank actually has other monetary policy instrument apart from being able to determine the money supply. The most important one is the target interest rate for the overnight market. In this book we will not consider the possibility of changing the target interest rate. However, we know that there is a negative relationship between the target rate and the money supply. Therefore, if you want to investigate the effect of an increase in the target interest rate, you may just as well investigate a decrease in the money supply.

8.2.4 There is just one interest rate

Including different interest rates with different maturities would complicate the models but it would not buy you very much. Since interest rates with different maturities are highly correlated, they typically move in the same direction and the direction of a variable is typically what we are interested in. If you like, think of "the interest rate" as the one-year interest rate on government securities.

8.2.5 Exchange rate

In all models except those in Chapter 16 we will assume that the exchange rate is flexible. Furthermore, we assume that the exchange rate is determined by the ratio of the domestic price level to the foreign price level. If, for example, domestic prices increase by 10% while foreign prices are constant, the domestic currency will depreciate by 10% against the foreign currency. Motivation for this assumption and the consequences of this assumption can be found in section 16.2.

With this assumption, exports and imports may be assumed to be independent of the domestic price level. If domestic prices increase by 10% while the currency loose 10%, the price of domestically produced goods abroad will be unchanged. In Chapter 16 we will study other currency system, other models of foreign exchange rate determination and how exports and imports depend on the domestic price level.

8.2.6 Capital Flows

In all models except those in Chapter 16, the domestic interest rate is not affected by foreign interest rates. With free capital flows, this is a very unreasonable assumption. If we the domestic interest rate increase against the foreign interest rates, capital would flow into our country which would drive down the domestic interest rate again.

Most reasonable models in which the domestic interest rate is affected by foreign interest rates are more complicated. To understand such models, you must first understand the models where this complication does not arise. Also, the predictions from models where the domestic interest rate is not affected by foreign interest rates are fairly similar to the more realistic models wchich allows for capital flows.

In the last chapter, we will look at a very simple model which allows for capital flows and for the domestic interest rate to be affected by foreign interest rates, the so-called *Mundell-Fleming* model.

8.3 The macroeconomic variables

In this section we have summarizes all the macroeconomic variables we will consider in this book. The first column indicates the symbol we use for the variable while column 2 shows the name of the variable. The third column shows you in which section the variable is defined.

Variabel	**Variabelnamn**	**Definition**
Y	Real GDP	3.3
P	Price level	1.1.1
$P.Y$	Nominal GDP	3.1
U	Unemployment	5.2
L	Hours worked	5.2
K	Amount of capital	4.11
W	Nominal wage	5.5.1
W/P	Real wage	5.5.4
M	Money supply (nominal)	6.1.1
R	Nominal interest rate	7.2
r	Real interest rate	7.5
C	Private consumption (real)	4.7
I	Investments (real)	4.12
G	Government expenditure (real)	4.8
NT	Net tax (real)	4.8
X	Exports (real)	4.8
Im	Imports (real)	4.8
NX	Net exports (real)	4.8
S_H	Household savings (real)	4.7
S_G	Government savings (real)	4.8
S_R	Rest of the world savings (real)	4.8
π	Inflation	1.2
π^e	expected inflation	7.5.3
π_w	Wage inflation	14.1.1
π_M	Growth in money supply	14.2.4
E	Exchange rate	2.1
π_E	Depreciation in exchange rate	16.2.5

Two of the variables are *stock variables*: K and M. Prices cannot be characterized as a stock or flow variable. P, W, R, r and E apply at a given point in time while π, π^e, π_w and π_E apply over a period of time. π, π_w and π_E are changes in P, W and E during the previous time period while π^e is the expected change in P during the next time period. All the other variables are *flow variables* measured in some unit per unit of time (for example, L is the number of hours worked per year or per any other unit of time).

8.3.1 Supply and demand

In microeconomics, we are careful to distinguish between the demand, the supply and the observed quantity. The first two are hypothetical concepts which indicate the desired quantities from households and firms under various conditions. The observed quantity is the quantity that consumers actually end up buying from the firms.

The main difference is that demand and supply are functions – they depend on other variables – while observed quantities are variables. These functions are usually illustrated in a chart where we illustrate how demand and supply depend on other variables.

In macroeconomics, we also consider the demand and the supply of many of the variables. So far, each variable has represented an observed quantity. For example, L has been the symbol for the actual number of hours worked, a variable that we can measure. However, we have not made any distinction between the demand and the supply of labor which we need to do from now on. The variables for which we will consider the supply and the demand are: Y, L, K M, C, I, G, X and Im.

In order to separate the supply and the demand from the observed quantity, we use subscript S for supply and subscript D for demand. For example, L is still the observed amount of work (a variable) while LS and LD represent the supply of labour and the demand for labour. Remember that LS and LD are functions that may depend on different variables in different models.

8.4 About the various models

We will in the rest of the book discuss a number of macroeconomic models. To make it easier to keep them apart we give the different names. We will talk about "the classical model", "the IS-LM model", etc.

Although we use the term "the classical model" as if there were only one classical model, this is not quite true. For all the models we discuss, there are many variations. However, the similarities between, for example, all the classical models are great enough to warrant the expression "the classical model". But you need to keep this in mind. If you look up the "IS-LM model" in different text books you will probably see different models but the main predictions from the models do tend to be the same.

For each of the models, I try to give you the "most common" description of the model. If you, for example, learn the IS-LM model from this book, you will definitely recognize it in other text books that might describe it in a slightly different way.

9 Growth theory

9.1 Introduction

The purpose of this chapter is to try to explain growth in GDP. The models in this chapter are very different from the rest of the models in this book as they use only the production function and factors of production to explain growth. Growth models are important, for example, if you want to understand why some countries grow faster and have a higher living standard than other countries.

By growth, we mean the percentage change in real GDP. We use real GDP to eliminate the effect of inflation. In this chapter, it is perfectly OK to think of inflation as being zero in which case real and nominal GDP are the same.

In this chapter we begin by describing the aggregate production function. The rest of this chapter will look at some different growth theories.

9.2 The aggregate production function

9.2.1 Definition

Imagine the national economy during a short period of time (say one week). We denote:

- L: the total amount of work used during this period (by all individuals in the economy).
- K: the total amount of capital used.
- Y: the total amount of finished goods produced during this period (real).

It is still the case that L and Y are flows while K is a stock. During a short period of time, we can assume that the amount of capital is constant.

The aggregate production function, or simply the production function is a function that relates L, K and Y. Specifically, we assume that Y is a function of L and K:

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

In most cases, we will not specify exactly what the function f looks like. However, we always assume that f is increasing in L and K, that is, when we use more labour and/or more capital, we will produce more goods.

9.2.2 The marginal product of labor and capital

We define *the marginal product of labor*, *MPL* as the derivative of *f* with respect to the *L* – that is, as (approximately) how much *Y* will increase when *L* increases by one unit. We also define *the marginal product of capital*, *MPK* as the derivative of *f* with respect to *K*. Note that *MPL* and *MPK* will depend on both *L* and *K* (MP_L and MP_K are functions, not variables).

$$MP_L = \frac{df}{dL}, \quad MP_K = \frac{df}{dK}$$

- Since *f* is increasing in *L*, MP_L must be positive for all values of *L* and *K*.
- MP_L assumed to be *decreasing* in *L* – the more work that is used, the lower the marginal product of labor.
- MP_L assumed to be *increasing* in *K* – the more capital, the higher the marginal product of labor.
- In the same way, MP_K must be positive for all values of *L* and *K*.
- MP_K is assumed to be decreasing in *K* and increasing in *L*.

When we view *Y* as a function of *L* holding *K* fix, *Y* will be increasing in *L* but at a decreasing pace (due to the fact that *MPL* is positive but decreasing in *L*).

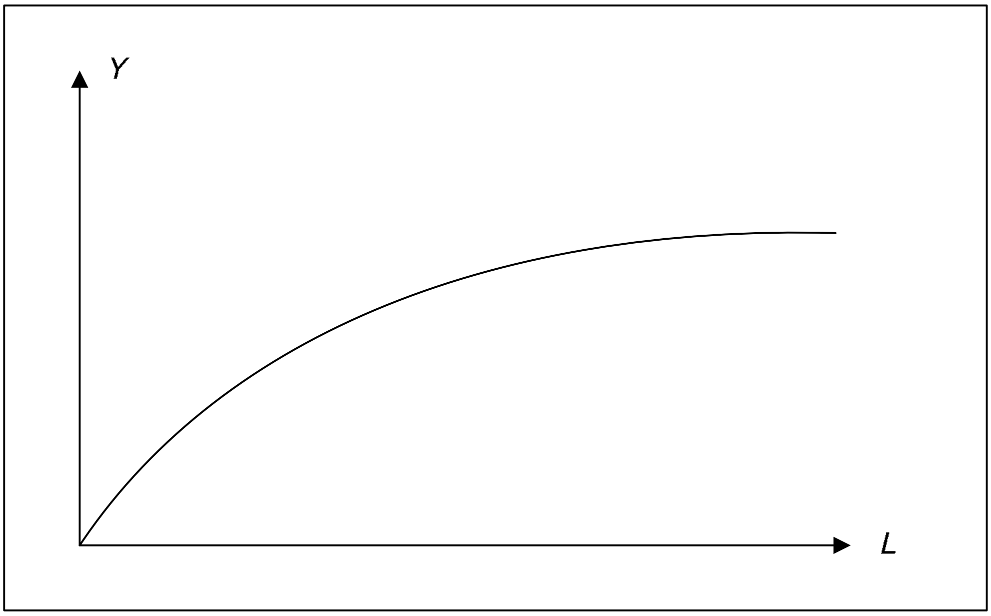


Fig. 9.1: Production function.

We define *labour productivity* as Y/L, that is, as GDP per hour worked. Labour productivity tells us how much we can produce using one hour of labour and it depends on the amount of capital as well as the technology.

9.2.3 Production function and Growth

From the simple production function $Y = f(L, K)$, we can identify three sources of growth:

- An increase in L.
- An increase in K.
- A change in the function f

The first two represent growth of the factors of production. L may increase if the population grows, if we have more individuals in the workforce, or if unemployment falls. K increases if investment are large as they are if total savings is large.

The function f need not be the same function over time. It is possible that Y increases even though L and K are fixed. When f changes so that the same amount of the factors of production will produce more output we say that we have *technological progress* or *productivity growth*. With technological progress, MP_L and MP_K will typically increase for given values of L and K, that is, the productivity of the factors increase.

Education and growth in human capital are important aspects of growth in GDP. Human capital is treated in different ways in the literature:

- You can think of human capital as being included in K – with this view education is a type of investment.
- You can add another variable in the production function: $Y = f(L, K, H)$ where H is the amount of human capital and K amount of physical capital.
- The amount of human capital may affect the function f. The more human capital, the more can be produced from the same amount of L and K. With this view, increasing the amount of human capital will lead to productivity growth.

Growth Accounting is the activity in which we try to figure out how much of the growth in GDP is due to growth in L, growth in K and growth in productivity.

9.3 Growth Theories

9.3.1 The classical growth theory

The production function will not provide us with a theory or explanation of growth. It is only a convenient tool which helps us breaking down growth into its components. However, there are many growth theories that try to go a step further. The oldest of these theories is the so-called *classical growth theory* which is primarily associated with Thomas Robert Malthus.

The classical growth theory should not be confused with the classical model that we will look at in the next chapter. Also, the classical growth theory, which was developed in the late 1700s, has little or no relevance today. We present it so that you can better understand more modern growth theories.

In short, the classical growth theory may be described as follows:

1. Due to technological development, the amount of capital increases and the marginal product of labor rises.
2. GDP per capita rises. With higher living standards, the population will increase.
3. As population increases, the labor productivity will fall (more individuals but the same amount of capital).
4. GDP per capita will fall again. When GDP per capita has fallen to a level just high enough to keep the population from starving, the increase in population will cease.

Destruction of capital, for example, through a war, works in the opposite way. The marginal product of labor falls, GDP per capita falls and the population decreases. This will again lead to an increase in the marginal product of labor and GDP per capita return to the "survival rate".

The main point of the model is that population growth will always eliminate the positive effects of technological development and GDP per capita will always return to the survival level. This very "dismal" growth theory was prominent in the early 1800s, and economics to this day is sometimes called the "dismal science".

Today we know that the predictions of the model where incorrect. During the rest of the 1800s Europe experienced a growth in GDP per capita. Although the population growth was high, it was not nearly sufficient to eliminate the positive effects of technological development.

9.3.2 The neo-classical growth model

The main purpose of another important growth model, the neo-classical growth model, is to explain how it is possible to have a permanent growth in GDP per capita. The model was developed by Robert Solow in the 1960s and it is sometimes called the Solow growth model or the exogenous growth model.

The neo-classical growth model should not be confused with the neoclassical synthesis, which we will study in chapter 10. "Neo" means "new" – the neo-classical growth theory is a "new version" of the classical growth model.

The crucial difference between the classical and neo-classical growth model is that population is endogenous in the former and exogenous in the latter. In the classical model, population will increase or decrease depending on whether GDP per capita is higher than or lower than the survival level. In the neo-classical model population growth is not affected by GDP per capita (however, the population growth will affect the growth in GDP per capita).

In the neo-classical model, it is the *technological progress* only that affects the GDP per capita in the long run. We will have a permanent increase in GDP per capita when there is a technological development that increases productivity of labour. Permanent *growth* in GDP then requires continuous technological progress.

It is not possible for the government, except temporarily, to affect the growth rate in the neo-classical growth model. The government might be able to affect GDP per capita (and thus is the growth rate) but the growth rate always returns to the level determined by the technological progress. The same is true for savings. An increase in savings may have a temporary effect on GDP but it will have no effect in the long run.

9.4 Endogenous growth theory

Endogenous growth theory or new growth theory was developed in the 1980s by Paul Romer and others. In the neo-classical model, technological progress is an exogenous variable. The neo-classical growth model makes no attempt to explain how, when and why technological progress takes place.

The main objective of the endogenous growth theory is to make the technological progress an endogenous variable to be explained within the model, hence the name endogenous growth theory.

There are many different explanations for technological progress. Most of them, however, have a lot of common characteristics:

- They are based on *constant return to scale for capital*. Thus, *MPK* is not a decreasing function of *K* in these models.
- They consider technological development as a public good.
- They focus more on human capital.
- It is possible for the government to affect the growth rate. Higher savings also leads to higher growth, not just higher GDP per capita.
- They predict convergence of GDP per capita between countries in the long run. This is a consequence of the public good property of the technological developments.

9.5 Separation of growth and fluctuation

It is often useful to separate the evolution of a variable that grows over time into a trend and fluctuations around the trend. The graphs below show such a separation for real GDP.

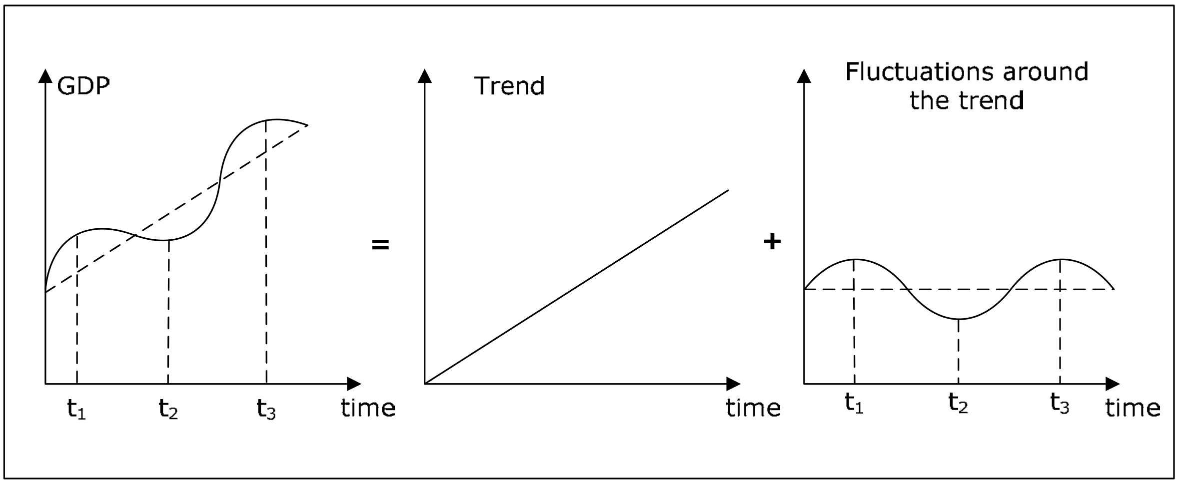


Fig. 9.2: Growth and the fluctuation around the trend.

The left diagram shows a stylized graph of real GDP over time. It demonstrates the two important characteristics in real GDP. GDP fluctuates over time and GDP grows over time – at least over a longer period of time. The left graph is the sum of the middle graph and the right graph.

The middle graph shows the *trend* in GDP. The trend represents the second characteristic of GDP – the fact that GDP grows over time. The right graph shows the fluctuations around the trend (cycles) of GDP. These fluctuations around the trend represent the first property of GDP.

In macroeconomics it is common to study trends and cycles separately. The purpose of growth theory is to investigate the trend while most of macroeconomics apart from growth theory is about the cycles. The trend is about the very long run perspective of the economy while cycles are about the short and medium run. The rest of this is all about cycles and not at all about trends. Therefore, when you think of GDP in the remaining chapters, you should think of GDP as in the right-hand graph: GDP has cycles but no trend. Basically, we will study GDP where the trend has been removed.

10 The classical model

10.1 Introduction

"The classical model" was a term coined by Keynes in the 1930s to represent basically all the ideas of economics as they apply to the macro economy starting with Adam Smith in the 1700s all the way up to the writings of Arthur Pigou in the 1930s.

In this chapter I will describe the main characteristics of what we now call the classical model and how the macroeconomic variables are determined in this model. As discussed in the previous section, we focus on the cycles and all the components included in the GDP (consumption, investment, imports and exports) are variables where the trend has been removed.

The classical model in this chapter will not discuss the determination of the exchange rate. In chapter 16 we will look at an extension of the classical model which will also include the exchange rate.

10.2 Labor Market

We begin by describing the classical model of the labor market.

10.2.1 Demand for labor

The demand for labor LD is assumed to be inversely related to the real wage W/P

Profit-maximizing firms will want to employ labor up to the point where the marginal product of labor *MPL* is equal to the real wage W/P. We have previously assumed that *MPL* is decreasing in *L* and the demand for labor can be illustrated in the following graph.

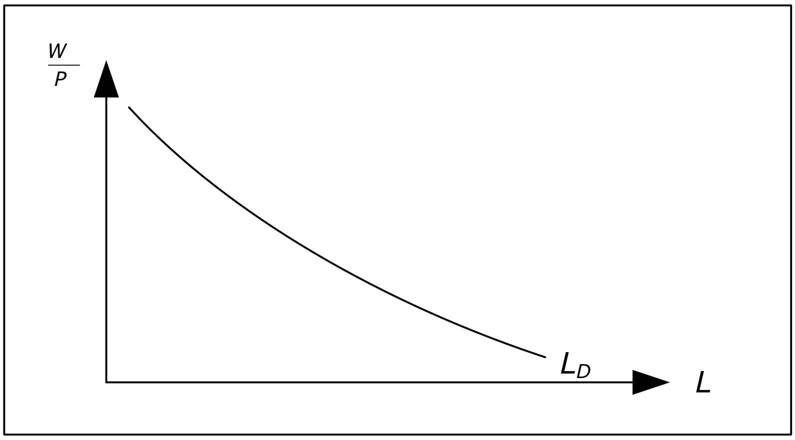


Fig. 10.1: The demand for labor.

From the graph you can conclude that the *aggregate demand for labor*, or just the demand for labor depends on the real wage. If the real wage increases, the demand for labor decreases and vice versa. For example, the demand for labor will fall if *W* increases and/or if *P* decreases but it will not change if *W* and *P* increase by the same percentage.

In the classical model, markets are characterized by perfect competition and the firms cannot affect *W* and *P*. However, they do decide how much labor to hire. If you sum all the labor that firms want to hire you get the total demand for labor.

10.2.2 The supply of labor

The supply of labour LS is assumed to be positively related to the real wage W/P

The total labor supply is determined by utility-maximizing individuals. The total labor supply is also affected by the real wage. An increase in the real wage has two effects:

- Income Effect: With a higher income, individuals will want to consume more leisure (as long as leisure is a normal good). Higher real wages will lead to a lower labor supply.
- Substitution Effect: A higher real wage will make leisure relatively more expensive, causing individuals to substitute leisure for consumption. Higher real wages will lead to a higher labor supply.

The overall effect of a change in real wages is the sum of the income and substitution effects. For some individuals, the substitution effect will be stronger than the income effect and they will increase the labor supply as the real wage increases and for some it will be the opposite. In the classical model it is always assumed that the aggregate labor supply increases when real wages increase (the substitution effect is stronger than the income effect).

10.2.3 Equilibrium in the labor market

Real wage W/P will be equal to the equilibrium real wage in the classical model

Without government intervention and trade unions, the labor market will always be in equilibrium in the classical model. This means that the real wage will be equal to the *equilibrium real wage* – the level of real wage which will equilibrate the labor demand and the labor supply.

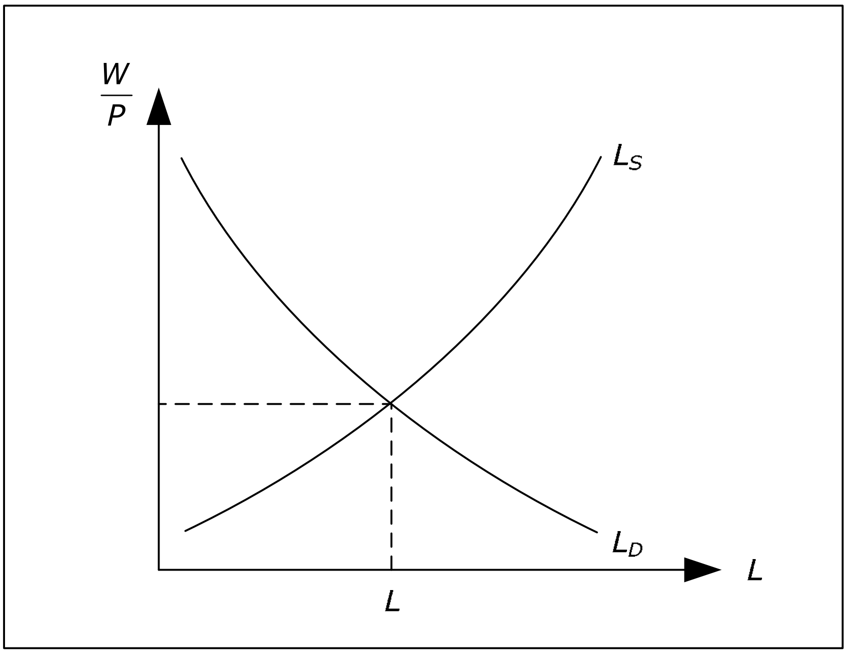


Fig. 10.2: Equilibrium in the labor market.

It is also clear from the graph that the total amount of labor *L* is determined in the labor market. When the real wage is equal to the equilibrium real wage, the supply of labor is equal to the demand for labor and this is the amount that will be used in the production. We then have full employment (see Section 5.4.2).

If real wages are higher than the equilibrium real wage, the demand for labor will be less than the supply. The difference is the amount of unemployment beyond the natural rate of unemployment. In equilibrium, there is therefore no "involuntary" unemployment in the classical model.

10.3 GDP, and Say's Law

10.3.1 Aggregate supply

YS = f(L, K) in the classical model where *L is determined in the labor market while K is exogenous*

The aggregate supply Y_S is defined as the amount of finished goods and services firms in a country will want to sell under given conditions. In the classical model the aggregate supply is determined by production function, $Y_S = f(L, K)$.

The amount of capital in the classical model is an exogenous variable; it is not determined within the model but assumed to be given. Although we typically assume that K is constant – which is reasonable in the short run – it need not be constant. K may increase over time, but we must know K at any point in time.

The amount of labor, however, is an endogenous variable that is determined in the labor market. This means that YS is determined entirely by the labor market in the classical model. The following chart illustrates.

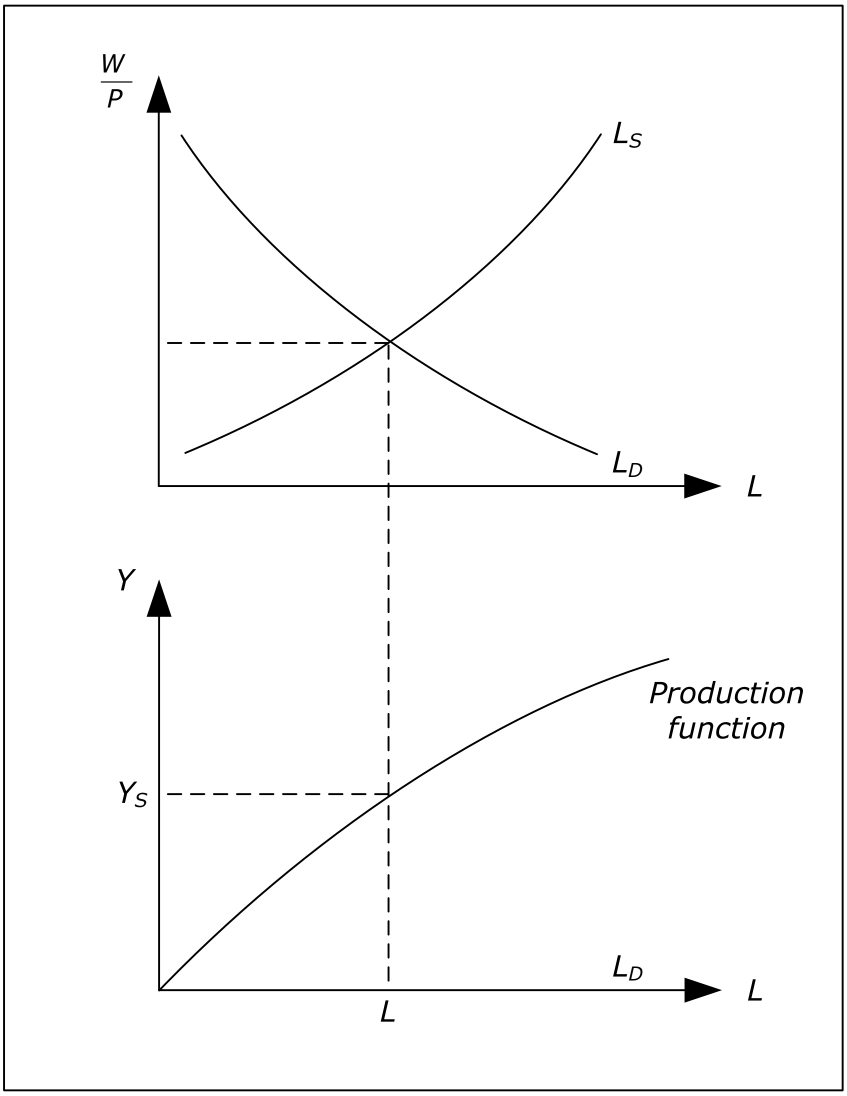


Fig. 10.3: Determination of aggregate supply.

10.3.2 Aggregate demand and Say's Law

$Y_D = Y_S$ in the classical model (Say's law)

The aggregate demand Y_D is defined as the quantity of nationally produced finished goods and services that consumers, government and the rest of the world *want* to buy under given conditions. One of the key elements of the classical model is Say's Law. According to Say's Law the aggregate demand is always equal to the aggregate supply: $Y_D = Y_S$.

Say's Law is sometimes stated as "supply creates its own demand". The motivation for this statement is something like this. If production (Y_S) increases by one billion, the national income will also increase by one billion. This means that individuals will have exactly one more billion for spending – just enough to buy the increase in production. Thus, *YD* will also increase by one1 billion. An increase in the supply of one billion has created an increased in the demand by the same amount.

In the classical model, *observed* GDP *Y* will be equal to the aggregate supply: $Y = Y_S$. GDP is determined entirely by the firms and there is no need to model aggregate demand. It is always the case that $Y_D = Y = Y_S = f(L, K)$.

10.3.3 How *not* to justify Say's Law

At first, Say's Law may seem "obvious". However, it is not – actually, it is highly controversial. The reason it may seem obvious is that you have probably learned from microeconomics that in equilibrium, demand is equal to supply. If you are outside equilibrium, prices will adjust and you will be taken back to equilibrium.

This is *not* the motivation behind Say's Law which is not an equilibrium condition. In the classical model, *YD* and *YS* are *real variables that do not depend on the price level*. This may strike you as odd. *YS* depends only directly on *L* and *K* and indirectly on the real wage. If the price level increases in the classical model, the wage level will increase by the same amount leaving the real wage unchanged. As for aggregate demand, if the price level and the wage level both increase (by the same amount), there is really no change for the consumers. If all prices double while you income doubles, there is no need to adjust you demand.

The justification for Say's Law is not as an equilibrium condition through price adjustments. No price adjustment in the world will equilibrate aggregate demand and aggregate supply in the classical model. Instead, the justification is based on income effects rather than on price effects: higher supply $\Rightarrow$ higher income $\Rightarrow$ higher demand.

The reason why Say's law is so controversial is the following. Suppose that consumers and investors fear that the economy will slow down. They might then decide to save a substantial part of their income and aggregate demand may not be equal to aggregate supply. This is really the starting point for Keynesian economics which we will meet in the next chapter.

10.4 The price level and the quantity theory of money

10.4.1 The quantity theory of money

One of the key elements of the classical model is the quantity theory of money. The quantity theory of money connects three important variables: M, P, and Y: the money supply, the price level and the real GDP.

$P{\cdot}Y$ is equal to *nominal* GDP. Suppose that nominal GDP is equal to 100 for a particular year while the money supply is constant and equal to 20 throughout that year. Since we are using money to buy finished goods, we may conclude that every monetary unit (USD or euro or whatever) has been used an average of 5 times during the year (100/20). This value is called the *velocity of money* and it is denoted by V. We have

$$V = (P{\cdot}Y)/M$$

This is not a theory but a definition. What makes it into a theory – the quantity theory of money – is the assumption that V is a *stable variable that does not depend on other economic variables*. In the quantity theory, the velocity of money is an exogenous variable.

The quantity theory of money: $M{\cdot}V = P{\cdot}Y$, V exogenous

The main consequence of the quantity theory of money is the direct relationship between M and P if Y is constant. For example, if the money supply increases while real GDP stays the same, P will increase exactly as much as M (in percentage).

10.4.2 The price level

The price level is determined from the quantity theory of money: *$P = (M \cdot V)/Y$*

In the classical model, money supply M is an exogenous variable (hence, the growth rate in the money supply π_M is exogenous). It is determined by the central bank (as discussed in Chapter 7.4.2). Similarly V is an exogenous variable in agreement with the quantity theory of money. Thus, $M \cdot V$ is exogenous and given.

Remember that Y is determined by the labour market and the production function. If we combine this with the quantity theory of money, we can determine the price level P: $P = (M \cdot V)/Y$.

Now, suppose that GDP is constant over time. Since V is stable (let's say it too is constant), the percentage change in P is equal to the percentage change in M. That is, inflation is equal to the growth rate of money or $\pi = \pi_M$.

Remember that we have removed the trend in Y which means that Y cycles around some average over time. Thus, Y is not constant over time but there is no growth in Y. Therefore, $\pi = \pi_M$ will still be approximately true even when Y is not constant (it will be true on average and in the long run).

If we do not remove the trend in Y, the result would instead be that inflation is equal to the growth in money supply *minus* the growth in real GDP.

10.4.3 Aggregate demand

P and Y are both endogenous variables and according to the quantity theory of money we need $P \cdot Y$ = constant. If we divide both sides by P we get Y = constant / P. Since $Y = Y_D$ in the classical model, we can write Y_D = constant / P. This relationship is sometimes called "classical aggregate demand" as it relates the real aggregate demand for goods and services Y_D to the price level P.

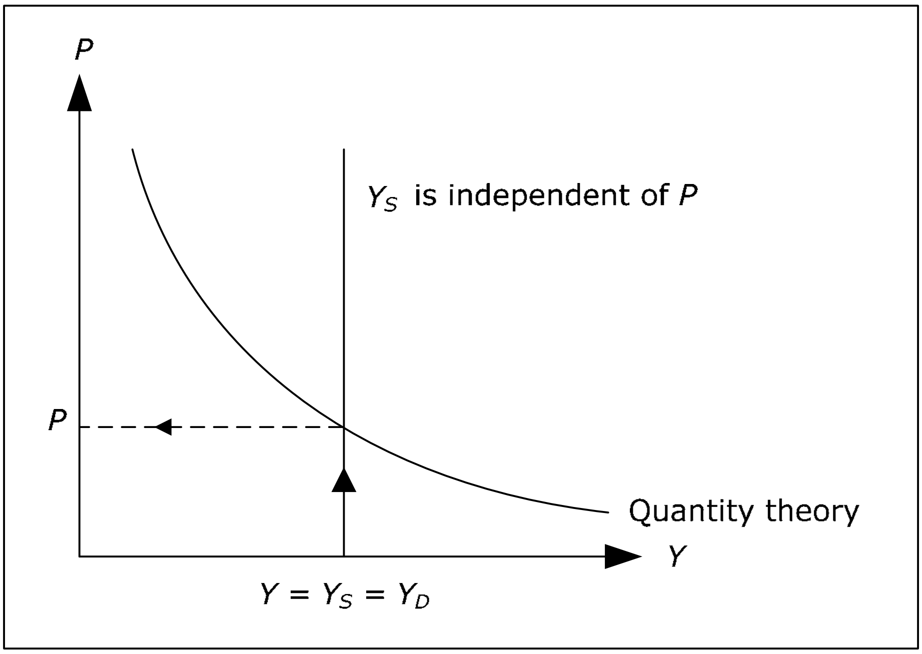


Fig. 10.4: Determination of price level.

However, it is important to remember that it is not price adjustments that make aggregate demand equal to aggregate supply in the chart above. Aggregate demand is always equal to the aggregate supply by Say's Law. In the classical model, *YD* is not determined by *P* but rather the opposite; *P* is determined by *YD* (which is equal to *YS*) and the money supply (which is included in the constant).

10.4.4 Nominal wages

W = (W/P)·P *The nominal wage is equal to the real wage times the price level.*

Since the real wages W/P is determined in the labor market and P is determined by the quantity theory of money, we can also determine the nominal wage in the classical model: $W = (W/P)\cdot P$. From the labor market, Say's Law and the quantity theory, we have now determined W, P, Y and L. We can also demonstrate how all these four are determined simultaneously:

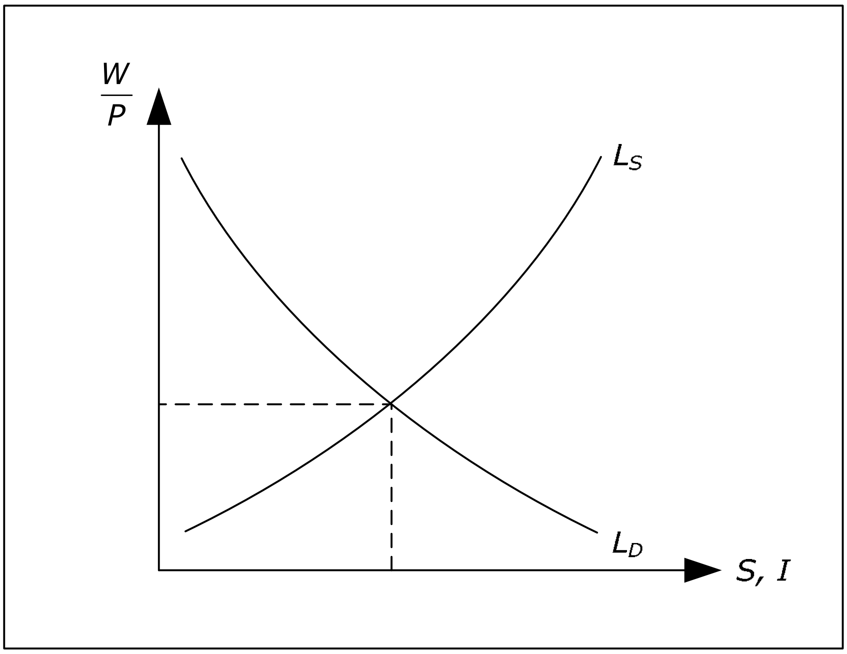


Fig. 10.5: Determination of *W*, *P*, *Y* and *L*.

10.5 Interest rate, consumption and investment

10.5.1 The consumption function

Consumption C(r) is assumed to be negatively related to the real interest rate r

The *aggregate demand for consumer goods* is defined as the total amount of finished goods and services that households *wish* to buy under different conditions. There is no specific supply of consumer goods – firms offer final goods but do not distinguish between the supply to consumers, the supply to investors and the supply to foreigners.

We have used the symbol C for the observed consumption. To be consistent with the notation we *should* denote the demand for consumer goods by CD. However, this is not common practice in macroeconomics. Instead, the symbol C is used for the demand for consumer goods as well. Fortunately, it is almost always obvious from the context if the symbol C represents the observed consumption – it is then a variable – and when C represents the demand for consumer goods – it is then a function.

Moreover, the term "demand for consumer goods" is often shortened to the "demand for consumption" or simply "consumption". Whenever you see "consumption", you need to figure out if it means observed consumption or consumption demand.

In the classical model, the demand for consumption is assumed to be negatively related to the real interest rate r. Higher real interest rates makes it more expensive to borrow money for consumption today. Similarly, it will be more favorable to postpone consumption to the future.

Consumption is therefore denoted by $C(r)$ and this notation makes it clear that we are talking about demand for consumption and not observed consumption.

10.5.2 Investment demand

Investment I(r) is assumed to be negatively related to the real interest rate r

The *total demand for investment goods* is defined as the total amount of investment goods firms wish to purchase under different conditions. Again, as for consumption, there is no "investment supply" and we often use "Investments" as short for the demand for investment. We use the same symbol I for observed investments and for the demand for investments.

In the classical model, investments are also negatively related to the real interest r. Investments will lead to a higher income in the future and with a higher real interest rate, such future income is worth less today. Fewer projects requiring investments will be profitable and investments will declines. Investments are denoted by $I(r)$ in the classical model.

10.5.3 Government revenue, government spending and net exports

G, NT and NX are exogenous variables in the classical model

In the classical model (and in most macroeconomic models) government spending and net taxes are assumed to be exogenous variables determined by the government.

Net Exports NX is also an exogenous variable which means that both imports *Im* and exports *X* are exogenous variables. Exports are determined by the rest of the world and this variable is exogenous in most macro models. It is possible to assume that imports depend on the real interest rate by the same arguments we used for consumption. It would be possible to modify the classical model such that imports depended on the real interest rate but the results would be largely the same. Therefore, we assume that imports are exogenous as well.

10.5.4 Household savings

Remember that consumption may refer to the observed consumption as well as to the demand for consumption. The same is true for "household savings", which may be the observed household savings as well as the supply of savings by the household sector. The supply of savings by the household sector is defined as the *net* amount that all households together which to lend under different conditions.

First note that for savings, we are always interested in the net. Some individuals will want to borrow and some will want to lend and some will want to do both. Household savings is the sum of all items where lending is defined as positive amounts and borrowing as negative amounts. If you borrow money in the bank, you are in effect reducing the total amounts of savings.

In the classical model the supply of savings SH depends positively on the real interest rate in the classical model. This follows by the fact that C depends negatively on r. When r increases, we consume less and save more. Therefore, household savings is denoted by $SH(r)$.

10.5.5 Total savings

Total savings S(r) depends positively on the real interest rate.

Remember that total savings is defined as $S = SH + SG + SR$, the sum of net savings from the household, the government and the rest of the world. As with SH, S may be the observed amount of savings or the total supply of savings. In the classical model, SG and SR are exogenous variables. $SG = NT - G$ and $SR = Im - X$ depend only on exogenous variables and are therefore themselves exogenous.

The only part of savings that is endogenous is household savings. Since household savings depend positively on the real interest rate, total savings will depend positively on the real interest rate. In the classical model we use $S(r)$ to denote total savings and we have

$$S(r) = S_H(r) + S_G + S_R.$$

Note that S_H, S_G, and/or S_R may very well be negative. For example, when SG is negative, $G > NT$ and the government is a net borrower.

10.5.6 Interest rate determination

The real interest rate r will be equal to the equilibrium real interest rate

In the classical model we define the equilibrium real interest rate r^* as the real interest rate where savings is equal to investments, $S(r^*) = I(r^*)$. From section 4.9 we know that $S = I$ is a requirement for the financial market to be in equilibrium.

In the classic model, the real interest rate determines the flow of funds into and from the the financial market. A higher real interest rates will lead to larger flows of funds into the market (savings depends positively on r) and the smaller flows out from the market (investment depends negatively on r). The real interest rate will be such that the flows into the market are precisely equl to the flows out of the market.

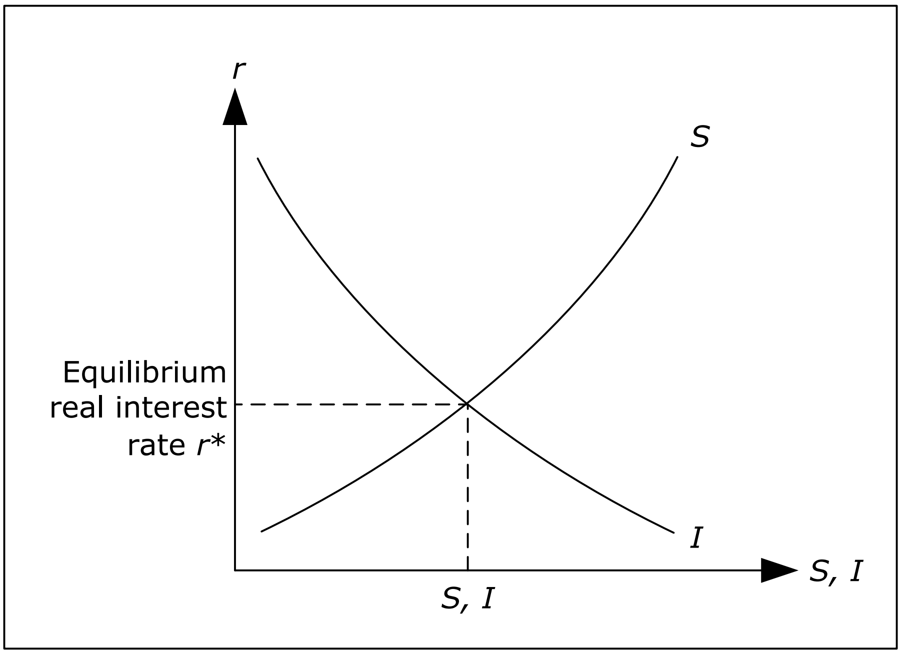


Fig. 10.6: Determination of the real rate.

From this graph we can also determine the size of investments and savings. In equilibrium when $r = r^*$, $S = I$ which is what we need for the GDP identity to hold. Once we know savings, we can determine household savings from $S_H = S - S_G - SR$.

In the classical model, expected inflation π^e is an exogenous variable and since $R = r + \pi^e$ we can determine the nominal interest rate from the real rate.

10.5.7 Consumption

The final variable to be determined in the classical model is consumption C. Consumption may be found in several ways which will all produce exactly the same answer:

- $C = C(r)$ from the consumption function as we know r.
- By solving for C in the equation $SH = Y - NT - C$. We have found Y and SH while NT is exogenous.
- By solving for C in the GDP identity $Y = C + I + G + NX$. We have found Y and I, while G and NX are exogenous.

10.6 Determination of all the variables in the classical model

The following diagram shows how all the variables are determined in the classical model:

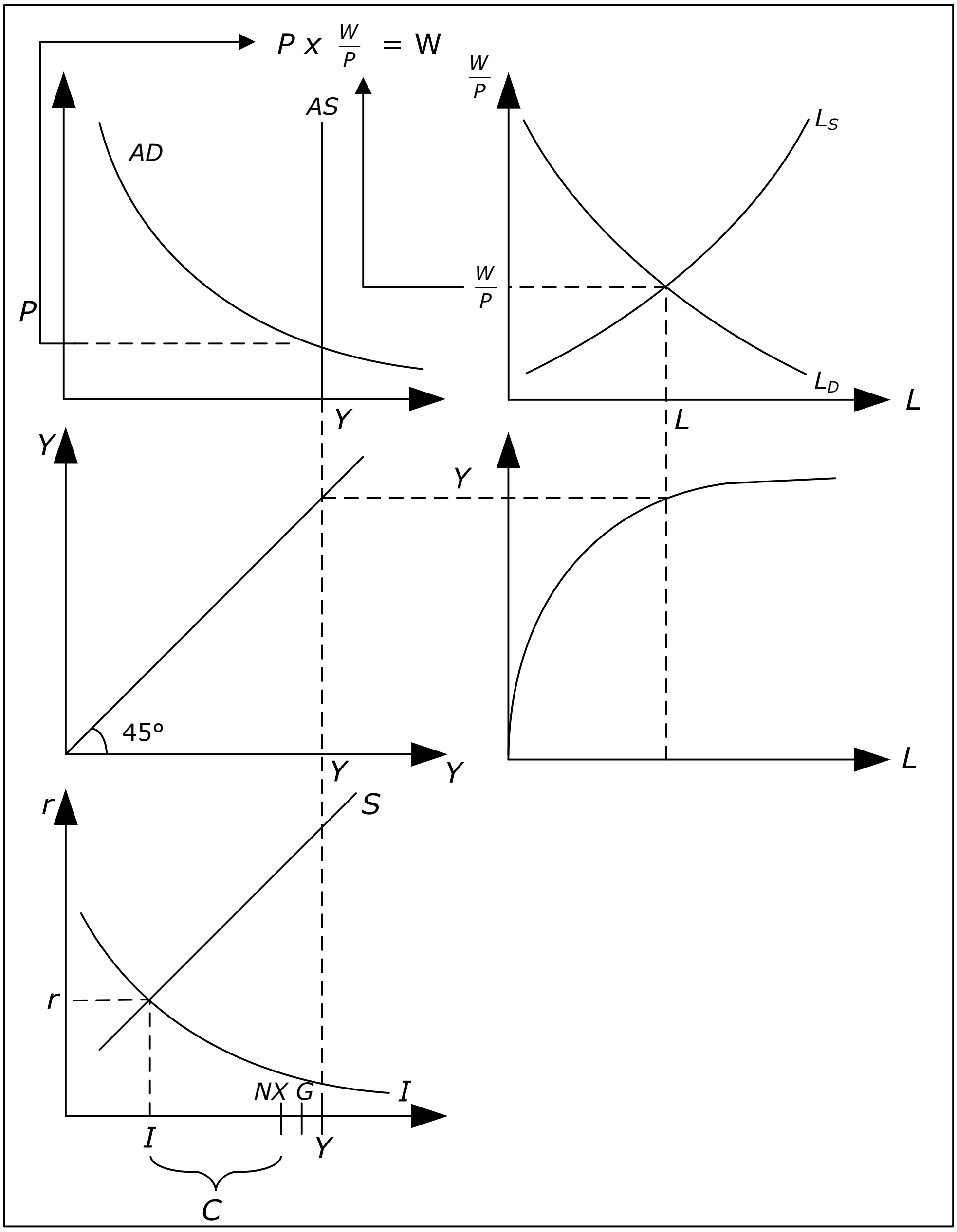


Figure 10.7 Determination of all the variables in the classical model.

1. Start at the top right. Here we determine *L* and real wage *W*/*P*.
2. Follow *L* down to the point on the production function in the middle to the right. Here you can find real GDP.
3. Follow GDP to the left to the graph of the left in the middle. This graph consists of a single 45-degree line. All points on a 45-degree line have the same *x* and *y* coordinates. Such graph is used to transform a variable from the *y* axis to the *x* axis.

4. Follow Y up to the top left graph. In this graph you find aggregate supply which is independent of P and aggregate demand which is just the quantity theory of money. From this graph, you get up P.
5. If you multiply P from the upper left-hand chart, by W/P from the upper right-hand chart, you get nominal wage W.
6. Follow Y from the middle left graph down to the bottom left graph. Here is S (r) and I (r) and a determination of real r and I in the balance. In C + + NX + G = Y, and since NX and G is exogenous, we can calculate C.

We will discuss the most impact from the classical model in the exercise book, but it may be interesting to also point out here the most important:

- Monetary and fiscal policy can not affect the GDP or unemployment in the classical model.
- In the classical model can no nominal variables affect a real variable. The price level, which is a nominal variable, for example, does not affect consumption, which is a real variable. This is known as the classic dichotomy.

11 Keynesian cross model

11.1 Introduction

11.1.1 The Keynesian model

In this chapter we will look at the Keynesian cross model. This model is a simple version of what we call the "complete Keynesian model" or simply the Keynesian model. The Keynesian model has as its origin the writings of John Maynard Keynes in the 1930s, particularly the book "The general theory of Employment, Interest, and Money". Although this book was written as a criticism of the classical model, the similarities between the Keynesian model and the classical model are definitely greater than the differences. Lets point out the three most important differences directly:

- Say's Law does not apply in the Keynesian model.
- The quantity theory of money does not apply in the Keynesian model.
- The nominal wage level *W* is an exogenous variable in the Keynesian model.

Remember that *W* being exogenous means that it is pre-determined outside the model. It does not necessarily mean that it is constant over time – even though this is a common assumption. However, the nominal wage must be known at any point in time in this model. To simplify our description of the Keynesian model, we will begin by assuming that *W* is constant.

The Keynesian model is slightly more complicated than the classic model, and it is developed in four stages by analyzing four separate models. Each model has, however, a value in itself. The models we will consider and the major characteristics of each are:

- *Cross model*: *W, P and R* are constant (and exogenous).
- *IS-LM model*: *W, P* are constant and *R* is endogenous.
- *AS-AD model*: *W* is constant, *P* and *R* are endogenous.
- *The full Keynesian model*: *W* is exogenous (but not constant), *P* and *R* are endogenous.

Once we have developed the full Keynesian model, we will combine it with the clasmodel which will lead to the neoclassical synthesis. The final chapter covers the Mundell-Fleming model – an extension of the neoclassical synthesis to an open economy where we also analyze the exchange rate.

11.1.2 Summary of the cross model

The following list summarizes the cross model and relates it to the classical model:

- *Labor Market*: The real wages W/P is exogenous in the cross model (W is exogenous in all the Keynesian models and P is exogenous in cross model). The detrmination of L is very different from the classical model, see Section 11.4.4.
- *Aggregate supply Ys* is determined by the production function $Ys = f(L, K)$. Again, we always remove any trend in GDP and its components.
- *Aggregate demand* is not always equal to the aggregate supply. Say's Law does not apply in any of the Keynesian models. Therefore, we must describe how aggregate demand and GDP is determined in the cross model. This can be found in Section 11.3.
- *The Quantity theory of money* does not apply anymore. Fortunatelly, we don't need it since P is given in the cross model.
- *Consumption* was a function of the real interest rate in the classical model. In the cross model it is a function of Y.
- *Investment* was also a function of r in the classical model. In the Keynesian model it is exogenous.
- Government spending (G) is exogenous but the net tax NX is endogenous (in the classical model, they were both exogenous). Net tax is assumed to be a function of Y which means that government savings will be endogenous ($SG(Y)= NT(Y) - G$).
- Exports (X) is exogenous, as it is in the classical model, but imports (Im) is endogenous. Imports will also be a function of Y. Net imports and external savings will therefore also be endogenous variables ($NX(Y) = X - Im(Y)$ and $SR(Y) = Im(Y) - X$).
- Household savings and total savings were functions of the real interest rate in the classical model. In the cross model they are functions of Y.
- The real interest rate is exogenous in cross model. This follows by the fact that the nominal interest rate is exogenous and prices are constant (π^e must be zero, and $r = R$).

We can divide our analysis of the cross model into three parts:

- *Aggregate demand*. Aggregate demand is a major component of the cross model. The main purpose of this section is to arrive at the conclusion that aggregate demand depends on real GDP.
- *Determination of GDP*. GDP is determined very differently in the cross model compared to the classical model.
- *Labor market*. One of the main points of the Keynesian model is to allow for unvoluntary unemployment. In the classical model of the the labor market, we are always in equilibrium and there is no unvoluntary unemployment.

11.2 Aggregate demand

11.2.1 The consumption function

Consumption C(Y) depends positively on GDP in the cross model

Remember that in the classical model, consumption depends on the real interest rate. In the cross model it depends on GDP. Note that it is not possible to include r in the cross model as it is fixed. However, we need to justify the dependence of C on Y.

11.2.2 Consumption and GDP

At first, it might seem obvious that consumption will depend on Y. If GDP is doubled in real terms over a number of years, private consumption, government consumption and investment will also each roughly be doubled. If you draw a graph of GDP and consumption over time you see that consumption does grow by about the same rate as GDP.

However, from this reasoning, we *cannot* conclude that C depends on the Y because *growth has been removed* from our variables C and Y. We need to think of Y as a variable that varies over time around some average. Sometimes it is above the average and sometimes it is below the average but there is now upward trend. The same is true for C.

The crucial question then is whether consumption is above its average in periods when GDP is above its average and vise versa (technically, if the detrended variables are correlated over time). Keynes would have said yes, while classics would have said no.

Keynes' motivation: In good times, when *Y* is high (above its trend), national income is high (above it trend). Consumers will take the opportunity to buy things they otherwise cannot afford. In bad times, on the other hand, consumers simply cannot buy things they would have bought if income was higher.

The classical motivation: Consumers want to smooth their consumption over time. In good times, consumers know that this is a temporary state. Instead of increasing consumption, they *save* and use their savings in bad times.

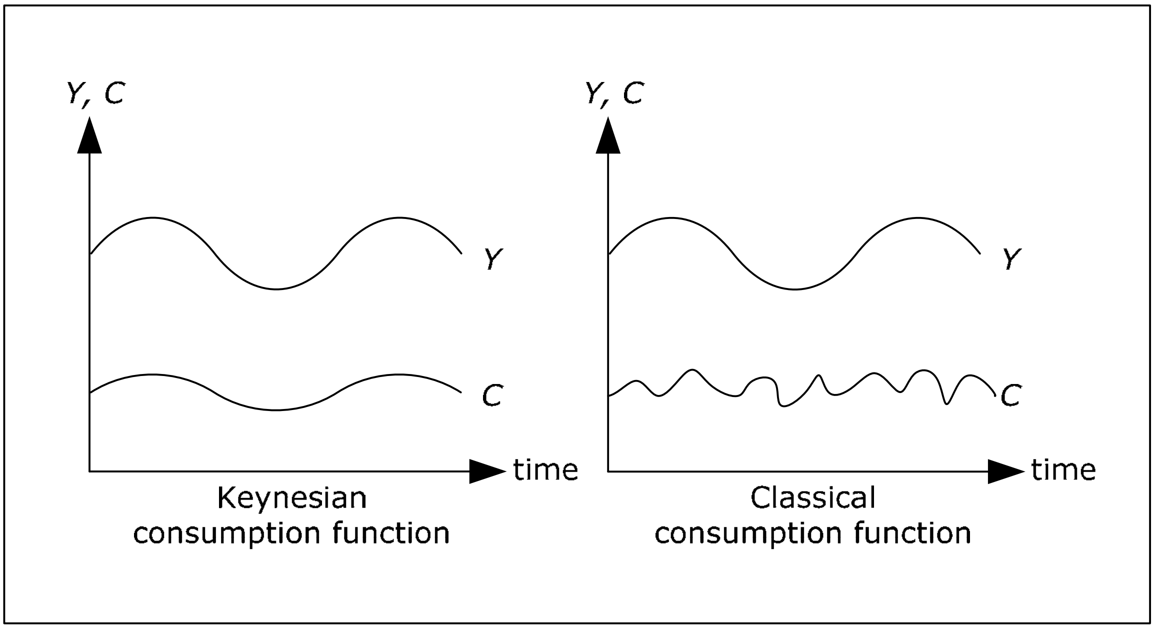


Fig. 11.1: Classical and Keynesian consumption function.

11.2.3 The rest of the world in the cross model

Imports Im(Y) depends positively on Y in the cross model

In the classical model, imports does not depend on *Y*. The discussion whether imports depends on *Y* or not is the same as for consumption. However, in the cross model, it is always assumed that when *Y* increases, consumption will increase by more than imports. This makes sense since C is ususally larger than *Y*. For example, suppose that *C* is 1000 while *Im* is 100 and that *Y* increases by 10%. If *C* and *Im* increase by 5% each, *C* will increase by 50 while *Im* will increases by only 5.

Net exports $NX = X - Im$ will depend negatively on the Y and rest of the world savings $SR = Im - X$ depends positively on Y in the cross model. If we want to be explicit about these dependences we write:

$$NX(Y) = X - Im(Y)$$
$$S_R(Y) = Im(Y) - X$$

11.2.4 The government in the cross model

Net taxes NT(Y) depends positively on real GDP in the cross model

In this model, when national income increases, the amount individuals pay in income taxes will increase. This is because income tax is specified as a percentage of total income. Other taxes may also increase when Y increases. However, government transfers to households will decrease. Therefore, net taxes NT will increase when Y increases.

Even though NT depends on Y, is still under the control of the government. NT may change even if Y does not change. This means that NT is part exogenous (as it may be controled by the government) and part endogenous (as it will automatically change when Y changes). Therefore, we write $NT(Y)$ but we must remember the exogenous nature of net taxes. Government savings, which is also part endogenous and part exogenous, depends positively on Y and we write:

$$S_G(Y) = NT(Y) - G$$

11.2.5 Savings

Household savings $S_H(Y)$ and total savings S(Y) depend positively on Y

Household savings depends on Y because $S_H = Y - C - NT$ and C and NT both depend on Y. How it depends on Y cannot be conclusively be determined from this relationship as C and NT both dpeends positively on Y. We always assume that this dependence is positive and the following example illustrates why this assumption makes sense.

Suppose that $NT = t{\cdot}Y$ where t is a constant between 0 and 1. t is the the proportion of income that we pay in taxes. Next, suppose that $C = c{\cdot}Yd$ where c is a constant between 0 and 1. c is proportion of disposable income that we use for consumption. If income Y increases by 1, NT increase by t, disposable income increases by $1 - t$ and C increases by $c(1 - t)$. Thus, SH increases by $1 - c(1 - t) - t = (1 - c)(1 - t) > 0$.

Since $S = S_H + S_G + S_R$ and all parts on the right hand side depends positively on Y, total saving S will depend on positive Y and we write $S(Y)$ for total savings (net total supply of savings).

11.2.6 Aggregate demand in the cross model

Since C and Im depends positively on Y while G, I and X are exogenous, aggregate demand YD will depend positively on Y:

$$Y_D(Y) = C(Y) + I + G + X - Im(Y)$$

When Y increases, C and Im increases but since C increases more than Im, aggregate demand will increase when Y increases.

You may react to the the notation $Y_D(Y)$. But if you think of Y as the national income (GDP = national income) then $Y_D(Y)$ simply tells us that aggregate demand depends on income. Aggregate demand is the total quantity of finished goods and services that all sectors (consumers, firms, government and the rest of the world) together wish to buy under different conditions. The notation $Y_D(Y)$ tells us that the only endogenous variable that affects aggregate demand is national income. The higher the income, the more we wish to buy. Y_D, C, Im, S, S_H, S_G, S_R and NT all depend on Y while I, G and X are exogenous. We can illustrate this using the following diagrams.

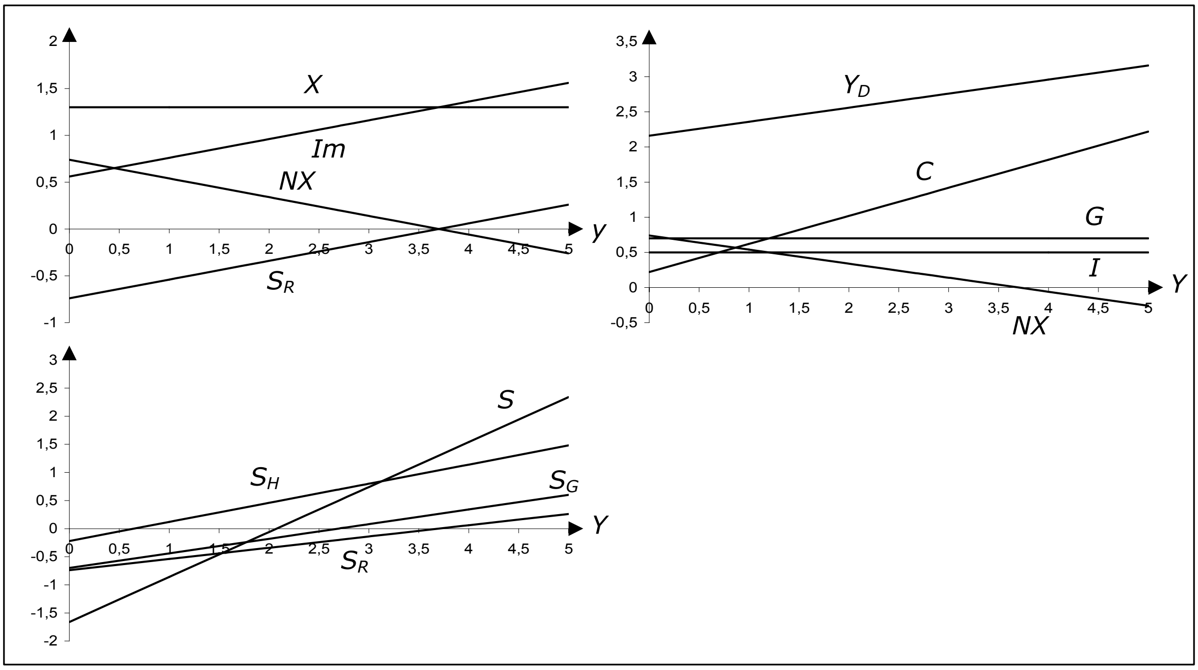


Fig. 11.2: Aggregate demand and its components.

Each diagram has real GDP on the *x*-axis.

- The first diagram shows exports (X), imports (Im), net exports (NX) and rest of the world savings (S_R). In this diagram, $X = 1.3$ and $Im = 0.56 + 0.2Y$.
- The second diagram shows private consumption (C), investment (I), government spending (G), net exports (NX) and aggregate demand ($Y_D = C + I + G + NX$). Here, $C = 0.22 + 0.4Y$, $I = 0.5$, $G = 0.7$.
- The third diagram shows private savings (S_H), public savings (S_G), the rest of the world savings (S_R) and the total savings ($S = S_H + S_G + S_R$). They are created from $NT = 0.26Y$.

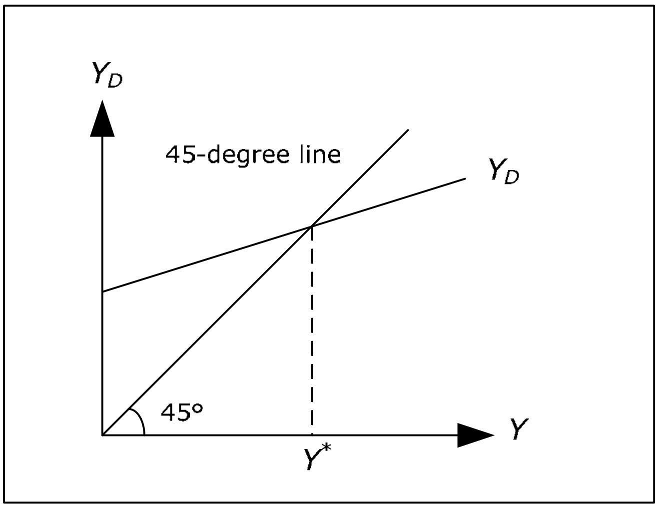
This diagram summarizes all varaiables in the cross model and how they depend on Y. Actually, these dependences will be the same in all of the Keynesian models.

11.3 Determination of GDP in the cross model

11.3.1 Main result

In the cross model, GDP is determined as the solution to the equation $Y_D(Y) = Y$

We may illustrate the determination of Y graphically:



Fig, 11.3: Determination of GDP in cross model.

All points on the 45-degree line has the same x- and y-coordinates. Since we have Y on the x-axis, and Y_D on the y-axis, $Y_D = Y$ for all points on the 45-degree line. The AD curve shows the aggregate demand Y_D as a function of Y. There is only one level of Y where aggregate demand is equal to Y, the point where AD cutts the 45-degree line. This level is called the equilibrium level of GDP and it is denoted by Y^*. Formally, Y^* is defined implicitly by $Y_D(Y^*) = Y^*$.

11.3.2 Justification

Note that we have not said anything about the aggregate supply so far. In order to justify why GDP is determined solely by aggregate demand we have to explain why aggregate supply Y_S plays no role and why Y_S always will be exactly equal to Y_D (which is required for the goods market to be in equilibrium).

We can explain why $Y_S = Y^*$ by analyzing what would happen if firms did not supply this quantity.

1. Imagine that the firms supplied and also produced a larger quantity so that $Y > Y^*$.
2. From the diagram above, $Y_D < Y$ and firms cannot sell everything they produce.
3. Unplanned stock investments will increase by $Y - Y_D$ when companies are forced to put unsold products in stock.
4. Firms will then want to lower their supply. The reduction will continue until $Y_S = Y^*$.
5. If, on the other hand, they supply and produce too little, $Y < Y^*$ and then $Y_d > Y$. Stocks will now be reduced and firms will want to increase the supply.

Note that the Keynesian model always assumes *quantity adjustment* to get back to equilibrium. There are no price adjustments in the Keynesian model.

11.3.3 Say's Law

Also note how the entire outcome of the cross model depends on the elimination of Say's Law. With Say's Law, aggregate demand would always be equal to aggregate supply and the cross model would be incorrect.

Keynes's argument as to why Say's Law does not apply can be illustrated in the cross model. According to Say's law, supply creates its own demand. When supply increases, income increases and a higher income creates an equally large increase in demand. Households and firms are stimulated to a higher demand by cuts in the real interest rates. Higher aggregate supply will lower the real interest rate and consumption and investment will increase. According to Say's Law, r will fall to the level where the total increase in C and I is exactly as large as the increase in aggregate supply.

According to Keynes and cross model, this will not happen. When Y increases, C will increase *but not as much as* Y (and I will not change at all). Aggregate demand will not increase as much as aggregate supply and Say's Law will fail.

11.3.4 Reversed Say's Law

In the cross model, *supply must instead follow demand*. The cross model not only rejects Say's Law, it turns it completely upside down. In the cross model "demand creates its own supply".

Just as Say's Law is criticized by many economists, there is criticism of this reversed form of Say's Law. In this reversed form, firms passively produce exactly what the consumers want. If there is an increase in demand, firms will just produce this additional quantity. The motivation for this behaviour by the firms is further analyzed when we describe the labor market in the cross model.

11.3.5 Determination of other variables

Once *Y* is determined, almost all of the other variables are determined because they are either exogenous or they depend on *Y*. From *Y* we can determine *C* by the consumption function, *Im* from the import function and *NT* from the net tax function.

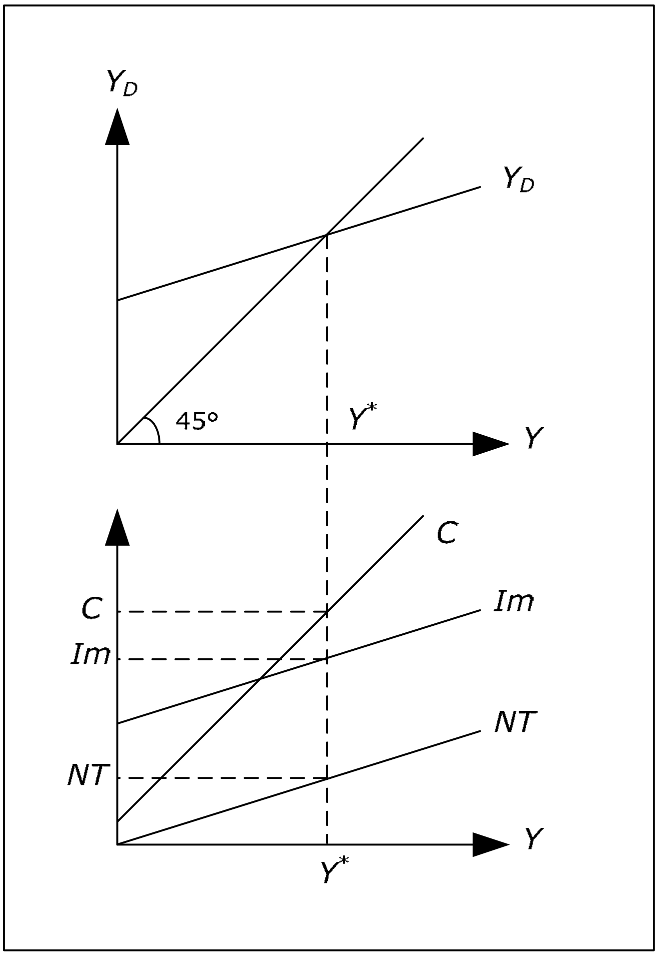


Fig. 11.4: Determination of C, Im and NT.

When these variables are determined, we can determine net exports, household savings, government savings and rest of the world savings. All macro variables except *L* and *U* are thus determined.

11.4 Labor market

11.4.1 Labor supply and labor demand in the Keynesian model

Remember that the supply of labor, $L_S(W/P)$, depends positively on real wages in the classical model. It is not always clear which individuals are included in the labor supply. The labor supply may consist of only individuals in the workforce or it may have a wider definition including individuals that are outside the labor force but would like to work if they could find a job. The second category may contain so-called "discouraged workers" and individuals that are in school but who would rather work.

The Keynesian labor supply differs from the classic labor supply in that it includes individulas that are outside the workforce. Therefore, for a given real wage, the Keynesian labor supply is larger than the classic labor supply. However, the Keynesian labour supply is still a positive function of the real wage.

The demand for labor $L_D(W/P)$ is the same as for the classical model. It is derived from the marginal product of profit maximizing firms. The following graph shows the classical labor supply, the Keynesian labor supply and the labor demand.

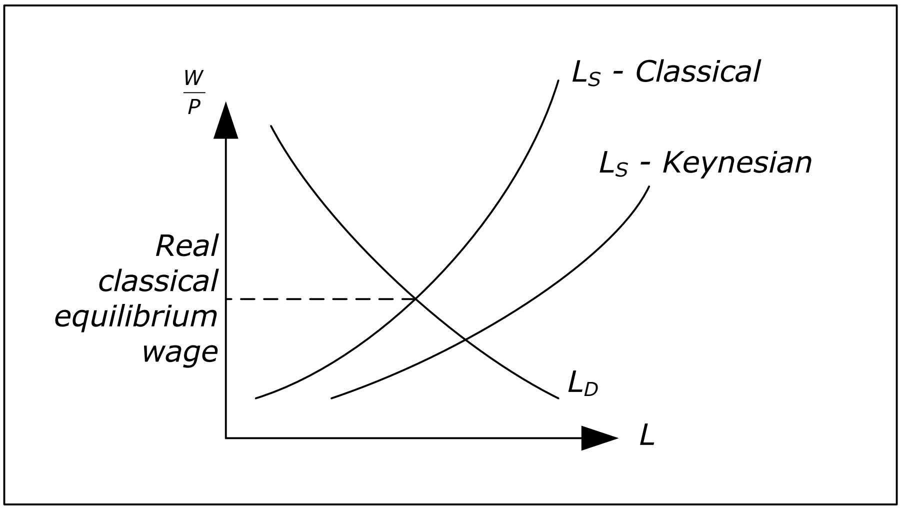


Fig. 11.5: Classical and Keynesian labor supply.

Note that for the classical equilibrium real wage, the Keynesian supply exceeds the demand. *In the Keynesian models, we do not assume that the real wage will be equal to the equilibrium real wage*. The labor market need not be in equilibrium in the classical sense. However, in the Keynesian models, the real wage is such that there is always an excess supply of labor (using the Keynesian supply).

11.4.2 The labor in the cross model

In the cross model, both P and W are constant and exogenous. Therefore, the real wage is constant and it is not necessarily equal to the equilibrium real wage. The modle of the labor market in the cross model can be illustrated by the following figure:

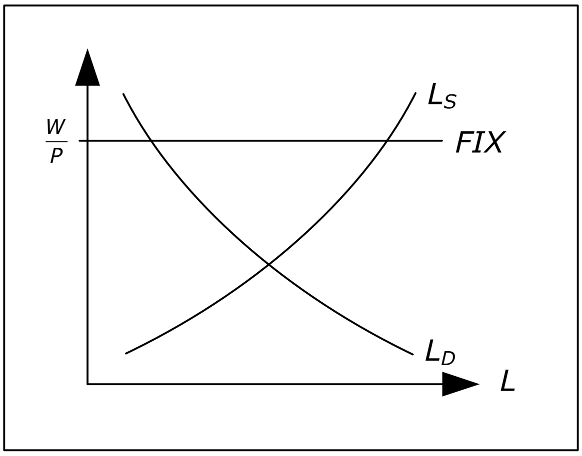


Fig. 11.6: The labor market in the cross model

11.4.3 Aggregate supply

Remember that labor demand gives us the profit-maximizing quantity of *L* for a given real wage. If *W*/*P* is given (as it is in cross model), we can find the profit-maximizing quantity of *L* from the graph. We denote this by L_{OPT}. If firms use L_{OPT} amount of labor, they wil produce $Y_{OPT} = f(L_{OPT}, K)$ where *f* is the production function and K the amount of capital (exogenous).

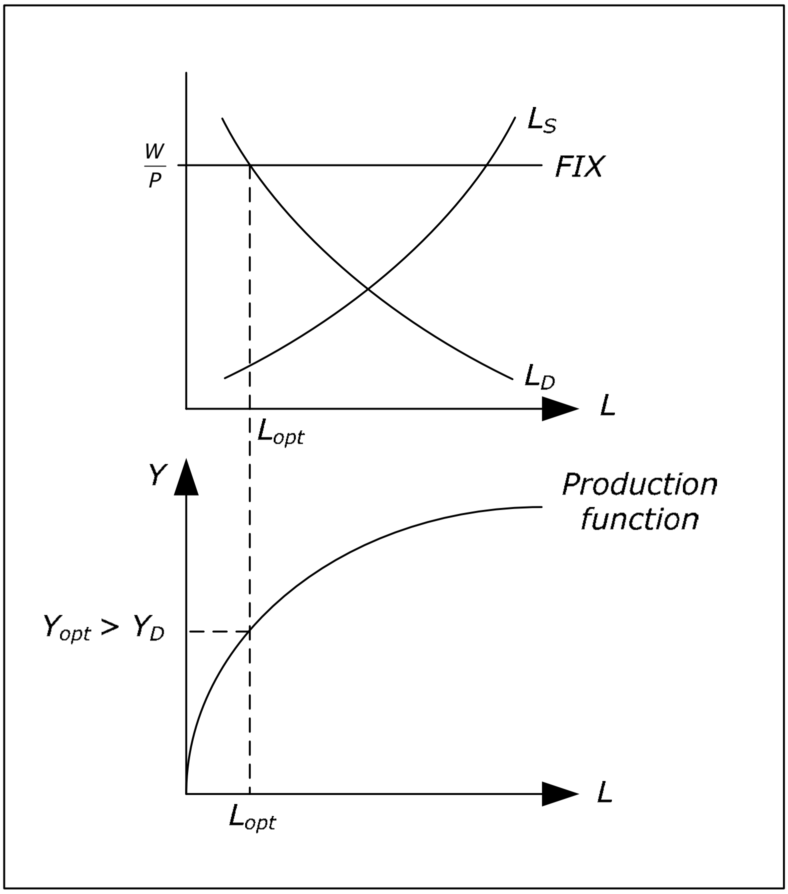


Fig. 11.7: profit-maximizing quantity of *L* and *Y*.

An important assumption in the cross model is that Y_{OPT} is always larger than Y_D – the aggregate demand is not sufficient for the amount that firms would like to supply at the given real wage. This assumption has a very important consequence. Even though producing Y_{OPT} would maximize profits, *firms will not produce this level due to the lack of demand*. They will only produce Y_D and we see why it is aggregate demand that is important in the cross model. Again, note how the Keynesian cross model works with *quantity adjustments* instead of *price adjustments* as in the classical model. We denote the level of output produced by the firms by *Y**.

11.4.4 Determination of *L* in the cross model

Since firms will produce less than Y_{OPT}, they need less labor than L_{OPT}. We can figure out exactly how much *L* they need in order to produce *Y** and this level of *L* is denoted by *L**.

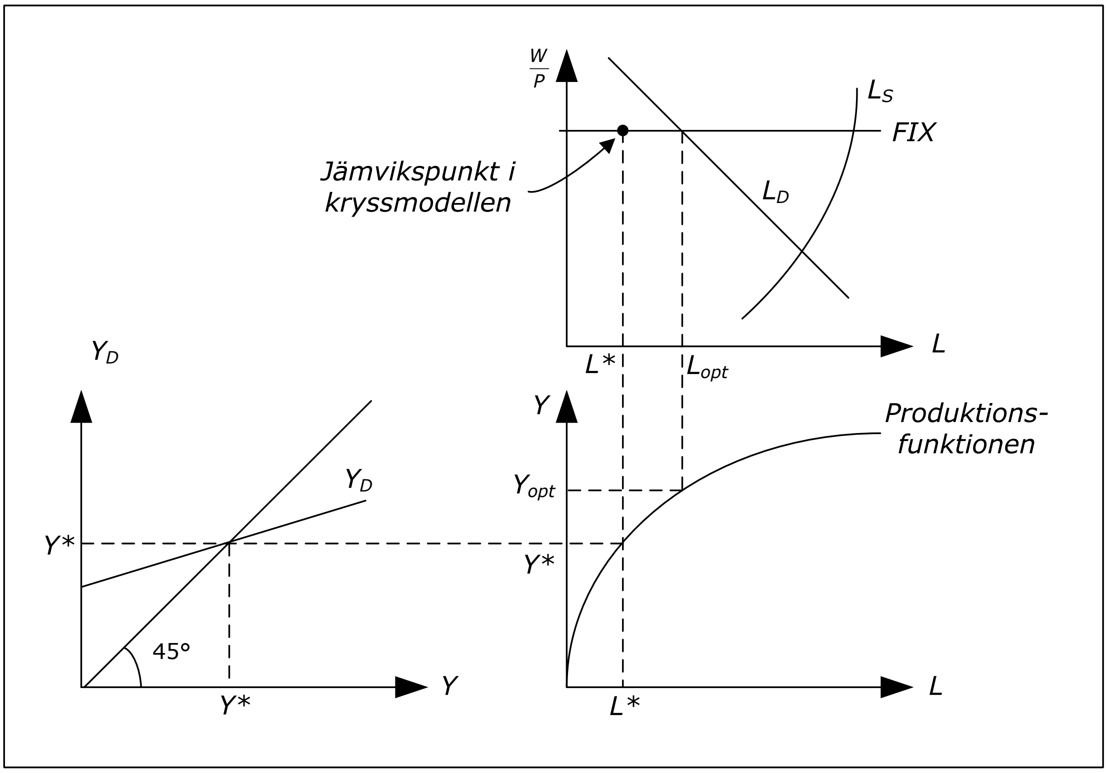


Fig. 11.8: Determination of *L* in the cross model.

1. Start at the bottom left. Here, the equilibrium level of GDP (denoted by *Y**) is determined. We can add *Y** on the *y*-axis as well since $Y_D = Y^*$ in equilibrium.
2. Extend *Y** to the bottom-right graph. This is the aggregate supply.
3. From the production function we can figure out exactly how much labor we need to produce *Y**. This amount is denoted by *L**.
4. Extend *L** up to the upper right-hand graph. Since real wage is fixed, we must be on the horizontal line and we find the equilibrium for the labor market.
5. In the same diagram you will also find also find L_{OPT}, the quantity of labor firms would choose if aggregate demand was sufficient.

Note a crucial difference between the classical and the Keynesian model: in the classical model we first determine *L* and go from *L* to *Y* while in the cross model we go from *Y* to *L*.

11.4.5 Equilibrium analysis

An important question is whether the equilibrium we have identified in the labor market (with a high unemployment rate) can remain in the long run. Will there not be adjustments that will take us back to a point with no unemployment? The Keynesian justification for why unemployment will persist is as follows.

The goods market is in equilibrium since firms will sell everything they produce and the demand for finished goods is satisfied. Firms then have no reason to hire more labor (they will only increase L when Y_D increases). And since the goods market is in equilibrium, they have no reason to change prices.

However, we have *involuntary unemployment* in the diagram above which may create a downward pressure on wages. In the cross model, this will not happen for the following arguments:

1. Nominal wages are sticky, particularly downwards. We hardly ever observe cuts in nominal wages.
2. Nominal wage cuts would not help. With lower wages, income would fall, reducing aggregate demand even more, making the situation worse. Lower nominal wages would allow firms to lower prices. But if prices fall as much as nominal wages, real wages will no, and we had stayed in the same paragraph.

As with the classical model, we study most of the check model characteristics in an exercise book. A couple of comments, however, may be of interest already here.

- It is difficult to explain long periods of high unemployment in the classic model with the model of labor used there.
- During the Great Depression in the early 1930s (the great depression), it became increasingly evident that the traditional model had flaws. Unemployment was very high for a long time and any adjustment to the balance of the labor market was not.
- In the Keynesian model, can the economy to be in balance even with a high level of involuntary unemployment and the model appeared to be a good explanation for depression.
- I check the model, financial policy is a very important role. By increasing G so, the government can increase GDP and thus reduce unemployment.
- The classic dichotomy between real and nominal variables will disappear in all Keynesian models.

12 IS-LM-model

12.1 Introduction

The main difference between the cross model and the IS-LM model is that the nominal interest rate is exogenous in the cross model but endogenous in the IS-LM model. In this chapter we will explain how the nominal interest rate is determined in the IS-LM.

P remains exogenous and constant in the IS-LM model. Therefore, inflation and expected inflation is zero. This in turn implies that the nominal interest rate is equal to the real interest rate: $R = r$. This will allow us to talk about "the interest rate" without specifying whether we mean the nominal or real interest rates.

12.2 Aggregate demand

12.2.1 The investment function in the IS-LM model

Investment was an exogenous variable in the cross model due to the fact that the interest rate was exogenous. Now that the interest rate is endogenous, investment will be endogenous. As for the classical model, investment depends negatively on the real interest rate but since $R = r$ in the IS-LM model, we can make investment a function of R: $I = I(R)$.

12.2.2 The consumption function in the IS-LM model

The consumption function will be the same as in the cross model, consumption will depend positively on Y. In the classical model, consumption depends negatively on the real interest rate. You may allow consumption to depend negatively on interest rates in the IS-LM as well. You must then write $C = C(Y, R)$. In the literature, both variants are found but since the results will be largely the same, we choose to let C depend on Y only, $C = C(Y)$. We will also, for the same reason, model imports as a function of Y only even though it may depend on R as well.

12.2.3 Aggregate demand

Aggregate demand depends on Y and R in the IS-LM model

Since investments depend on R and consumption and imports depend on Y, the aggregate demand will depend on both Y and R. In the cross model, we used the notation $Y_D(Y)$ for aggregate demand. In the IS-LM model, we must instead use the notation $Y_D(Y, R)$. We have

$$Y_D(Y, R) = C(Y) + I(R) + G + X - Im(Y)$$

It does not make much of a difference if we allow C and Im to depend on R as well, Y_D will depend positively on Y and negatively on R in any case.

It should also be clear that we can no longer determine GDP the way we did it in the cross model. We cannot successfully solve the equation $Y_D(Y, R) = Y$ as we have only one equation but two unknowns (Y and R). We need *one more equation* if we want to solve for both Y and R. This equation will come from the money market.

12.3 The money market

12.3.1 Demand for money

The demand for money depends negatively on R and positively on the Y in the IS-LM model

As for any kind of goods, there is *a demand for money and a supply of money*. Remember that the demand for an arbitrary good is the amount an individual wishes to buy (and pay for with money) under different conditions. The demand for an arbitrary good is always related to money. But the demand for money cannot relate to money itself – how much money we want to "buy" with money becomes a rather useless definition.

Instead, we define the ***demand for money*** as *the amount out of your wealth that you wish to hold as money*. We use the symbol MD to the demand for money. In the IS-LM model, there is only one alternative to money and that is *bonds*.

If your total wealth is 1.000 euro and you wish to keep 100 euro in cash or in an account connected to a debit or credit card and the rest in government bonds then your demand for money is precisely 100 euro. It is the amount that you want to have easily accessible for immediate payments. Note that having a low demand for money does *not* mean that you do not *want* money. Instead, it means that you prefer to hold most of your wealth in other types of assets

12.3.2 Demand for money and the interest rate

Money has one important advantage and one important disadvantage compared to bonds:

- *Advantage*: Money is more *liquid* than bonds. If most of your wealth is invested in bonds, you must first sell some of the bonds whenever you want to make a payment.
- *Disadvantage*: You receive interest payments on bonds but not on money.

At 0% interest, there would be no reason to hold bonds and the demand for money would be maximized. The higher the interest rate, the more you lose by holding money instead of bonds. Therefore, we would expect the demand for money to fall when R increases and this is the assumption in the IS-LM model.

12.3.3 Demand for money and GDP

The demand for money also depends on the GDP as GDP is closely related to national income. If you choose to hold a fixed proportion of your wealth as money, you will want to hold more money when Y increases (you will want to hold more bonds as well). In the IS-LM model we assume that the demand for money is positive function of GDP.

As the demand for money depends on Y and R in the IS-LM model, we write $M_D(Y, R)$ for the demand for money. Remember that it depends positively on Y and negatively on R.

12.3.4 Supply of money

The supply of money is an exogenous variable in the IS-LM model

The money supply is completely under the control of the central bank in all models in this book. Money supply is therefore an exogenous variable not affected by either interest rates or GDP. We denote the money supply by M_S.

12.3.5 Equilibrium in the money market

In the IS-LM-model, we have equilibrium in the money market when
$M_D(Y, R) = M_S$

This is our "missing equation" as discussed in section xx. It is now possible to determine all endogenous variables in the IS-LM model:

$Y_D(Y, R) = Y$	equilibrium in the goods market
$M_D(Y, R) = M_S$	equilibrium in the money market

We now have two equations and two unknown (Y and R) and in most cases we can find a unique solution to the system of equations. Exactly how this is done is best illustrated by the IS-LM diagram which is presented in section xxx.

12.3.6 Money market diagram

Let us begin by studying the money market when the *GDP is given*. When Y is given, M_D will only depend (negatively) on R and we can draw a diagram with supply and demand for money as functions of R.

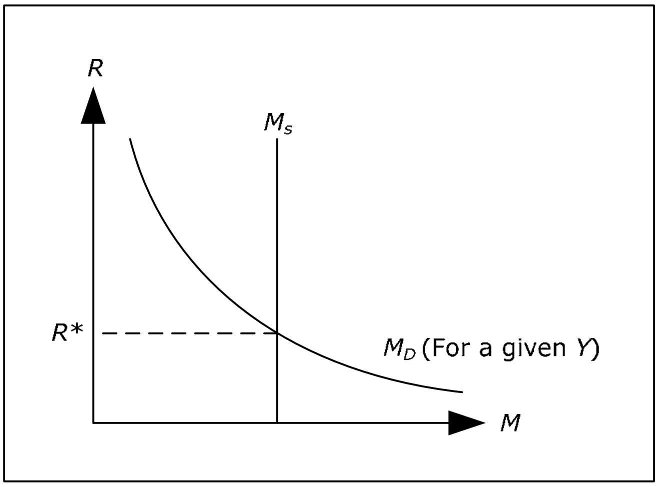


Fig. 12.1

In the diagram above, R^* is the interest rate in which the demand for money is exactly equal to the supply of money (again for a given Y). The IS-LM model, R will always tend to R^* until they are equal and we have an equilibrium in the money market.

The justification for why R will tend to R^* is not entirely straightforward:

- Say that $R < R^*$.
- In this case, $M_D > M_S$, that is, people want to hold more money than what is available.
- People increase the amount of money they hold by selling bonds so there is an excess supply of bonds.
- This excess supply of bonds will drive down the price of bonds.
- When the price of bonds falls, interest rates increase. We discussed this negative relationship between the price of bonds and the interest rate in section 7.2.3.
- The interest rate will increase until $R = R^*$. Only then will the demand for money have decreased enough such there is no longer an excess demand for money. Then there is no excess supply of bonds either. The money market is in equilibrium.
- The case of $R > R^*$ can be analyzed in the same way.

The money market diagram can be used to determine the equilibrium rate of interest *if we know* GDP.

12.4 IS-LM diagram

12.4.1 IS-curve

The IS curve shows all combinations of R and Y where the goods market is in equilibrium. The IS-curve slopes downwards.

The goods market is in equilibrium when $Y_D(Y, R) = Y$. Note that when R is given, the IS-LM simplifies to the cross model:

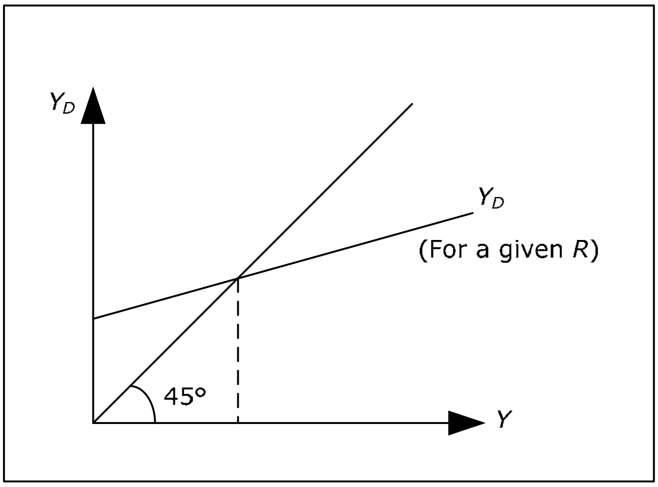


Fig. 12.2

If we know R, we can determine the equilibrium value of Y using the cross model. Also, if we know Y we can determine R from the money market. None of the methods, however, will gives us both R and Y simultaneously.

Consider the following question: What must happen to Y when we change R if we want the goods market to remain in equilibrium? To answer this question, consider two different interest rates, R_1 = 5% and R_2 = 10%. Since Y_D depends negatively on R, $Y_D(Y, R_1)$ will be larger than $Y_D(Y, R_2)$. With a higher R, we must have a lower Y for the goods market to be in equilibrium.

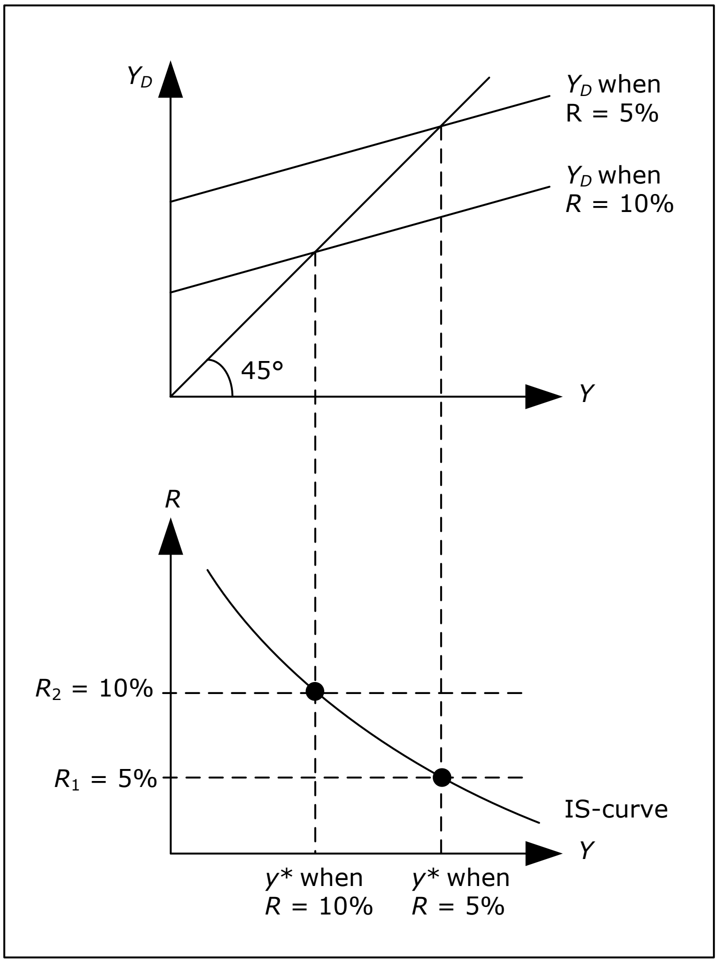


Fig. 12.3

We can illustrate this argument with the above diagram.

1. Start by identifying R_1 and R_1 in the lower graph.
2. Draw aggregate demand for both interest rates – the one corresponding to the lower interest rate will be higher than the other.

3. Identify the resulting GDP in the upper diagram for both interest rates – the highest level of GDP corresponds to the lower interest rate.
4. Extend these levels of GDP to the lower graph. This will give you two points in the lower graph.
5. Continue with other interest rates if you like. The result will be a curve in the lower graph that we call the IS-curve.

The IS curve will identify all combinations of Y and R where $Y_D(Y, R) = Y$, that is, where the goods market is in equilibrium. The economy must be on this curve if the commodity market is to be in equilibrium. However, an analysis of the goods market alone will not help us identify at which point all markets are in equilibrium. Note that the cross model is represented by a single point on the IS-curve – the point corresponding to the exogenously given interest rate. This is why we can determine Y in cross model only from the commodity market.

12.4.2 The LM curve

The LM curve shows all combinations of R and Y, where the money market is in equilibrium. The LM-curve slopes upwards.

The money market is in equilibrium when $M_d(Y, R) = M_s$. In section 12.3.6 we demonstrated how the money market diagram will determine R when we know Y. In this case, the question to consider is the following: What must happen to R when we change the Y if we want the money market to remain in equilibrium?

To answer this question, we try two different values for GDP $Y_1 = 100$ and $Y_1 = 200$. Since the M_D depends positively on Y, $M_D(Y_1, R)$ will be smaller than the $M_D(Y_2, R)$. R must therefore be larger when Y increases for the money market to be in equilibrium.

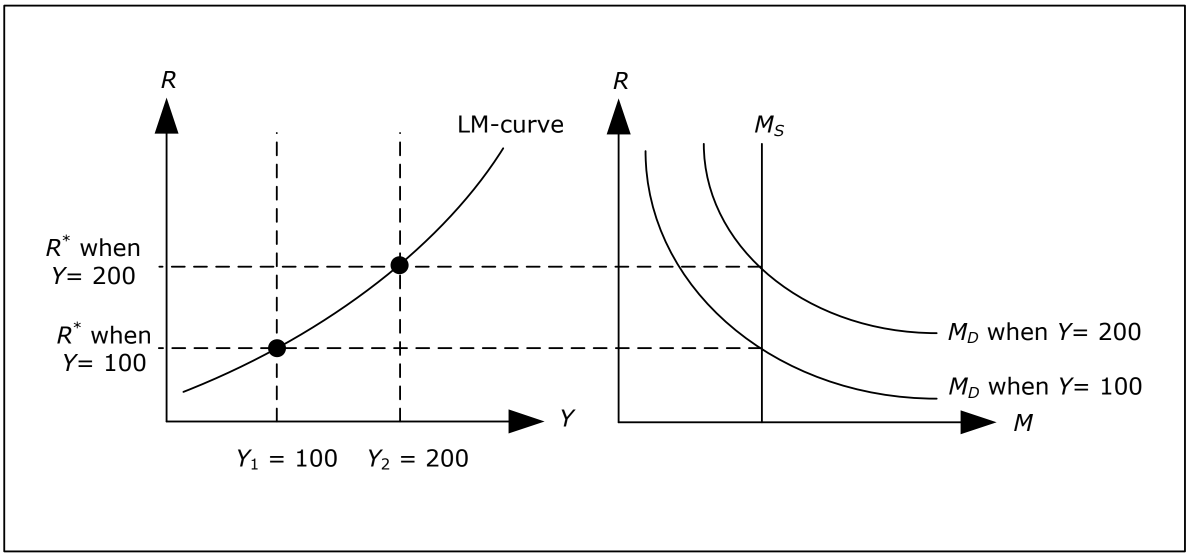


Fig. 12.4 Derivation of the LM-curve.

The diagram above illustrates this point.

1. Start by selecting Y_1 and Y_2 in the left graph ($Y_2 < Y_2$).
2. Draw the money demand for each of the different levels of GDP in the diagram to the right – the one corresponding to the lower value of GDP must be the smallest.
3. Identify the resulting interest rate in the diagram to the right for both levels of GDP – the larger of the interest rates corresponds to the larger value of GDP.
4. Extend these interest rates to diagram on the left. This will give you two points where the money market is in equilibrium.
5. Continue with the other levels of GDP. The result will be a curve in the left diagram that we call the LM-curve.

The LM curve will show you all combinations of Y and R where $M_d(Y, R) = Ms$, that is, where the money market is in equilibrium. Again, the economy must be on the LM curve if the money market is to be in equilibrium and the money market alone cannot determine which point will lead to equilibrium in all markets.

12.4.3 Simultaneous determination of Y and R in the IS-LM model

By combining the IS curve and the LM curve, we can graphically illustrate what interest rate and what level of GDP that will satisfy both equations: $Y_D(Y, R) = Y$ and $M_D(Y, R) = M_S$. For all points on the IS-curve, we have equilibrium in the goods market and for all points on the LM-curve, we have equilibrium in the money market. There is only one point where both markets are in equilibrium, Y^* and R^*.

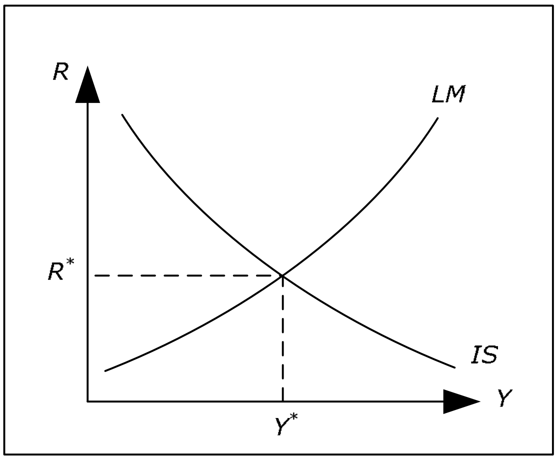


Fig. 12.5: IS-LM model.

According to IS-LM model, the economy will move to Y^* and R^*. The argument is as follows.

1. Imagine that $R > R^*$. It is the not possible to be on both the IS and the LM-curve.
2. Suppose that we are on the IS-curve, but to the left of the LM curve. The interest rate is higher than the equilibrium interest rate and R will fall as discussed in 12.3.6.
3. Suppose that we are on the LM-curve, but to the right of the IS-curve. Y is then higher than the equilibrium value and Y will fall as discussed in 11.3.2. We will then move away from the LM-curve and the interest rates will fall.
4. If we are neither on the IS- nor on the LM-curve, then Y will fall as long as we are to the right of the IS-curve and R will fall as long as we are to the left of the LM-curve.

12.5 The Labor Market

The labor market in the IS-LM model is the same as in the cross model. Therefore, the IS-LM model is only applicable if the profit-maximizing quantity of L would lead to an aggregate supply that was larger than the aggregate demand and aggregate demand will therefore determine L.

Once R and Y is determined, all the endogenous variables are determined. The diagram below shows the determination of Y, R and L in the IS-LM model.

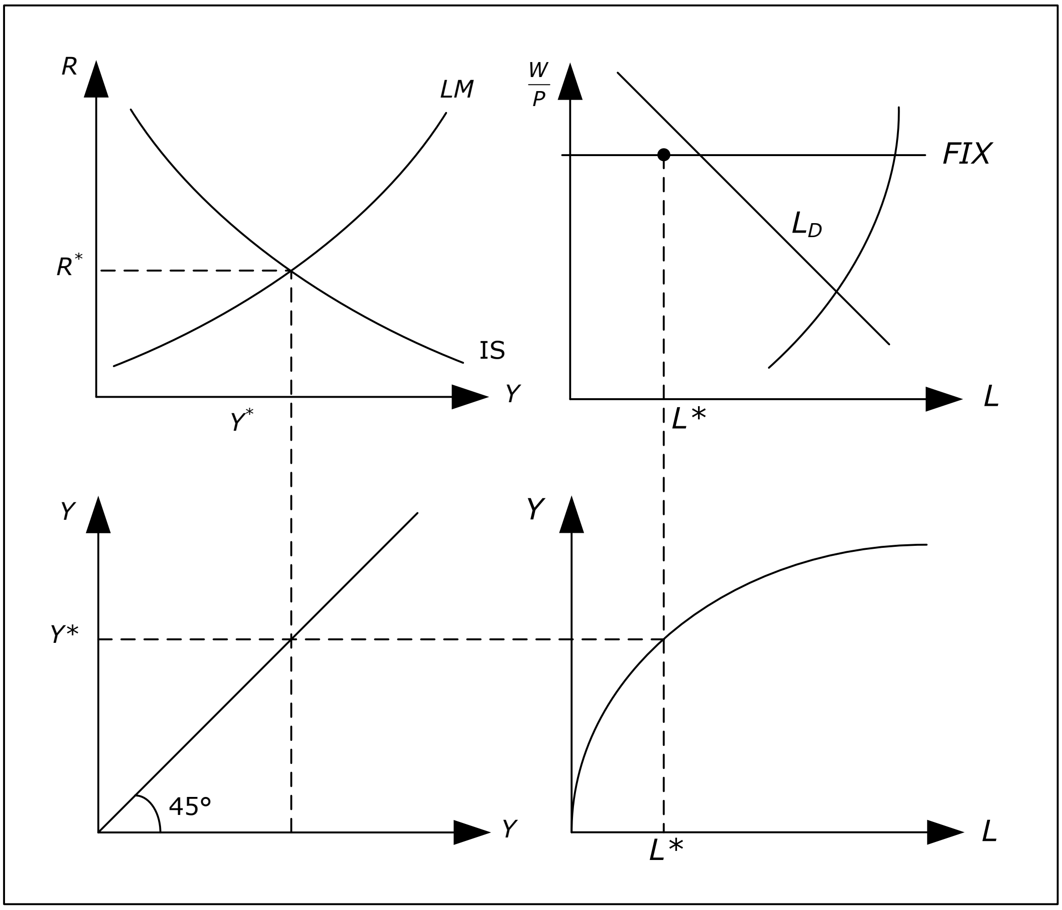


Fig. 12.6: Determination of Y, R and L of the IS-LM model.

We start at top to the left and extend Y^* down, through the "mirror" at the bottom left, on to the production function at the bottom right and then up to the diagram representing the labor market.

The IS-LM is simply an extension of the cross model in the sense that the interest rate becomes an endogenous variable and we will be able to analyze how the interest rate is affected by changes in the economy. We could have developed the IS-LM model directly, skipping the cross model as the cross model adds nothing in relation to the IS-LM model. The reason that most books (including this one) start with cross model is entirely pedagogical. The cross model is much simpler since GDP can be determined from the goods market only as the solution to one equation one equation $Y_d(Y) = Y$. Most students would probably find the IS-LM model even more complicated had they not previously encountered the cross model.

13 The AS-AD-model

13.1 Introduction

13.1.1 The problem with the IS-LM model

The starting point of the AS-AD model is an assumption in the IS-LM model (and in the cross model) that *limits its usefulness*. This is the assumption that if firms where to choose the profit maximizing quantity of L (L_{OPT}), they would produce more than the aggregate demand. In the IS-LM, $Y_{OPT} > Y_D$ must hold as discussed in section 11.4.3.

To realize why this is a problem in the IS-LM model, we gradually increase the aggregate demand by increasing G. We can illustrate the process using figure 12.6 in Section 12.5.

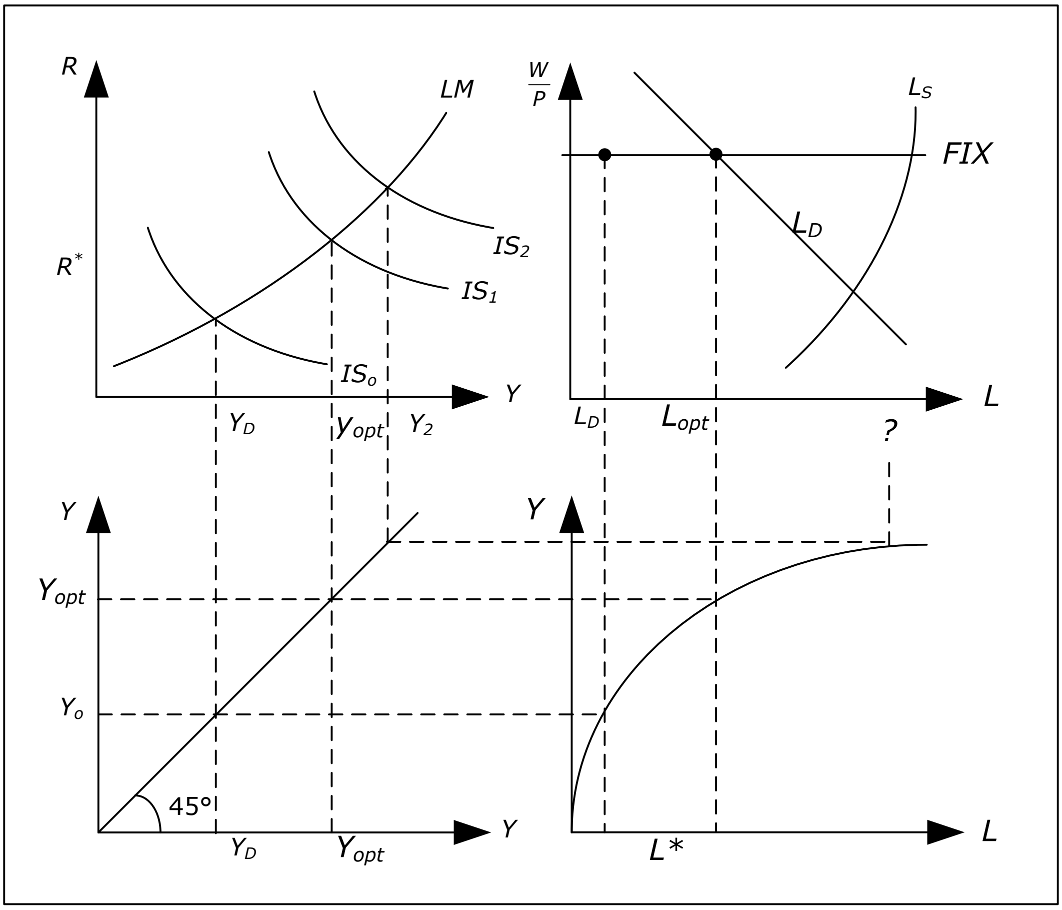


Fig. 13.1: Illustrating the problem in the IS-LM model

1. Let us begin with a given real wage *W*/*P*, an IS curve (IS_0) and an LM curve. In equilibrium, we will have $Y = Y_0$ and $L = L_0$.
2. Now increase *G* so that IS curve shifts outwards from IS_0 to IS_1. In the first step, we increase *G* just enough so that $Y = Y_{OPT}$ in equilibrium, i.e. exactly to the level that firms want to produce at the given real wage.
3. Firms will now want to hire L_{OPT} which is precisely the profit-maximizing quantity of *L*. It is no longer necessary for firms to hire less than the profit maximizing quantity as there is no longer a shortage in aggregate demand. So far, no problems in the IS-LM model.
4. Now imagine that we increase *G* even more so that the IS curve shifts to IS_2 such that so that $Y = Y_2 > Y_{OPT}$. Now the IS-LM model is in trouble.
5. According to the production function, to produce $Y = Y_2$ we need $L = L_2$. *But firms will only hire LOPT if the real wage is constant* (which is assumed in the IS-LM model). *LOPT* is the profit maximizing quantity – to produce more would reduce profits.
6. As firms will not hire more than *LOPT* if real wages are constant, GDP cannot be larger than of *YOPT* in the IS-LM model. This model simply cannot give an answer to what will happen when we increase *G* in step 4 since we would be violating one of the main assumptions of the IS-LM model.

This problem is not limited to changes in G and shifts in the IS-curve. The same problem appears when we change MS and shift the LM-curve. If we shift the LM-curve to the right by an amount such that $Y > Y_{OPT}$, the IS-LM model cannot be used.

The IS-LM model is not "wrong", but *it is applicable only as long as* $Y > Y_{OPT}$. Generally, the IS-LM model will perform reasonable as long as the price level is stable (low inflation) and it will do better in a recession than in a boom.

13.1.2 How the AS-AD model solves the problem

The purpose of the AS-AD model is to extend the IS-LM model so that we can analyze situations where $Y > Y_{OPT}$. To accomplish this, we must make P endogenous in the AS-AD model. When P is endogenous and allowed to vary, real wage W/P may vary even if the nominal wage W is fixed. The AS-AD model, therefore, maintains the assumption of fixed and exogenous nominal wages W. This is consistent with "The General Theory of Employment, Interest and Money" by John Maynard Keynes in which he quite vigorously argue that "wages tend to be sticky in terms of money" while real wages will not be as stable (see chapter 17 in the General Theory).

When P is allowed to increase, real wage W/P may fall and with a lower real wage, labor demand will increase and so will GDP (as long as there is sufficient demand). By making P endogenous, we can allow for Y to be greater than Y_{OPT}.

13.2 The assumptions of the AS-AD model

13.2.1 Summary

The most important change we make going from the IS-LM model to the AS-AD model is to allow P to be endogenous. Since P was constant in the IS-LM model, we must "redo" the IS-LM model allowing P to be endogenous. Here is a summary of the changes that must be made and what will not change:

- Even if P is endogenous, we still assume that the expected inflation is 0. The real interest rate r is therefore still equal to the nominal interest rate R.
- There is no change in the aggregate demand, $Y_D(Y, R) = C(Y) + I(R) + G + X - Im(Y)$. None of the components will be a function of P for given values of Y and R.
- M_D will depend *positively* on P in AS-AD model. In the AS-AD model, the demand for money is given by $M_D(Y, R, P)$. M_D still depends positively on Y and negatively on R.
- Aggregate supply will be more complicated. In the IS-LM model, aggregate supply was simply equal to aggregate demand but this is no longer the case in the AS-AD model.
- Since real wages are no longer constant, we must make a more detailed analysis of the labor market.

13.2.2 The AS-AD model and inflation

Even though the AS-AD permits changes in the price level, *it does not allow for persistent inflation or deflation*. We cannot have continued increases or decreases in the price level if nominal wages are to be constant since this would lead to continued decreases or increases in the real wages which does not make sense (remember that we have removed growth when we do the analysis).

There will of course be periods with inflation/deflation in the model as prices change but inflation/deflation must disappear when the economy reaches a new equilibrium. In the next chapter, we remove the assumption of fixed nominal wages and the model will then allow for persistent inflation.

13.3 The goods and the money market in the AS-AD model

We begin by studying the goods market and the money market when prices are no longer constant. First up is the goods market.

13.3.1 The goods market and aggregate demand

Aggregate demand is not affected by P in the AS-AD model as long as Y and R are held constant

Y_D still depends (positively) on Y and (negatively) on R and we continue to write $Y_D = Y_D(Y, R)$ in the AS-AD model. Let us justify this assumption.

Remember that aggregate demand is the sum of the demand for consumption goods, investments, government consumption and net exports. None of these components will depend on *P* if *Y* and *R* are held constant in the AS-AD model.

- Consumption. Suppose that *P* increases by say 10% while real GDP (*Y*) is constant. Nominal GDP and nominal national will now have increased by 10%. If your income increases by 10% and prices increase by 10%, it is reasonable to assume that your consumption (in nominal terms) will increase by 10% (nothing has changed in real terms). This means that the demand for real consumption *C* is unchanged.
- Investment demand. As long as we keep the nominal interest rate (and thereby the real interest rates) constant, there is no reason for the demand for real investment to change. We would expect nominal investments to increase by the same percentage as the price level.
- Government consumption. *G* is an exogenous real variable and we expect no dependence on *P* by the same argument as for private consumption.
- Exports and imports. This is more difficult to justify due to the exchange rate. Suppose that we have a flexible exchange rate (see Section 8.2.5) and that the price level is constant in the foreign country. Say that *P* increases by 10%. It is reasonable to assume that the exchange rate will then depreciate by 10% (see xxx). The price of domestically produced goods in the foreign market will then be unaffected (in their currency) and so will exports. Due to the depreciation of the exchange rate, the price of imported goods will increase by 10% as well it makes sense to assume that the demand for real imports will not change.

It is important to understand that *P may* affect Y_D *indirectly* in the AS-AD model. *P* does not affect Y_D directly if we keep *Y* and *R* constant. But *P* may very well affect *R* and/or *Y*, and thereby indirectly affect Y_D. In fact, this is exactly what will happen in the AS-AD model as we will describe later.

13.4 The money market

The demand for money depends negatively on R, positively on Y and positively on P in AS-AD model

When *P* is no longer exogenous, we must figure out how M_D is affected by *P* if we keep *Y* and *R* constant. In the AS-Ad model, M_D increases as *P* increases (and vice versa).

Imagine that *P* is increased by 10% while *Y* and *R* are constant. All nominal variables such as nominal GDP, nominal consumption and nominal income will then increase by 10%. This means that you will need to hold more *money* to pay for the increase in consumption. Therefore, the demand for money is denoted by $M_D(Y, R, P)$ in the AS-AD model.

13.4.1 The money market and price changes

The money demand curve will shift to the right (left) in the money market diagram if P increases (decreases).

Money supply is an exogenous variable controlled by the central bank so there is no automatic mechanism that will change M_S when P changes. Remember that the money market diagram shows the supply and the demand for money as functions of R everything else held fixed. Therefore, we can still use the money market diagram in AS-AD model as long as we keep P fixed.

We must now figure out how to analyze changes in P in the money market. To do this, keep P constant at two different levels, $P_1 = 10$ and $P_2 = 20$. We know that M_D depends positively on P and $MD(Y, R, P_2) > MD(Y, R, P_1)$. The demand for money increases when P increases if Y and R do not change.

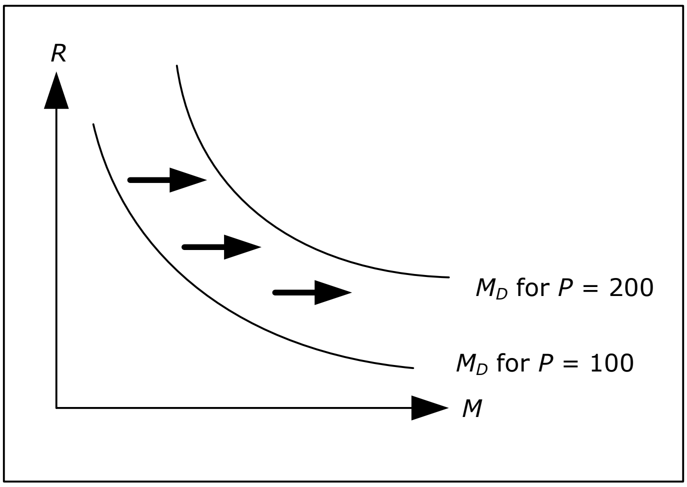


Fig. 13.2: Money market diagram with different prices.

If P increases, the demand for money will increase *for all interest rates*. This means that the demand curve must be shifted outwards to the right when P increases. Note that with a fixed Y and a fixed money supply, if P increases, R must increase for the money market to remain in equilibrium.

13.4.2 The IS-curve in the AS-AD model

The IS-curve is not affected by P in the AS-AD model

We can define an IS-curve in the AS-AD model in exactly the same way as in the IS-LM model: it will give us all combinations of R and Y where the goods market is in equilibrium, that is, where aggregate demand is equal to GDP, $Y_D(Y, R) = Y$.

Since P does not affect any part of the goods market, P will not affect the IS curve. The IS curve in the AS-AD model is exactly the same as IS-curve in the IS-LM model.

13.4.3 The LM-curve in the AS-AD model

The LM-curve will shift upwards (downward) when P is increases (decreases) in the AS-AD model is moved

The LM-curve in the AS-AD model is slightly more complicated as P will affect the demand for money. In the IS-LM model, the LM-curve is defined as all combination of R and Y where the money market is in equilibrium, that is, where the demand for money is equal to the supply of money, $M_D(Y, R) = M_S$.

In the AS-AD model, the LM-curve shows all combinations of R and Y, where the money market is in equilibrium *for a given P*. For a given P, we can still draw the LM curve in the AS-AD model just as we did in the IS-LM model. For a given P, there are different combinations of R and Y where the money market is in equilibrium. *But for another given P*, *another* set of combinations of R and Y will be associated with equilibrium in the money market. *This means that the LM-curve will shift when P changes.*

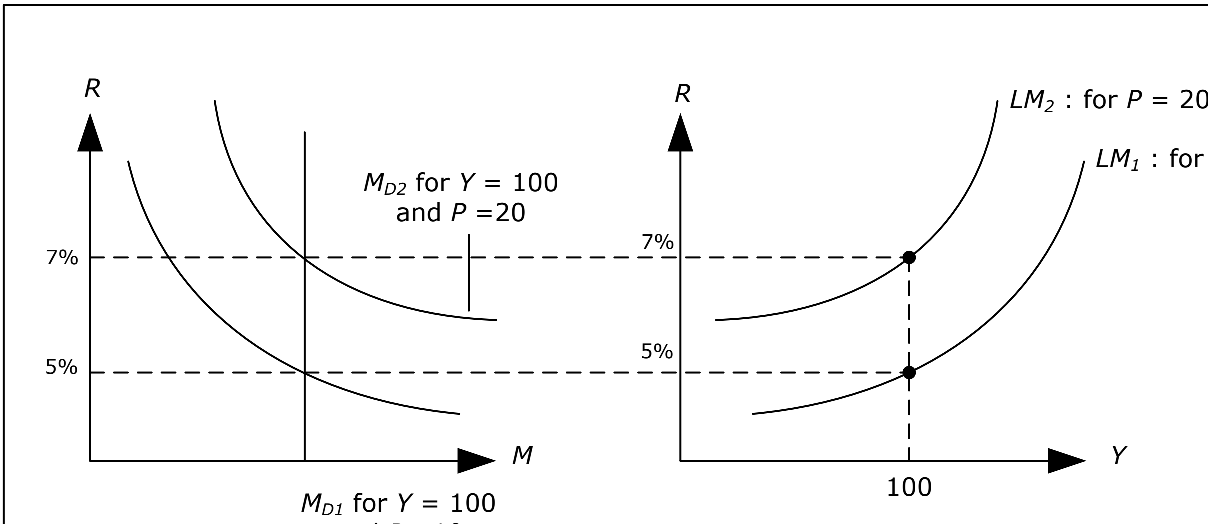


Fig. 13.3: Money market diagram with different prices.

1. First consider the top left figure. The demand curve for money, M_{D1}, is drawn for $Y = 100$ and $P = 10$. The equilibrium interest rate is $R = 5\%$.
2. $Y = 100$ and $R = 5\%$ will provide us with a point on the LM_1 curve to the right.
3. Now suppose that *P* increases to 20. We know that the demand for money will increase and the curve will shift to the right (to M_{D2}).
4. We see that $R = 5\%$ and $Y = 100$ *is no longer an equilibrium* in the money market.
5. To the left you see that $R = 7\%$ will be an equilibrium when $Y = 100$ for $P = 20$.
6. $R = 7\%$ and $Y = 100$ must be on a new LM curve (LM_2) associated with the higher price $P = 20$.

There is an LM curve for $P = 10$ (LM_1) and an LM curve for $P = 20$ (LM_2). The important thing to remember is that in the AS-AD model, there is one LM-curve for each value of *P*. *When P increases, the LM curve will shift to a new curve which will be above the old one*. The reason, again, is that *R* must increase when *P* increases to keep the money market in equilibrium.

13.4.4 Equilibrium in both the goods and in the money market

If both the goods – and the money markets are to be in equilibrium…
…if P increases, Y must fall and R increase …
…if P decreases, Y must increase and R fall

For a given P, we can use the IS and the LM curves to find the equilibrium values of interest rate and GDP. However, we can also figure out how the equilibrium values of *R* and *Y* depend on P.

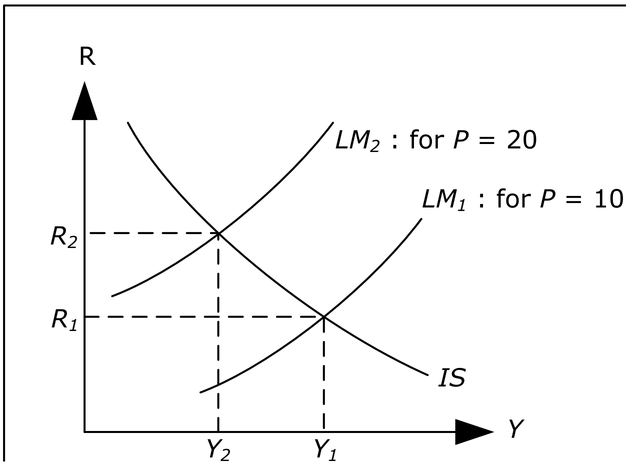


Fig. 13.4: How *P* affects the equilibrium in the goods and money market.

LM_1 is the LM curve when $P = 10$, while LM_2 is the LM curve when $P = 20$. LM_2 is above LM_1 as explained in the previous section. If Y_1 and R_1 are the equilibrium values when $P = 10$ and Y_2 and R_2 are the equilibrium value when $P = 20$, *we see that* $Y_2 < Y_1$ *and that* $R_2 > R_1$.

We may draw the following conclusion. *When prices increase, GDP must fall and interest rates must increase if both the goods and the money market is to be in equilibrium*. The economic intuition is something like this

1. When P increases, the demand for money increases
2. When M_D increases, the interest rate increases
3. When R increases, investments fall
4. When I falls, GDP falls

Of less importance is the following point: when GDP falls in step 4, M_D will fall slightly – although not as much as it increased in step 1. Therefore, the interest rate will decline somewhat compared to the level in step 2.

More importantly, *we no longer have a unique equilibrium from the money market and the goods market*. Since there is a unique LM curve for each value of P, there is an equilibrium (in both markets) for each value of P.

13.4.5 The AD curve

The AD curve shows all combinations of P and Y where the goods and the money markets are both in equilibrium. The AD curve slopes downwards.

From the section above, we know that Y must fall if P increases if we want both markets to remain in equilibrium. In this section we derive the exact relationship between Y and P when both markets are in equilibrium.

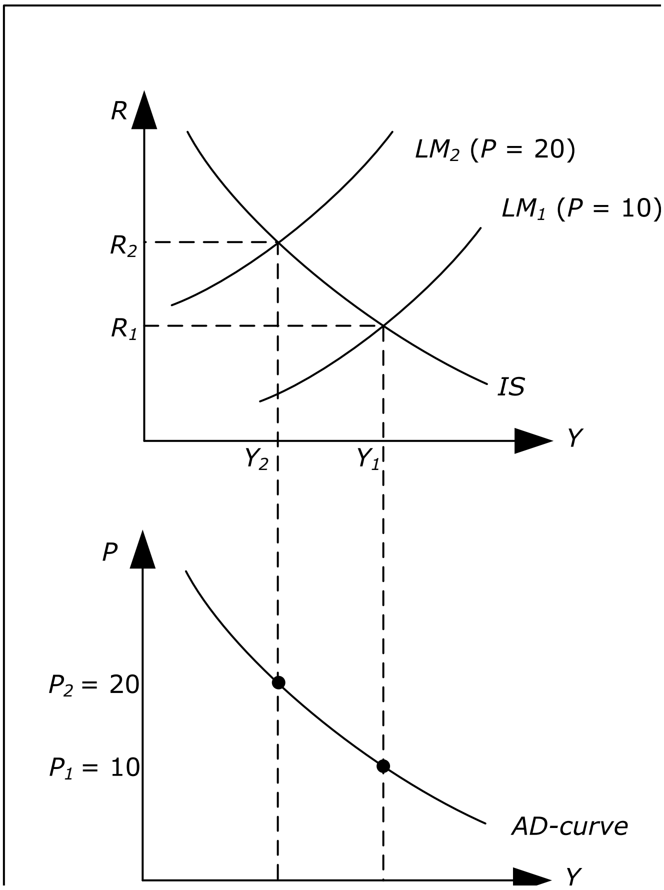


Fig. 13.5: Derivation of the AD curve.

We can illustrate our derivation using the diagram above.

1. First select $P_1 = 10$ and $P_2 = 20$ in the lower diagram.
2. Draw the IS curve in the upper diagram and two LM curves – the one corresponding to $P = 20$ must be above the one for $P = 10$.
3. Identify the resulting GDP in the upper graph for both prices – the highest level of GDP is associated with the lower of the prices.
4. Extend these levels of GDP to the lower graph. This will result in two points in the lower graph.
5. Keep on doing this with other prices. The resulting downward sloping curve in the lower graph is called the AD-curve.

Keep in mind that both the goods market and the money market is in equilibrium at all points on the AD curve. Therefore, the AD-curve alone cannot identify to which point the economy will move.

13.4.6 The AD curve is the aggregate demand

The AD curve is the aggregate demand as a function of P when the goods and money market are both in equilibrium

The AD curve shows not only the equilibrium combinations of P and Y – it also shows the *aggregated demand as a function of P when both markets are in equilibrium*. This follows from the equilibrium condition in the goods market which requires aggregate demand to be equal to GDP. When we change P, the AD curve will tell us the response of Y and therefore also the response of Y_D. You may therefore use the AD curve to find the aggregate demand for different prices under the condition that both markets are in equilibrium.

Initially, this may seem like a contradiction. In section 12.2.3, we claimed that the only endogenous variables that affect aggregate demand where R and Y. Specifically, we stated that P does not affect Y_D as long as we kept the R and Y fixed.

- If we start in equilibrium and change P but keep R and Y constant, Y_D will *not* change but we will *not longer be in equilibrium in the money market*.
- If we require both markets to be in equilibrium, R and Y must change when P changes.
- Specifically, R must fall and Y must increase when P decreases if both markets are to be in equilibrium.
- Since Y_D depends positively on Y and negatively on R, Y_D will then increase.
- Thus, Y_D increases when P falls when both markets remain in equilibrium and there is no contradiction.

13.5 Aggregate supply

In order to determine all the variables in the AS-AD model, we need one more equilibrium condition so that we can identify a unique point on the AD curve as the unique equilibrium. This condition will come from the production side and the labor market.

13.5.1 The Labor Market

In the AS-AD model, the economy will always be on the ***response curve*** – the thick line in the chart below.

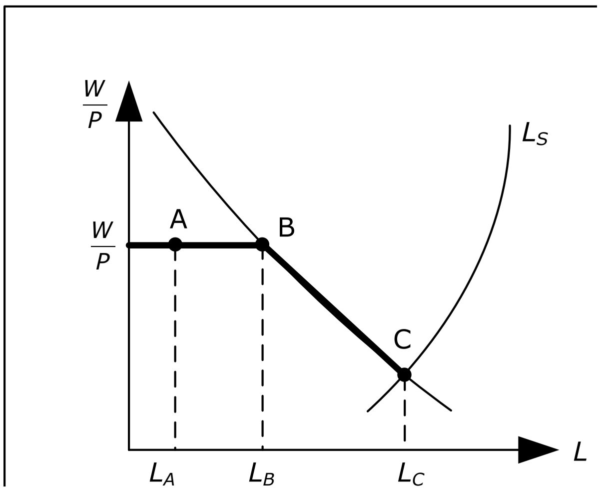


Fig. 13.6: The labor in the AS-AD model.

The response curve has a horizontal part and a downward sloping part. In the IS-LM model, we had only the horizontal since real wages where constant. We could not move beyond L_B.

We can explain the response curve by examining the economy moving from point A to point C.

- First, the economy is at point A, with prices P, wages W, real wages W/P and amount of labor L_A. The profit-maximizing quantity of labor is L_B but firms do not choose this quantity due to lack of demand.
- If aggregate demand increases, L may increase without P being affected, up to $L = L_B$. To the left of point B, the IS-LM model is fully sufficient and the AS-AD model is redundant.
- When $L = L_B$, L cannot increase without real wages falling. In the AS-AD model, real wages are reduced by an increase in P (with W constant) and we begin to move down the demand curve for labor.
- Between the points B and C, L will increase when P increases.
- However, we cannot increase L above L_C. When we are at point C, not even a price increase will help. Real wages are no so low that the *labor supply* sets the limit – there are no more people that want to work for these low real wages.

Let us summarize:

- As long as *L* is smaller than *LB*, *L* may change with no change in prices. In this range, there is no relation between *P* and *L*.
- When *L* is between *LB* and *LC*, then *L* increases with *P*.
- *L* can never be greater than the *LC*.

The chart below shows the relationship between L and P

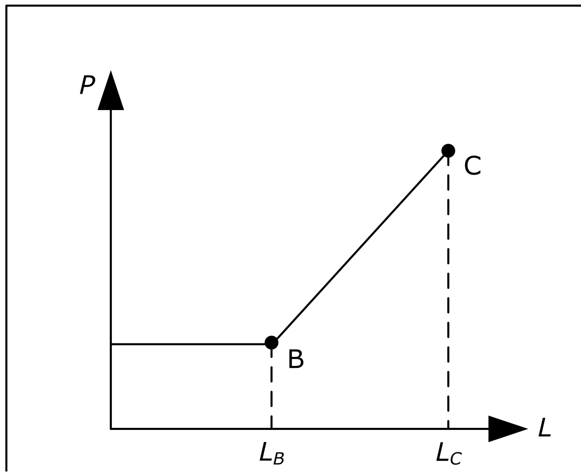


Fig. 13.7: The relationship between *L* and *P*.

13.5.2 Aggregate supply and the AS curve

> *The AS curve is the aggregate supply as a function of P. It is horizontal when the supply is low and upward sloping when the supply is high.*

From the relationship between *L* and *P* we can derive the relationship between *YS* and *P* as *YS* is determined by *L* by the production function (the higher *L*, the higher the the).

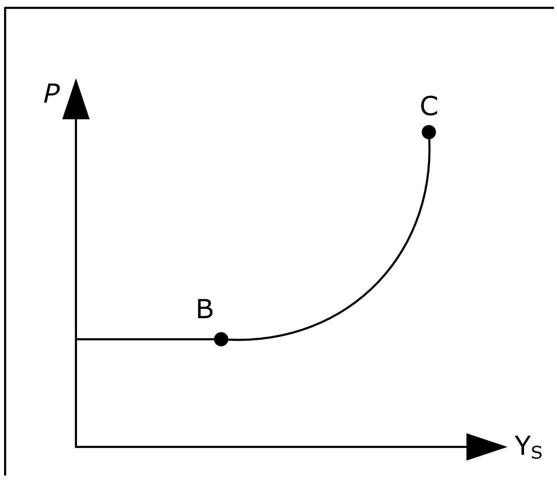


Fig. 13.8: The relationship between *YS* and *P*.

Between points A and B prices are constant and firms produce an amount exactly equal to the aggregate demand. Here, the reversed Say's Law and the IS-LM model apply. In this interval, the AS-AD model is redundant. Between points B and C we have a positive relation between P and Y_S. Neither the reversed Say's Law nor the IS-LM model apply.

It is, however, unreasonable to believe that there would be a "sharp edge" in the relationship between L and P and between YS and P in the real economy. The schedules are drawn this way to simplify the explanation. A more reasonable assumption would be that the relationships are smooth curves.

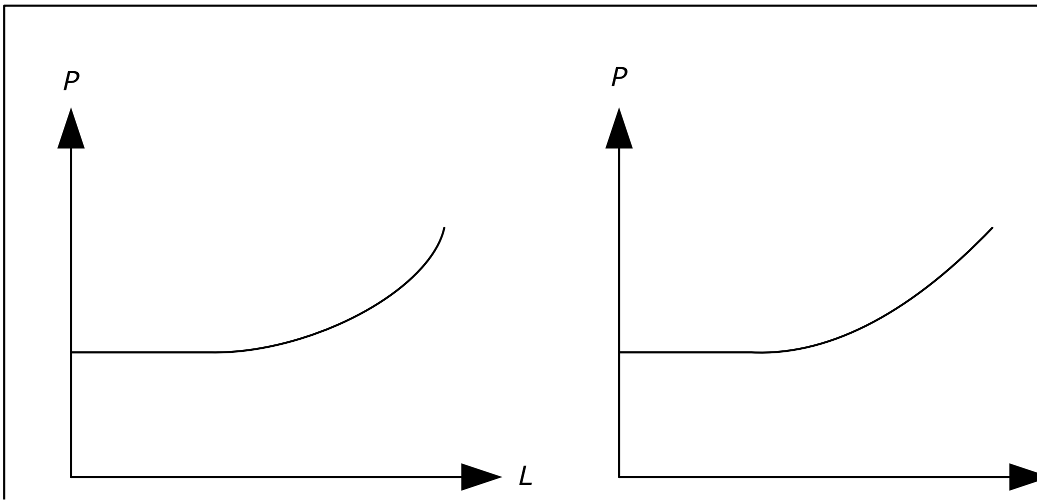


Fig. 13.9: More realistic relationships between *L* and *P* and between Y_S and *P*.

13.6 Determination of all the endogenous variables in the AS-AD model

13.6.1 Determination of *P* and *Y*

Prices and GDP are in equilibrium when aggregate supply is equal to the aggregate demand in the AS-AD model

We know that for all points on the AD curve, both the goods and money market are in equilibrium. We also know that firms will always produce an amount consistent with the AS-curve.

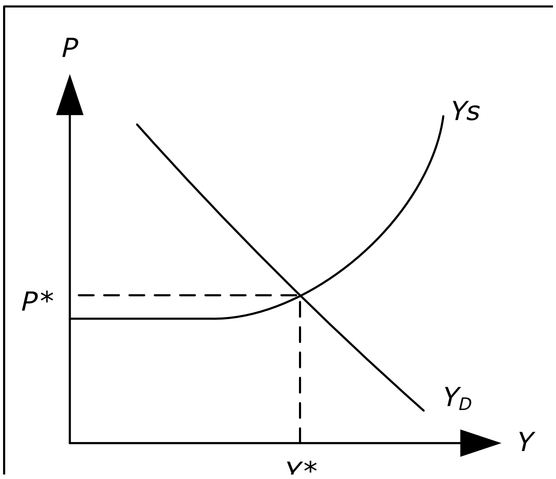


Fig. 13.10: Determination of *P* and *Y* in the AS-AD model.

There is only one level for *P* and for *Y* which is consistent with equilibrium in both markets and which is consistent with firm behavior. The price level at this point is the equilibrium price level and the GDP level at this point is the equilibrium quantity of GDP. We denote these levels by *P** and *Y**.

The AS-AD model, P will always move towards P^* and Y will always move towards Y^*. To justify this behavior of the economy, let us consider what will happen if $P < P^*$.

1. From the graph, we see that in this case $Y_S < Y_D$.
2. Since we are on the upward sloping part of the AS-curve, aggregate supply will not automatically increase. But since firms can sell everything they produce and since stocks are diminishing, they will raise prices.
3. When P increases, real wages W/P falls and L increases. With more labor, firms can increase production.
4. When P increases, the demand for money will increase. Interest rates will then increase and YD will fall (the LM-curve shifts upwards).
5. Overall, YS increases and YD falls when P increases. As long $Y_S < Y_D$, firms will continue to raise prices. Thus, prices will continue to increase until $Y_S = Y_D$ and the economy is in equilibrium.

13.6.2 Determination of other variables

Once P and Y are determined, all other endogenous variables will be determined as well. The interest rate is determined by money market diagram and the components of GDP are either exogenous or they depend on R or Y. W is constant and since P is determined, so is the real wage. Then L and the unemployment rate is determined as well.

Note that although this diagram is looks exactly like the "standard supply and demand curves" for a single good from microeconomics, the derivation and interpretation is very different.

13.6.3 The equations of the AS-AD model

To summarize the AS-AD model, we can look at its equations. The IS-LM model was "solved" by simultaneously solving the equations

$$Y_D(Y, R) = Y$$
$$M_D(Y, R) = M_S$$

for Y and R. Since M_S was exogenous, we had two equations and two unknown and the system of equation could be solved. The solution was illustrated by the IS-LM diagram.

In the AS-AD model, the situation is slightly more complicated because MD now depends on *three* variables: Y, R and P. We can no longer solve

$$Y_D(Y, R) = Y$$
$$M_D(Y, R, P) = M_S$$

for Y, R and P as we have three unknowns and only two equations. We need an additional equation in the AS-AD model. The third equation in the AS-AD model comes from the production function and the labor market. We showed that L depends on P and since Y_S depends on L, Y_S will depend on P. Equilibrium requires that their supply equals actual production, i.e., $Y_S(P) = Y$. The three equations of the AS-AD model are therefore

$$Y_D(Y, R) = Y$$
$$M_D(Y, R, P) = M_S$$
$$Y_S(P) = Y$$

These are to be solved for Y, R and P. The solution is illustrated in the AS-AD diagram, where the first two equations are summarized in the AD curve $Y_D(P) = Y$.

Note how the three different versions of the Keynesian model we have studied so far are related to the number of variables/equations.

- In the *cross model*, we have only one variable (Y) and an equation: $Y_D(Y) = Y$.
- In the *IS-LM model*, we have two variables (Y and R) and two equations: $Y_D(Y, R) = Y$ and $MD(Y, R, P) = M_S$.
- In the *AS-AD model*, we have three variables (Y, R, P) and three equations: $Y_D(Y, R) = Y$, $M_D(Y, R, P) = M_S$ och $Y_S(P) = Y$.

14 The complete Keynesian model

14.1 Introduction

14.1.1 Wage inflation

In this chapter, we will continue to develop the Keynesian model removing the assumption of fixed nominal wages. We define *wage inflation* π_w as the percentage average increase in wages. Wages and wage inflation are still *exogenous*, i.e. they are not determined within the model. One justification for this assumption is that wages often are determined by agreements which often last for several years.

We do not need a new model to deal with inflation. Non-constant wages can be handled within all three Keynesian models as long as they are exogenous. The reason we chose to let wages be constant in the previous Keynesian models were entirely pedagogical – these models are easier to understand when wages are constant.

14.1.2 Price Inflation

The main reason for allowing for non-constant wages in the model is that we then can allow for persistent inflation/deflation. With constant wages, we cannot have persistent inflation as real wages would go to zero.

Neutral inflation is defined as a situation where wage inflation is equal to inflation (in prices). With neutral inflation, the real wages are constant. The Keynesian model does not require neutral inflation and real wages may vary over time. However, we cannot have an inflation which is always greater than or always smaller than wage inflation as real wages again would go to zero or infinity (again, remember that growth has been removed so we expect no upward trend in real wages). However, a few adjustments must be made in the models when we have inflation.

14.2 Adjustments to the Keynesian models when wages are no longer constant

14.2.1 Real interest rates, nominal interest rate and expected inflation

When we have inflation, we cannot, of course, assume that expected inflation is zero. Therefore, real interest rate will no longer be equal to the nominal interest rate and we must use $R = r + \pi^e$. In this chapter, expected inflation π^e is *exogenous* (although not necessarily constant. In more advanced Keynesian models you will find various assumptions on how expectations are formed.

14.2.2 Aggregate demand with inflation

In previous versions of the Keynesian model, none of the components of aggregate demand depended on P. In the IS-LM and in the AS-AD models, investments depended on the nominal interest rate R. We argued that investment *actually* depends on the real interest rate r, but since $R = r$ when $\pi^e = 0$, we could make it a function of R.

When π^e no longer is zero and the real interest rate $r = R - \pi^e$, we should write $I(r)$ or $I(R - \pi^e)$. We should also write $Y_D(Y, r)$ or $Y_D(Y, R - \pi^e)$. Since inflation expectations are exogenous (given), it is still the case that Y_D depends negatively on R. Note that if there is an equal increase in expected inflation and in nominal interest rate, real interest rate is unaffected and so is investments and aggregate demand.

14.2.3 The IS curve with inflation

We can draw the IS curve for a given value of π^e. As previously explained, the IS curve is not affected by changes in P. However, it will shift upwards when π^e increases.

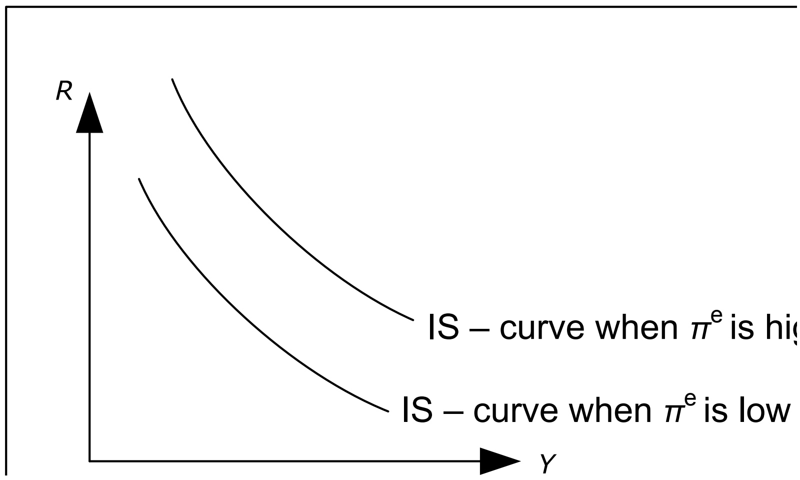


Fig. 14.1: The IS curve and expected inflation.

If π^e increases, R must increase by the same amount to keep r and Y_D unaltered.

14.2.4 The money market with inflation

Let us begin with the money market diagram in 12.3.6 and introduce inflation. Since the M_D depends positively on P, the M_D curve to "glide" out towards the right when inflation is positive and toward the left when we have deflation.

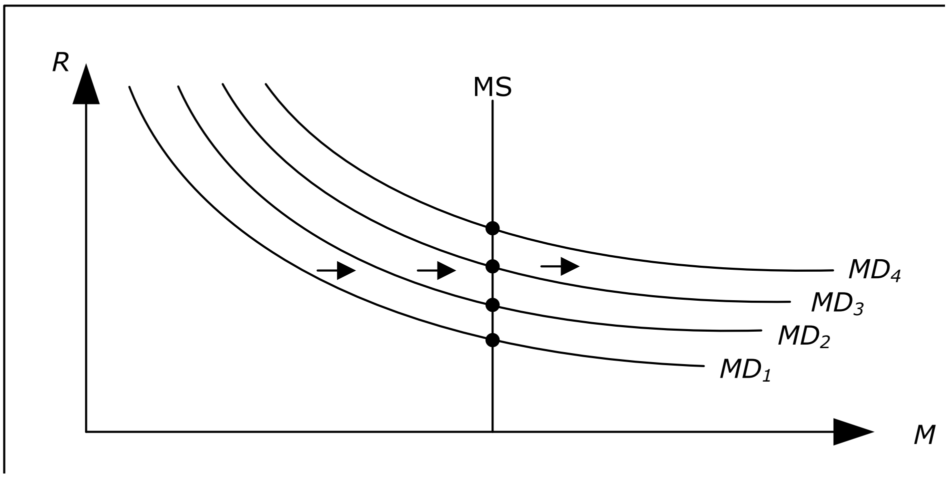


Fig. 14.2: The money market with inflation and constant money supply.

If money supply is constant, nominal interest rate will continuously increase when we have inflation and continuously decrease when we have deflation.

An interesting special case is when *money supply increases by the same rate as P*. In this case, the money supply curve will also glide outwards or inwards (depending on whether we have inflation or deflation) at exactly the same rate as the money demand. *The nominal interest rate will then be constant*.

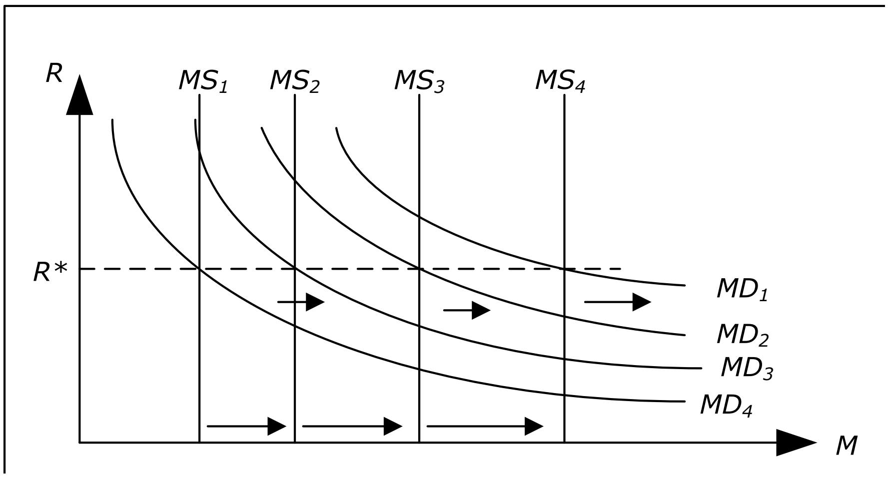


Fig. 14.3: The money market with inflation and rising money supply.

If we let π_M denote the growth rate in money supply, we can conclude the following. For a given Y, R will increase if $\pi > \pi_M$ (prices increase faster than the money supply) and R will fall if $\pi_M > \pi$. R is unchanged if $\pi = \pi_M$.

For example, when $\pi > \pi_M$, the M_D curve glides out to the right faster than M_S curve which is why R increases.

14.2.5 The LM curve with inflation

In the previous chapter we found that the LM curve will shift upwards when *P* increases (assuming *MS* is constant). This is still true but we can also add that the LM curve *glides* upwards if $\pi > \pi_M$ (as *R* increases) and the LM curve glides downwards if $\pi_M > \pi$.

The previous result is a special case of this result. If *P* increases, then $\pi > 0$ and if M_S is constant then $\pi_M = 0$ and the LM curve glides upwards. Earlier, we only considered cases when *P* jumped (from say 100 to 120). This translates into having inflation for a short period, an LM curve that glides upwards and when *P* reaches 120, inflation cease and the LM curve will stop moving.

14.3 The IS-LM model with inflation

14.3.1 The basic assumption

In Chapter 12, we developed the IS-LM model with constant wages and prices. We can now extend this model to allow for inflation. Instead of constant wages and prices, we must assume that $\pi = \pi_W = \pi^e$. In the same that we dropped the assumption of constant *P* when we went on to the AS-AD model to allow for changes in real wages, we will drop the assumption that $\pi = \pi_W$ in section 1.4 to allow for inflation and changing real wages.

Let us briefly justify the assumption $\pi = \pi_W = \pi^e$. $\pi_W = \pi^e$ may be explained by realizing that if workers expect 6% inflation, they will demand 6% wage increases to maintain the same real wage (they usually require more than 6% and an increase in real wages, but this is because the growth of the economy will allow for this – always think of these models as if there is no growth).

The assumption $\pi = \pi_W$ means that we have a balanced inflation. As in the IS-LM model, the real wage is then constant. This is a reasonable assumption if the economy is in a state where aggregate demand is insufficient and L is lower than the profit-maximizing level.

14.3.2 Results

If $\pi_M = \pi$ and $\pi^e = \pi$, both the IS- and the LM-curve will be fixed.

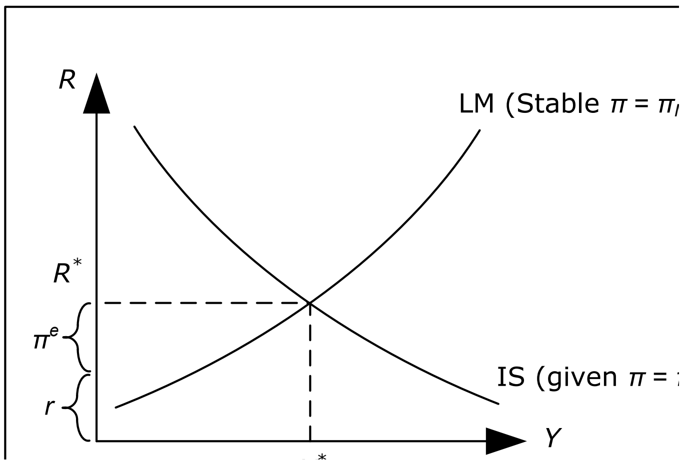


Fig. 14.4: The money market with inflation and constant money supply growth.

It is then possible to determine R^* and Y^* exactly as we did in chapter 12. We can also determine the real interest rate as $r = R - \pi^e$ and π^e is given. All variables are now determined. Since π and π_W are exogenous, P and W are given over time (as long as we know P and W at one point in time). L is determined exactly as chapter 12 and we do not allow L to exceed L_{OPT} as this would require a drop in real wages $\pi > \pi_W$ at least for a while.

If, for example $\pi_M < \pi$, the LM curve will glide upwards, R (and r) will increase while Y will fall. In a model with inflation, we typically consider changes in the *growth* of the money supply, π_M, rather than changes in the in the money supply itself when we discuss monetary policy.

14.4 The AS-AD model with inflation

In chapter 13 we removed the assumption of constant prices to allow varying real wages. The resulting model was called the AS-AD model. In the same way, we now remove the assumption that $\pi = \pi_W$ (but remember the discussion in 14.1.2 – π may only deviate from π_W temporarily and they must be equal on the average).

14.4.1 The AD-curve at a given point in time

The AD-curve, just like before, displays combinations of P and Y where both the money market and the goods market are in equilibrium. *At any given time, even when we have inflation, aggregate demand will as before depend negatively on P*. The explanation, as follows, is little more involved.

Say that the price level one year ago was 100 and that P is the price level today. Then $\pi = (P - 100)/100$ is the rate of inflation during the previous year and $P = (1 + \pi)\cdot 100$ today. For example, if π is 10%, we have $P = (1 + 0.1)\cdot 100 = 110$ today. *Given* the price level in the previous year, we have a positive relationship between P and π.

Given price level last year, there is a price level today which would make inflation exactly the same as the growth rate in money supply over the last year. For example, say that π_M was 4% in the previous year and P was 100 a year ago, then if $P = 104$ today we have $\pi = \pi_M$, the IS- and LM-curves are stable and we can find the level of GDP which gives the equilibrium in both markets by finding the point where they intersect.

Now, to show that the AD curve slopes downwards, we must show that if $P > 104$, a lower level of GDP will result in simultaneous equilibrium. To see this, simply note that for $P > 104$, the inflation has been a little higher and the LM curve will be a little higher up resulting in a lower level of GDP. A similar argument shows that GDP must be higher if $P < 104$ for both markets to remain in equilibrium.

Thus, at a given point in time, given the price level last year, aggregate demand will still depend negatively on P and the AD curve will slope downwards.

14.4.2 The AD curve over time

With inflation, the AD curve will no longer be stable over time. Instead, it will *glide upwards or downwards at a rate determined by the growth rate of the money supply* π_M. Let us look at the case $\pi_M = 10\%$.

If AD_1 is AD curve in year 1, AD_1 will show us all combinations of P and Y where both markets are in equilibrium in year 1. For example, both markets are equilibrium at point A where $P = 100$ and $Y = 10$.

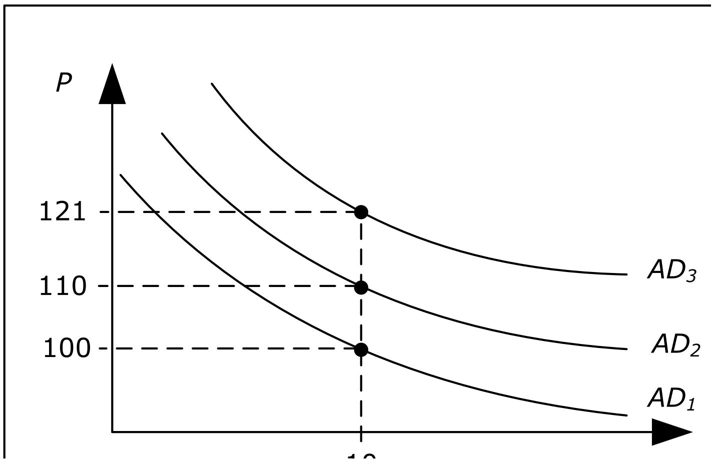


Fig. 14.5:AD curve glides if $\pi_M \neq 0$.

In year 2, the money supply is higher – it has increased by just 10%. *If P* had increased by 10%, then this new value of *P* together with the level of GDP we had last year would still give us equilibrium in both markets. Inflation has then been 10% and none of the IS or LM curves have shifted.

In year 2, $P = 110$ and $Y = 10$ must be on AD_2. In year 3, by the same arguments, $P = 110 \cdot 1.1 = 121$ and $Y = 10$ must be on the AD_3 and we see that the AD curve glides upwards by 10% per year – exactly the same rate as the growth in the money supply.

We must remember that if $\pi_M \neq 0$, then the AD curve is applicable only for a given point in time. At another point in time, we must draw a different AD-curve. The rate at which the AD curve glides is equal to π_M – if π_M is high, a higher inflation is necessary if the same level of GDP is to lead to equilibrium in both markets.

Even though π_M determines the evolution of the AD curve over time, there are still many combinations of *P* and *Y* leading to equilibrium in the goods- and money market (all points on the AD curve at precisely the given point in time). Only one point will be an equilibrium point for the entire economy and, as before, the AS curve will help us to find this point.

14.4.3 The Labor Market

Remember the model of labor market in the AS-AD model with constant wages. On the y-axis, we had real wage and on the x-axis, we had *L* (see Figure 13.6). The response curve had two parts, a horizontal part and a downward sloping part. On the horizontal part, prices where constant and *L* was determined by the aggregate demand. Real wages in this part of the response curve may be denoted by $(W/P)_{MAX}$ as real wages can never be higher than this level. On the downward sloping part of the response curve, *P* is no longer constant and *L* is determined by *P*. On this part of the curve, the real wage is lower than $(W/P)_{MAX}$. We also concluded that the real response curve is a smooth version of this one.

With inflation, *the reaction curve will not change*. The reason for this is that we have *real wages* on the y-axis. If wages increase by 10% while prices increase by 10%, real wage will not change.

In our model of the labor market with inflation, there is still a maximum real wage $(W/P)_{MAX}$. As long as we are to the left of point B, there is no reason for firms to change the growth rate of prices (which is given by $\pi = \pi_W$) and the real wage will remain constant. In order to induce firms to go past the L_B, real wages must fall below $(W/P)_{MAX}$ which means that prices must increase faster than wages: $\pi > \pi_W$.

However, we must be careful with the notation:

- With no inflation, we said that said prices were constant on the horizontal part. With inflation, we must say that we have *neutral inflation* ($\pi = \pi_w$) on the horizontal part.
- With no inflation, we said prices increase as *L* increase on the downward sloping part. With inflation, we must say that *prices increase faster than wages* as *L* increase on this part.

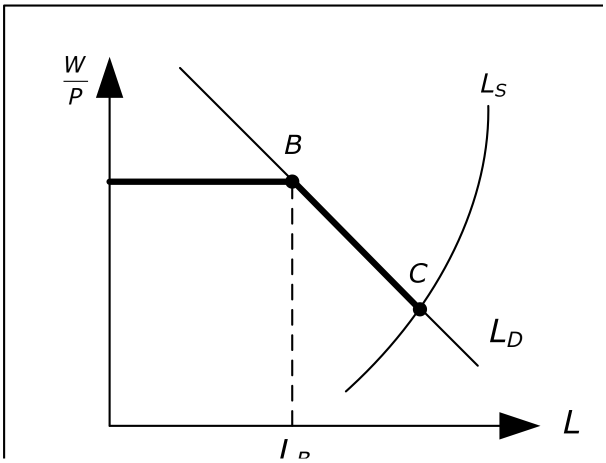


Fig. 14.6: The labor market with inflation.

14.4.4 The AS curve

Say that the nominal wage in year 1 (at a particular point in time) is equal to 1000. On the horizontal part of the response curve, real wage is constant and equal to its maximum value. Say that $(W/P)_{MAX} = 10$. On the horizontal part, $P_1 = 100$, where P_1 is the price level in year 1. Firms will employ at most *LB* at this real wage. For firms to hire more than *LB*, P_1 must be higher than 10. We realize that the AS curve at this point in time, AS_1, will look like before. First, it is horizontal along $P = 10$, then, for higher *Y*. it is upward sloping.

Suppose that π_W is equal to 10%. Next year, nominal wages will be equal to 1100. Wages in year 2 are determined by π_W which is an exogenous variable, making wages in year 2 exogenous. As the maximum real wage is given and equal to 10, we conclude that P_2 is equal 110 on the horizontal part of the response curve and that $P_2 > 110$ on the downward sloping part. AS_2 *glides upwards* up by 10% as given by the wages inflation. Using the same argument, $P_3 = 121$ on the horizontal part of the response curve at year 3 and so on.

Just like the AD curve, the AS curve is to glide upwards or downwards depending on whether $\pi_w > 0$ or $\pi_w < 0$ when we allow for inflation. As for the AD curve, the AS curve is applicable only at a particular point in time if $\pi_W \neq 0$. At another point in time, we must draw a new AS curve.

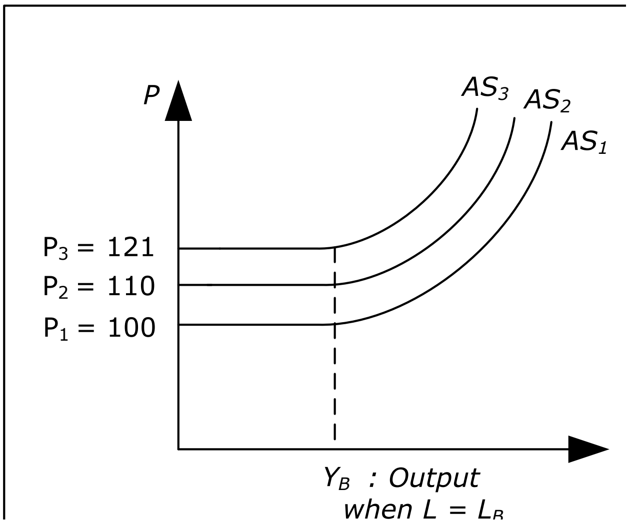


Fig. 14.7: AS curve gliding if $\pi_W \neq 0$.

14.4.5 The AS-AD model with inflation

When we have inflation, both the AD curve and the AS curve will be gliding. "The glide rate" of the AD curve is given by π_M while it is π_W which applies to the AS curve (where both rates are exogenous). Using the AS-AD curves, we can determine the equilibrium price P (and thus π) at any point in time and we can determine all endogenous variables. For example, we realize that if $\pi_M = \pi_w$, both curves glide at exactly the same rate. Y will then be unchanged and π will be equal to π_w.

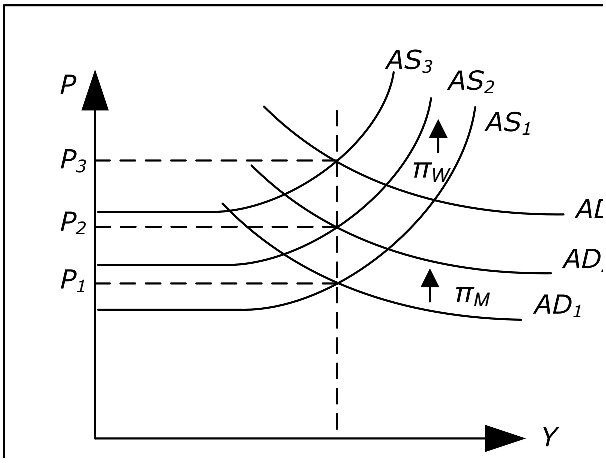


Fig. 14.8: Determination of *Y* and *P* in the AS-AD model with inflation.

14.5 The Phillips curve

14.5.1 The problem with the Keynesian model

We can identify two problems with the Keynesian model as developed so far:

1. π_W is exogenous. Even though inflation may temporarily deviate from the wage inflation, this deviation cannot be too large and it cannot last for too long (as real wages would become unreasonable low or unreasonable high). This model has no determination of π_W and therefore no complete determination of π. A model that predicts an inflation of around 6% by *assuming* a wage inflation of 6% is not very useful. The Keynesian model with inflation is therefore incomplete.
2. It is quite unreasonable to assume that π_W would be independent of *Y*. More reasonable would be to model π_W as a positive function of *Y*. If we are in a boom, *L* will be above its average and unemployment below its average. In such a situation, it is reasonable to expect wage inflation to increase.

To solve these problems, we need to make π_w *endogenous*. We do this by to the Keynesian model adding the *Phillips curve*.

14.5.2 The Phillips curve

According to the traditional Phillips curve, there is a *negative and stable relationship between wage inflation and unemployment.*

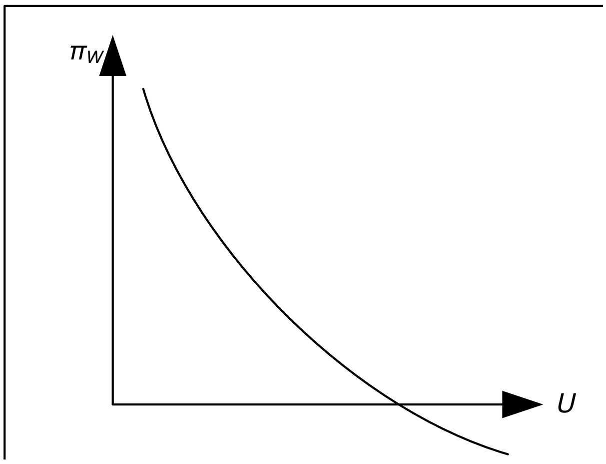


Fig. 14.9: The Phillips curve.

The Phillips curve is often drawn with π instead of π_W on the y-axis, but since these variables may deviate only temporarily, the difference is small. The Keynesian model plus the Phillips curve provides us with a full determination of all variables.

Some comments on the Phillips curve

- The Phillips curve was initially an *empirical relationship* between wage inflation and unemployment that was observed in many countries. It was usurped rather quickly and many Keynesian economists and integrated into the theory because it allowed them to determine inflation within the model.
- The Phillips curve was not a part of Keynes original theory. The relationship was discovered long after Keynes wrote the "General theory". Therefore, many prefer to view the Phillips curve as an addition to the Keynesian model – not as a part of the Keynesian model.
- The Phillips curve is often interpreted as an important *political* curve. Some view this curve as giving the government a *choice* of low inflation or low unemployment (or something in between). Most economists, however, do not share this view – the reason for tis will be explained in the next chapter.
- The Phillips curve can also be interpreted in the terms of the business cycle. In a boom, Y is high; U is low and π *is* high. In a recession, the opposite holds. In a boom, we are at a point up on the left on the Phillips curve, while in a recession, we are at the bottom right. Business cycles may be viewed as oscillations between these two points.

14.5.3 Determination of all endogenous variables

We can illustrate how all the endogenous variables are determined in the following diagram:

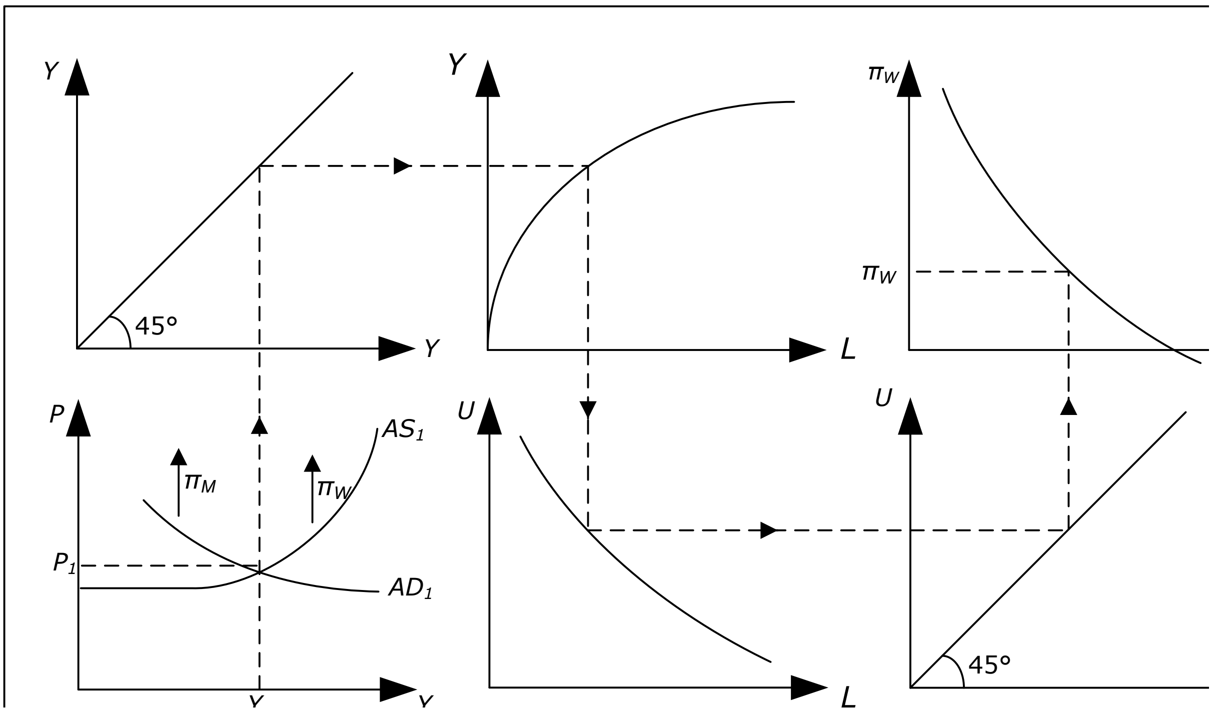


Fig. 14.10: The Keynesian model with the Phillips curve.

1. Start at the bottom left. In year 1, AD_1 and AS_1 apply, the price level is P_1 and GDP is Y.
2. Extend this level of GDP up to the top left diagram and through the 45-degree line to the production function at the top in the middle.
3. In this diagram we can determine how much L we need to produce Y. Extend this amount of labor down to the lower middle graph and through the 45-degree line to the bottom right graph.
4. This diagram shows the relationship between L and U. The higher the unemployment rate U, the lower the amount of labor L and the curve slopes downwards. From L we can determine U which we extend up to the Phillips curve in the right top graph.
5. From the Phillips curve, we can determine wage inflation π_W.
6. Going back to the AS-AD diagram, we now the rate at which the AS curve slides up or down. The AD curve slides at a rate determined by π_M which is exogenous.

An important case is when the growth in money supply is equal to the wage inflation. In this case, Y is fixed and $\pi = \pi_w = \pi_M$. If, however, π_M exceeds the wage inflation, the AD curve will glide upwards at a faster rate than the AS curve. Now Y will increase and if you follow the effect through all the 6 diagrams, you see that L will increase, U will decrease and π_W will increase. Y will continue to increase as long as $\pi_W < \pi_M$ which means that W will continue to increase until $\pi_W = \pi_M$.

In the Keynesian model with the Phillips curve, π and π_W will eventually be equal to π_M. As wages are assumed sticky in this model, it may take a long time for π_W to become equal to π_M.

15 The neo-classical synthesis

15.1 Introduction

The neo-classical synthesis is a synthesis of the classical model and the Keynesian model. In short, it states that the Keynesian model is correct in the *short run* while the classical analysis is correct in the *long run*.

Let us consider a concrete example. According to the Keynesian model, an increase in G will increase Y and reduce unemployment. In the classical model, an increase in G will have no effect at all on Y and unemployment. In the neo-classical synthesis, an increase in G will create a *temporary* increase in Y but Y will return to its original value after some time.

To justify the neo-classical synthesis, it is helpful to identify the problem with the classical model in the short run and the problem with the Keynesian model in the long run. As for the classical model in the short run, we concluded that within this model, it is difficult to explain deep recessions with high involuntary unemployment. In the long run, it is more reasonable to believe that that the economy can get out of the recession by itself. The problem with the Keynesian model in the long run, as we will see, is the assumption of a stable Phillips curve.

15.2 The various Phillips curves

15.2.1 The augmented Phillips curve

Remember that the Phillips curve, as it was incorporated into the Keynesian model, assumed a stable relationship between unemployment and wage inflation: for a given level of unemployment (say $U = 5\%$), a given level of wage inflation would apply (say $\pi_w = 4\%$). As U increased, π_w would fall and vice versa.

Mathematically, the Phillips curve may be described by a decreasing function f as $\pi_w = f(U)$. *In the neo-classical synthesis, expected inflation is added and* $\pi_w = f(U) + \pi^e$. To justify this amendment, imagine $U = 5\%$ and $\pi_w = 4\%$ (so that we are on the Phillips curve) and the expected inflation rises from 4% to 6%. Since employees care about real wages, it is reasonable to assume that π_w will increases as well (for a given U) and the Phillips curve will *shift upwards*.

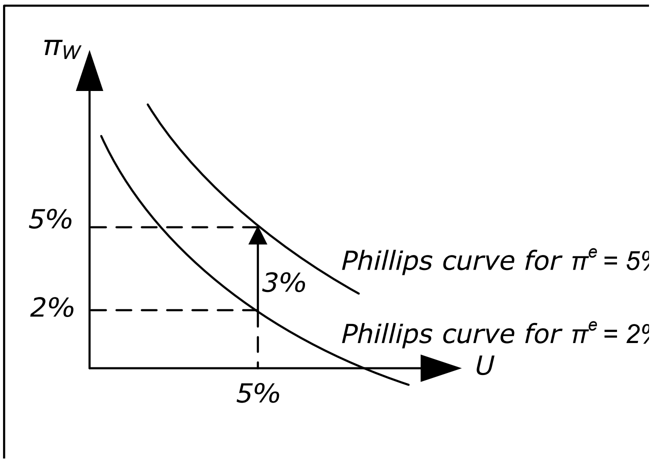


Fig. 15.1: The augmented Phillips curve.

According to the synthesis, the Phillips curve must be drawn *for a given value* of *πe* and it must be shifted upwards (downwards) as π^e increases (decreases). When the position of the Phillips curve is allowed to depend on π^e, is called the *augmented Phillips curve* (or the expectations-augmented Phillips curve). This amendment to the Phillips curve is actually a consequence of a criticism of the traditional Phillips curve and the Keynesian model from the late 1960s (the Keynesian – Monetarism debate).

15.2.2 Money illusion

An important argument for the augmentation has to do with the concept of *money illusion*. Money illusion means that you care about nominal rather than real amounts. Imagine that your salary increases by 20% over one year. Does this mean that you can increase your consumption? The answer is that *it depends on the inflation*. If inflation is 20%, you can consume as much as you did before. You must actually decrease you consumption if inflation exceeds 20%. We say that you have suffer from money illusion if you believe that you are better off if your salary increases by 20% while prices also increase by 20%. A higher nominal salary may create the "illusion" that you are richer.

If employees suffer from money illusion they will only care about nominal wage increases, expected inflation will not matter and there is no reason for the traditional Phillips curve not to hold. If, however, they do not suffer from money illusion, π_w must depend on both *U* and π^e and the augmented Phillips curve is more realistic.

15.2.3 The long-run Phillips curve

The augmented Phillips curve has an important consequence: the long-run Phillips curve must be vertical.

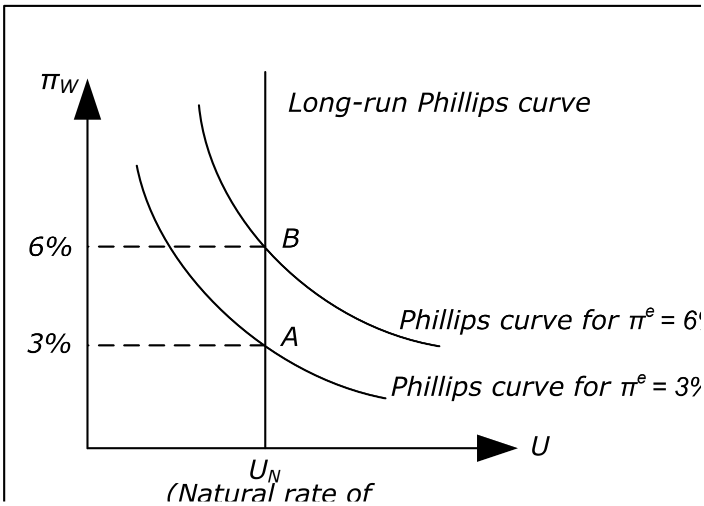


Fig. 15.2: The long-term Phillips curve.

To realize this, start by drawing a Phillips curve for π^e = 3%. The only point on this curve that may apply *in the long run* is π_W = 3% (point A). For example, π_W = 2% and π^e = 3% is not consistent with equilibrium in the long run as there is no level of inflation which is consistent with these values. π = 3% is not possible as real wages would go to zero. π = 2% is not possible since it would be unreasonable to continue to expect 3% inflation if inflation each year was 2%.

According to the neo-classical synthesis, we may temporarily be anywhere on the lower Phillips curve when π^e = 3%, but the economy must eventually return to point *A* (as long π^e = 3%)

Now draw a Phillips curve for π^e = 6%. Again, on this curve there is only one point is consistent with equilibrium in the long run and that is the point where π_W = 6% (point *B*). This point must be exactly above *A* as the new curve must be exactly three units above the first curve.

If we draw all possible Phillips curves, we see that all points consistent with long run equilibrium must lie on a vertical curve and this curve is called *the long-run Phillips curve*. In the long run, the economy must return to this curve. This means that in the long run, *there is no relation between inflation and unemployment*. In the long term, the economy returns to the natural unemployment rate as in the classical model.

15.2.4 Summary of the Phillips curves

In the neo-classical synthesis, the augmented Phillips curve is called the *short-run Phillips curve*. It is assumed to be stable as long as expectations of future inflation do not change. To summarize, we have three Phillips curves:

- *The traditional Phillips curve*. $\pi_W = f(U)$ and the same downward sloping relationship applies to both the short and the long run.
- *The short-run Phillips curve* (*SPC*). $\pi_w = f(U) + \pi^e$ and the curve is valid only in the short run (SPC = Short-run Phillips Curve).
- *The long-run Phillips curve* (LPC). $\pi_w = \pi_M$, $U = U_N$ and there is no relationship between π_w and U (U_N is the natural rate of unemployment).

15.2.5 The classical model and the long-term Phillips curve

In the classical model, L and the real wage are determined from equilibrium conditions in the labor market. L and W/P, therefore, are only affected by the marginal product of labor (which determines the demand for labor) and by the utility function of the employees (which determines the supply of labor). All unemployment is voluntary and L, U or W/P are all affected by exogenous variables only.

In the classical model, inflation is determined solely by the growth in the money supply π_M. From the quantity theory of money, $M{\cdot}V = P{\cdot}Y$ and if the growth rate of M is π_M, then P must increase by the same rate as V and Y are constant. From the quantity theory we can conclude that $\pi = \pi_M$ must hold. The relationship $M{\cdot}V = P{\cdot}Y$ is therefore sometimes called the quantity theory *in levels* while $\pi = \pi_M$ is called the quantity theory *in rates*.

In the classical model, inflation is balanced and $\pi_W = \pi$ (real wage is constant). Since $\pi = \pi_M$, we have $\pi = \pi_M = \pi_W$. As U is not affected by any endogenous variables, there is no relationship between π_W och U in the classical model and the vertical LPC applies even in the short run. The position on the LPC determined by π_M.

Unlike the neo-classical synthesis, where the economy temporarily may depart from LPC, the economy must always be on the LPC in the classical model.

15.2.6 Developments around 1960

The augmented Phillips curve and the long-run Phillips curve where developed during the late 1960s by Milton Friedman and Edmund Phelps. Friedman argued that a stable Phillips curve could exist in the *short run* as long individuals did not expect changes in the economy. Eventually, expectations would change and the traditional Phillips curve would shift and we would return to a point on the long-run Phillips curve.

If the Phillips curve depends on π^e, we can no longer expect observations of unemployment and wage inflation to nicely line up on a downward sloping curve. Instead, different observations will belong to different Phillips curves that move over time and we should expect to see all possible combinations of U och π_w.

Most Keynesian chose to hold on to the traditional Phillips curve. If you buy the augmented Phillips curve, you must buy the long-run Phillips curve and the economy must automatically return to the natural level of unemployment. This would violate one of the main results in the Keynesian analysis namely that the economy may be stuck in a long-run equilibrium with a high level of involuntary unemployment. With the long-run Phillips curve, it would again be impossible to determine the rate of inflation within the Keynesian model as all levels of inflation would be consistent with equilibrium (as for the Keynesian model without the Phillips curve). Since the traditional Phillips curve had a strong empirical support at this time, there was no reason to give it up.

Milton Friedman argued that this stable relationship was a pure coincidence. He predicted that observations in line with Figure X would be common in the future. A period of "stagflation", a situation with high unemployment *and* high inflation, in the early 70s was a great victory for the augmented Phillips curve and a serious setback for the Keynesian model. According to the Keynesian model, the government should pursue an expansionary policy if unemployment was high and a tight policy if inflation was high. The Keynesian model had no answer on what policy to pursue if both were high.

In the late 1970s it was clear that the augmented Phillips curve was superior to the traditional Phillips curve which from now on was assumed to be valid only in the short run. The neo-classical synthesis became the most popular model in macroeconomics and the synthesis is still the dominating model in macroeconomics taught in introductory and intermediate courses. The synthesis is also often the starting point for more advanced models in macro economics.

It should be noted that the development in the 1970s was a setback for the Keynesian model which incorporated the Phillips curve. The Keynesian model without the Phillips curve was less affected by the debate. With constant wages it does determine all of the macroeconomic variables but without the Phillips curve, it cannot explain inflation (see chapter 14). For this reason, many macro economists believe that the Keynesian model can be used in the short run or in recession when prices and wages do not change very much.

15.3 From short to long run

15.3.1 The dynamics from the short to the long run

We shall describe how the synthesis explains the transition from the short run to the long run where the Keynesian model applies in the short term and the classic model in the long run.

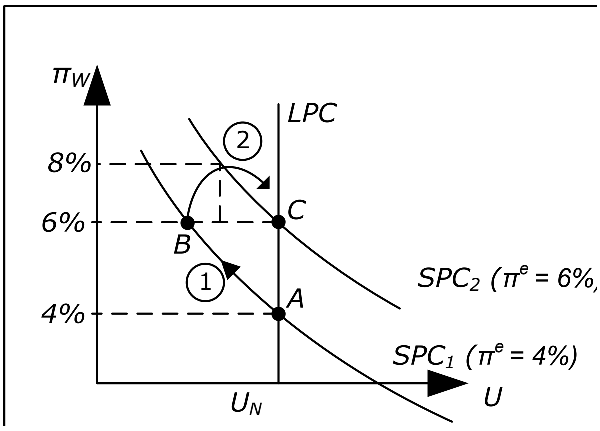


Fig. 15.3: From short run to long run.

- Point *A*: We start at point *A* which is on LPC where the economy is in equilibrium. Say that expected inflation is 4% so we are also on the SPC_1 corresponding to an expected inflation of 4%. Since we are in equilibrium, inflation and the growth of the money supply is equal to wage inflation and these must be equal to expected inflation. In point *A* we therefore have $\pi = \pi_M = \pi_w = \pi^e = 4\%$.
- Movement 1: Suppose that π_M suddenly and unexpectedly rises to 6%. The AD curve will then glide upward faster than the AS curve and *Y* will increase and π will increase. When *Y* increases, *L* increases and *U* will fall. Since the increase is not expected, inflation expectations will not change and neither will SPC. We move up along SPC_1 and π_W increases. According to the discussion in section X, π and π_W will eventually increase until they reach 6% and we move up to point *B*. So far, the discussion is completely consistent with the Keynesian model (as we have not replaced the SPC).
- $SPC_1 \rightarrow SPC_2$: As inflation is 6% at point *B*, *inflation expectations must eventually increase*. If inflation was 4% for a long time and it rises to and stabilizes at 6%, it is reasonable to expect future inflation to be 6%. *In the synthesis*, SPC shifts upwards to SPC_2 which applies to $\pi^e = 6\%$.
- Point *B*: When inflation expectations have become 6%, we are *below* the new short-run Phillips curve. When the economy is at point *B* with unemployment below the natural rate, wages will rise by more than 6%. From SPC_2 we can conclude that a wage inflation of 8% is consistent with an expected inflation of 6% when unemployment is equal to *UB*.

- Movement 2: If wages, and therefore prices, rises by more than 6%, the AS curve will glide upwards faster than the AD curve which means that *Y* will fall and *U* will increase. This must continue until we reach point *C*, where we once again are in equilibrium.

Note that in the Keynesian model SPC_1 is the only Phillips curve and it is valid in the long run as well. In this model, there is no "movement 2". The economy may remain in point B with $\pi = \pi_w = \pi_M = 6\%$ if this is desired by the government. The economy may return to point *A* by using restrictive fiscal and monetary policy.

In this section, inflation expectations did not change until we reached point *B*. This choice was more of a pedagogical choice to isolate and study each event individually. In reality, it is more likely that inflation expectations will slowly increase as we begin to move from point *A* to point *B* as inflation increases in this move. We would then have a movement from *A* to *C* more similar to movement 3 in the figure below. If the change in π_M was announced *prior* to the actual change, it is possible that πe immediately changed to 6% at point *A*. We would then see the movement 4 directly from *A* to *C* (which, however, may take some time because of wage contracts).

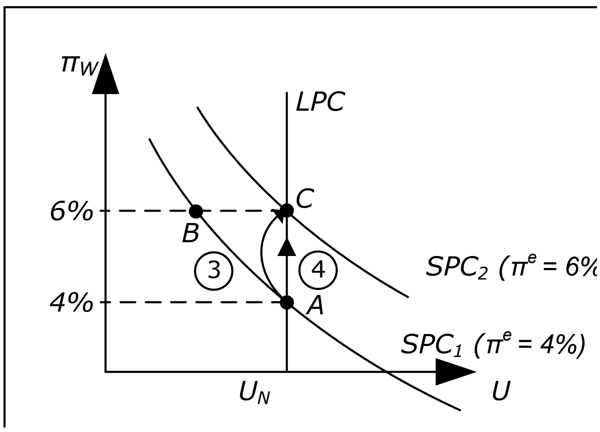


Fig. 15.4: From short to long run with a faster change in inflation expectations.

15.3.2 NAIRU

From the neo-classical synthesis, another important conclusion may be drawn. *In order to keep U below U_N, you need an accelerating inflation*. Suppose that full employment is compatible with 4% inflation in the long run. In the Keynesian model, we can keep *U* below U_N if we accept that inflation is above 4%. An inflation of, for example 7%, would keep the *U* below U_N indefinitely. In the neo-classical synthesis, this will not work. If we want to keep *U* below U_N, we must accept an ever higher inflation. In order to keep *U* one percentage unit below U_N we might need an inflation of 7% in the first period, 9% in the second period, then 13% and so on.

Figure 15.3 will explain why. In order to reduce unemployment below U_N, the growth rate in money supply must increase (unexpectedly). If nothing else is done, U will fall back to U_N (now with a higher inflation). In order to keep U below U_N, π_M must increase again and again at an accelerating rate.

Only the natural rate of unemployment, U_N, is compatible with a non-accelerating inflation and this rate is therefore often called the NAIRU (Non-Accelerating Inflation Rate of Unemployment).

15.4 SAS-LAS-AD model of the neo-classical synthesis

15.4.1 AS-AD in the Keynesian and the classical model

First, a brief review of the AS-AD model according to the classical and the Keynesian model when W is constant and exogenous.

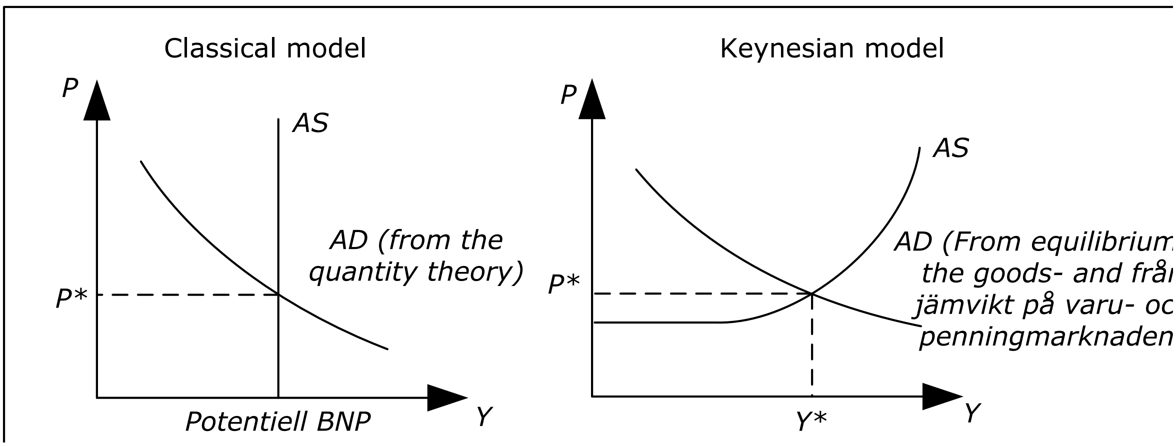


Fig. 15.5: The two AS-AD models.

According to the classical model, aggregate supply is independent of the price level and equal to potential GDP. Potential GDP is the amount produced when $U = U_N$ and the AS curve becomes a horizontal line through Y_{POT}.

The AD curve in the classical model consists of combinations of Y and P where the quantity theory $M \cdot V = P \cdot Y$ is satisfied. Aggregate demand is equal to the aggregate supply according to Say's Law. In the classical model, one starts from Y and finds P from the AD curve. The only function of the AD curve in the classical model is to determine the price level.

The AD curve slopes downwards in the Keynesian model as it does in the classical model but interpretation and the reason are quite different. In the Keynesian model, you start with P and you find Y_D from the AD curve. Here, the AD curve slopes downwards because when P falls, R decreases, I increases and Y_D increases (see section X). Another difference is that the AD curve may be affected by fiscal and monetary policy in the Keynesian model but not in the classical model.

In the Keynesian model, the AS curve is horizontal for low value of Y. In this region, the AS curve determines P while the AD curve determines GDP. Aggregate supply will be equal to aggregate demanded by the reverse Say's Law. For higher values of Y you need higher prices to stimulate aggregate and the AS curve will slope upwards. In this region, the AS and the AD curves simultaneously determine P and Y.

15.4.2 SAS, LAS, and AD

In the neo-classical synthesis, the Keynesian model is correct in the short run while (a slightly modified version of) the classical model applies in the long run. We therefore need to reconcile the AS-AD analysis of these models. In synthesis, the following concepts are introduced:

- Long-run aggregate supply (LAS): The classical AS curve (L for Long run)
- Short-run aggregate supply (SAS): The Keynesian AS curve (S for Short run)

In synthesis, it is the *Keynesian* AD curve that must be used. We can combine SAS, LAS, and AD in the same graph.

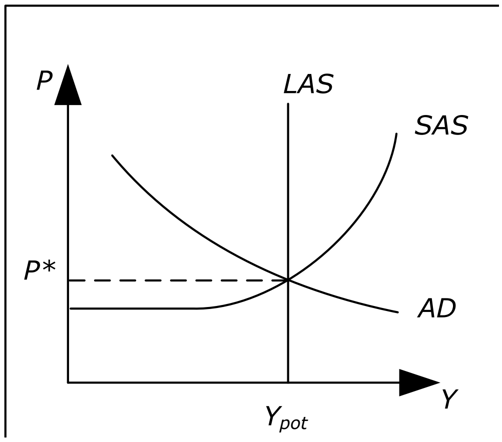


Fig. 15.6: SAS, LAS, and AD.

We begin by drawing them in such a way that both models agree in the determination of Y, $Y = Y_{POT}$. In the synthesis, this corresponds to long run equilibrium – there is no tendency for Y to increase or decrease.

Note that the price level is determined in according to the Keynesian model both in the short and the long run (as we use the Keynesian AD curve). There is no reason however, to believe that this price level is consistent with the quantity theory. In other words, the classical AD curve (not shown) may intersect LAS at a completely different P. The quantity theory in levels need not hold in the neoclassical synthesis neither in the short run nor in the long run. However, the quantity theory *in rates* ($\pi = \pi_M$) must hold in the long run. Therefore, it is not entirely correct to claim neo-classical synthesis reduces to the classical model in the long.

15.4.3 The dynamics from the short to the long run

We will now describe the dynamics from short to the long run in the LAS-SAS-AD model. To avoid having AS and AD curves "gliding", we will assume that $\pi_M = 0$. The case $\pi_M \neq 0$ is not much harder to analyze.

We begin by analyzing an increase in M_S (π_M is still zero – except for the brief when M_S increases, which we assume is very short). We start in the long-run equilibrium as in Figure 15.6. Initially $\pi = \pi_w = \pi^e = 0$.

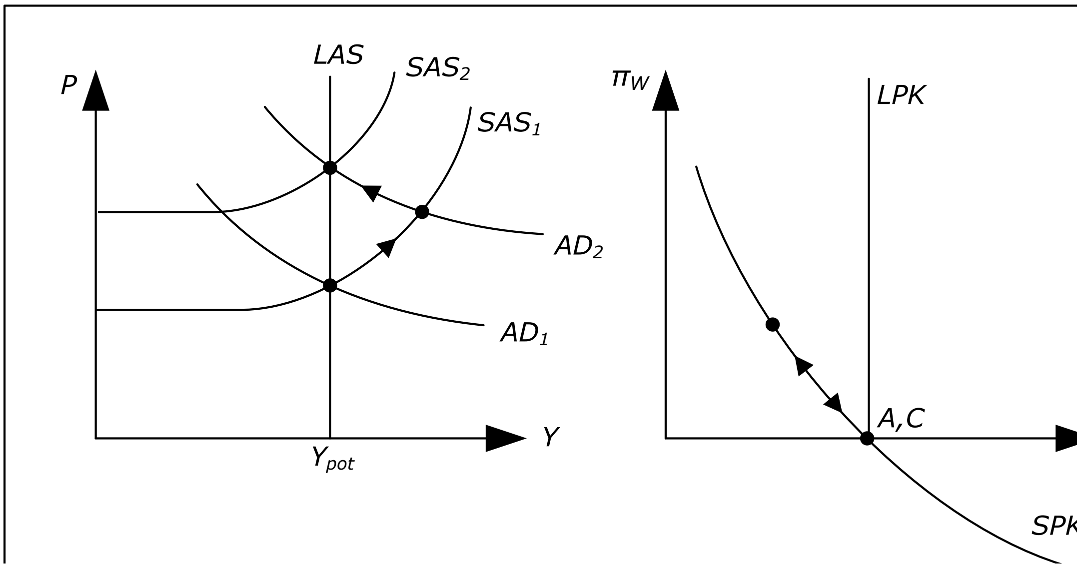


Fig. 15.7: Dynamics in the neo-classical synthesis.

1. We are in the initial point *A*.
2. When *MS* increases, the AD curve moves outwards from AD_1 to AD_2.
3. We move from point *A* to point *B*. *Y* increases and *P* increases.
4. As *Y* increases, *U* falls and we moving to point B on the SPK.
5. At point *B* on the SPK, wages increases.
6. When wages increase, the SAS curve will shift upwards.
7. When the SAS curve shifts upwards, *Y* will fall and *U* will again increase. We move back along the SPK.
8. The SAS curve must continue to shift upwards as long as $Y > Y_{POT}$. It will shift from SAS_1 to SAS_2 and we move to point *C*. We are back on the LAS and we are back on the LPK.

Whenever you use the neo-classical synthesis for your analysis, you should begin as if you where using the Keynesian model (with exogenous wages). This will give you the short-run outcome. To obtain the long-run results, remove the assumption of exogenous wages. Let wages adjust so that you will return to LAS and LPC.

16 Exchange rate determination and the Mundell-Fleming model

16.1 Introduction

16.1.1 The open economy

So far, our model for exchange rate determination has been very simple. We have assumed that domestic interest rates are unaffected by foreign interest rates. We begin this chapter by looking more carefully at this assumption (the classical model of exchange rate determination). Then, a more realistic model of exchange rate determination is considered. Finally, we will discuss the Mundell-Fleming model (MF-model).

The MF model is a model for an open economy. Such models must consider the determination of the exchange rate and how the exchange rate affects imports and exports. They also typically assume that capital may move freely and that investments will flow to countries where the return is maximized.

The Mundell-Fleming model is probably the simplest among the many macroeconomic models of the open economy. The MF model is basically an extension of the neo-classical synthesis with a model for the exchange rate that allows for free capital flows.

16.1.2 The rest of the world as one country

Most of the open economy models treat the rest of the world as one country. Focus in these models is on *aggregate* exports and imports and we are less interested in which particular countries we trade with. The same argument applies to capital flows. In these models, the rest of the world will have a single currency that we call *the foreign currency*. Therefore, there are only two currencies (the foreign and the domestic) and a single exchange rate.

16.1.3 Exchange rate systems

For an open economy, the particular exchange rate system in use becomes important. In Chapter 2 we discussed some possible systems. In simple models, only two systems are considered: a floating or a fixed exchange rate.

- With a *floating exchange rate*, the exchange rate is determined as any price, that is, by supply and demand. The central bank never intervenes in the market.
- With a *fixed exchange rate*, the exchange is completely fixed. In reality, most countries with a fixed rate allow the exchange rate to vary within certain limits. These variations are disregarded and the central bank will always intervene to keep the exchange rate at its fixed value.

Also remember the following notation:

	Fexible exchange rate	Fixed exchange rate
Our currency stronger	Appreciation	Revaluation
Our currency weaker	Depreciation	Devaluation

Fig. 16.1: Changes in exchange rates.

16.2 The classical model of exchange rate determination

The classical model of exchange rate determination is the one we have used so far. This section will consider the foundations of this model.

16.2.1 The law of one price

The classical model for exchange rate determination is based on *the law of one price*. This law claims that there can be only one price for a given product at any given time. Gold, for example, must cost more or less the same wherever you buy it.

If gold was traded for USD 30,000 per kilo in New York and for USD 40,000 per kilo in Chicago, you would be able to make a lot of money by buying gold in New York and selling it in Chicago. There would be opportunities for *arbitrage* – opportunities to make money with no risk. Gold would be transported from New York to Chicago until the price difference was eliminated.

The law of one price need not apply exactly due to the following reasons.

- *Transportation costs*: If the price difference is less than the cost of transport, the difference may remain.
- *Ease of access*. A soda in a convenience store is often more expensive than in a super market. You pay slightly more for the convenience of the ease of access.
- Government intervention. The government may, for example, by subsidizing electricity for firms, create a market with two different prices for the same good.

For *non-transportable* goods and services, the price difference may be much larger. Even if the price of a haircut is much higher in Chicago than in Boise, Idaho, there are no strong arbitrage possibilities that will remove the price difference.

16.2.2 PPP

If we apply the law of one price to goods in different countries, we can derive the purchasing power parity (PPP). If gold is trade in the U.S. at USD 30,000 per kilo and 1 euro costs USD 1.40, you can be pretty sure that gold will trade for around 30,000/1.4 ≈ 21,400 euro per kilo. If that was not the case, there would again be arbitrage opportunities (unless there are restrictions on transporting gold across borders).

If *PF* is the price of a good in the foreign country, *P* is the price of the same good in our country and *E* is the exchange rate (domestic/foreign) then PPP claims that

$$P = P^F \cdot E$$

16.2.3 The Big Mac Index

Based on PPP, the Economist regularly publishes the "Big Mac Index". P^F is then the price of a Big Mac in the U.S. In February of 2009, P^F was on average 3.54 USD and E = 1.28 USD/euro. According to PPP, a Big Mac should cost 2.77 euro in the euro area. In reality, it costs on average 3.42 euro. We would need an exchange rate of 3.54/3.42 = 1.04 USD/euro for the PPP to be entirely correct for the Big Mac.

According to Big Mac index, the euro is over-valued by about 24% in relation to the USD. The most expensive Big Mac, however, is found in Norway. Here a Big Mac costs USD 5.79 at the current exchange rate making the Norwegian krona overvalued by 63%.

16.2.4 Exchange rate determination

In PPP, P^F and P denote the domestic and foreign price of a particular good. If we instead let P^F and P denote *price levels*, we can derive the classical model of exchange rate determination simply by dividing both sides in PPP by E:

$$E = P/P^F$$

If the UK is our home country and a basket of goods costs 12.0 million UK pounds (GBP) while the exact same basket costs 14.1 million euro in France, the exchange rate, according to the classical model, ought to be 0.851 GBP/EUR or 1.175 EUR/GBP.

The exchange rate that we just calculated is often called the *purchasing power adjusted exchange rate*. If this was the actual exchange rate, the price levels (in the same currency) in the two countries would be the same. When we compared GDP per capita for various countries in section 3.6, it was the purchasing power adjusted exchange rate that we used to transform GDP into the same currency.

For countries where the GDP per capita is very different, the actual exchange rate is often very far from the purchasing power adjusted exchange rate. The price level in countries with a high GDP per capita is generally higher than the price level in countries with a low GDP per capita (in the same currency). It is often for services and non-transportable goods where prices deviate the most.

16.2.5 Inflation

If the price level in the home country and the foreign price level do not change, then, according to the classical model of exchange rate determination, E will be constant. The same is true if P and P^F increase at the same rate, that is, if the home country has the same inflation as the rest of the world: $\pi = \pi^F$, where π^F is the rate of inflation abroad.

If, however, $\pi > \pi^F$ (P increases faster than P^F), then E will increase (our currency will depreciate). For example, if $\pi = 8\%$ while $\pi^F = 5\%$, P increases by 8% while the P^F increases by 5% over the same period. P/P^F will then be $1.08/1.05 \approx 1.03$ times larger than the old value, that is, E will increases by about 3%. Our currency will have depreciated by 3% during this period.

If π_E is the rate of increase in the exchange rate (rate that our exchange rate depreciates), the classical model predicts:

$$\pi_E \approx \pi - \pi^F$$

The rate of depreciation is (approximately) equal to the differences in inflation between the countries. In the exercise book, we show that the exact relationship is $1 + \pi_E = (1 + \pi)/(1 + \pi^F)$ and the difference between these two results is small if inflation ratess are not too high.

16.2.6 Differences in inflation under fixed exchange rates

Suppose that we have a fixed exchange rate with the foreign country (rest of the world) but that we have different rates of inflation. Say that $\pi^F = 0$ while $\pi = 10\%$ – our prices increase 10% annually (in our currency) while foreign prices are stable (in their currency).

If the exchange rate is fixed, domestically produced goods will the also increase by 10% per year in the foreign country. As they have stable prices, the demand for our goods will continually decline. Also, import prices in our country will remain unchanged but since the price of domestic products increase by 10% per year, imported goods will continuously become cheaper and cheaper relative to domestically produced goods and imports will increase. Such a situation is unsustainable in the long run – we will eventually be forced to devaluate our currency. *To keep a fixed exchange rate between two countries, it is necessary that these countries have the same inflation.*

16.2.7 Differences in inflation under flexible exchange rates

With flexible exchange rates, no such restriction exists – countries may have different rates of inflation and no problem with trade need to occur. To see why, imagine again that $\pi^F = 0$ while $\pi = 10\%$ (per year) but that $\pi_E = 10\%$ as the classical model predicts. Our country has an inflation of 10% and our currency loses 10% of its value each year.

Say that Germany is our home country and that a domestically produced machine costs 10 EUR (in millions or whatever). At the same time, a foreign produced computer costs 4 USD. The exchange rate at this time is 0.711 EUR/USD. The machine will then cost 14.05 USD abroad while the computer will cost 2.85 EUR in Germany.

One year later, the price of the machine has increased to 11 EUR in Germany while the price of the computer has not changed. Also, the euro has lost 10% (E has increased by 10%) and the new rate is 0.783 EUR/USD. The price of the German machine abroad is still 14.05 USD (11/0.783) and exports will not be affected. Further, the price of the foreign-produced computer has increased to 3.13 EUR in Germany, an increase of exactly 10%. Since all other prices increase by 10% in Germany, imports will not change either.

We note that under flexible exchange rates, as long as the exchange rate depreciates at a rate equal to the difference in the rates of inflation, we may assume that exports and imports are unaffected by changes in the price levels and the exchange rate. This is exactly the assumption we have made so far.

16.3 The exchange rate

We now includ capital flows between countries. We denotes the foreign currency by the symbol $ while € denotes the domestic currency. Remember that the exchange rate E is the units of € we need to by one unit of $. For example, E = 0.8 €/$ means that $1 costs 0.8€. That in turn means that €1 costs $1.25. Note that if E is the exchange rate in €/$ then 1/E is the exchange rate in $/€.

In principle, there are two reasons for selling or buying currency:

- Trade and tourism
- Foreign investment

16.3.1 Trade and tourism

Domestic firms that import goods from abroad must pay for the goods using \$. Since they are paid in €, they will continuously need to sell € and buy \$. *Domestic import firms create a demand for \$.* People in our country that visits foreign countries will also contribute to this demand.

Foreign firms that import goods from our country must pay in €. They thereby create a demand for €. Whenever there is a demand for €, there will be a simultaneous supply of \$. *Foreign importers create a supply of* \$ (foreign tourists also contribute to this supply). Note that even though foreign importers pay in \$, the end result will be the same. If domestic exporters receive payments in \$, they will contribute to the supply of \$ as they have expenses in €.

Imports create a demand for \$
Exports create a supply of \$

16.3.2 Capital flows

Another factor that contributes to the demand and supply of \$ are capital flows. If someone in our country wants to invest abroad, she must first buy \$ thereby adding to the demand for \$. In the same way, foreigners who want to invest in our country must first buy € and they will contribute to the supply of \$.

Domestic investments abroad adds to the demand for \$.
Foreign investing in our country adds to the supply of \$.

16.3.3 Trade and exchange rate

We begin by analyzing how *E* affects exports and imports (*X* and *Im*). Imagine first that *E* = 0.8 €/\$. A product that costs \$100 abroad will cost €80 in our country (ignoring transportation costs and other factors affecting the validity of PPP). A domestic product costing €100 will cost \$125 abroad.

Say that *E* increases to 0.9 €/\$ (everything else the same). € has depreciated or has been devalued and is now weaker against \$. The \$100 good now costs €90 in our country. *Foreign-produced goods have become more expensive in our country and imports will decrease*. The €100 good will now cost \$111 abroad. *Domestically produced goods have become cheaper abroad and exports will increase*.

Depreciation or devaluation (E up = weaker currency): X increases, Im decreases
Appreciation or revaluation (E down = stronger currency): X decreases, Im increases

This is true if everything else is the same, an important qualification as we will soon see.

16.3.4 Investment and the exchange rate

When you invest money abroad, the *future exchange rate* at the time when you want to transfer your funds back to your country is important. Say for example that you invest €1 million in the foreign country at a 10% interest rate. When you make the investment, *E* = 0.8 €/\$ which means that you invest \$1.25 million. After one year, this amount has increased to \$1.375 million.

If the exchange rate is the same one year later, this amount is equal to €1.1 million and your return is 10%. If, however, our currency has strengthened and *E* = 0.4 €/\$, the amount \$1.375 million will only give you €0.55million, and you have *lost* 45% of your investment! On the other hand, if € has weakened and *E* = 1.6 €/\$ a year later, you will now receive €2.2 million, a nice return of 120%.

From this example, we can figure out how *E* affects capital flows. Suppose that the expected exchange rate one year from now is 0.8 €/\$. If *E* = 0.8 €/\$ today, we expect to neither gain nor loose from changes in the exchange rate from investments within the next year.

If *E* increases to 0.9 €/$ today while the expected exchange rate remains at 0.8 €/$, those who want to invest abroad for one year will expect to make a currency loss (they buy the $ for 0.9€ and can expect to sell it a year later for 0.8€). At the same time, foreigners who invest in our country can expect to profit from the expected change in the exchange rate. When the current *E* increases (with a fixed future *E*), investing abroad will be less attractive while investments in our country will be more attractive.

E up = weaker currency: less investments abroad, more investments in our country
E down = stronger currency: more investments abroad, less in our country

Again, this assumes that everything else is the same (in particular, the expected future exchange rate).

16.3.5 Supply and demand for the foreign currency

We denote the supply and demand for the foreign currency by $S_\$$ and $D_\$$. $S_\$$ will depend positively on the *E* and $D_\$$ will depend negatively on *E*. The reason is as follows:

1. When *E* increases (weaker currency) exports will increase, imports will fall, investments abroad will fall and investments in our country will increase.
2. Increasing export will increase the supply of $ ($S_\$$ up)
3. Decreasing imports will decrease the demand for $ ($D_\$$ down)
4. More investments in our country will increase the supply of $ ($S_\$$ up)
5. Less investments abroad will decrease the demand for $ ($D_\$$ down)

With a completely floating exchange rate, the exchange rate is determined in the same way as any other price:

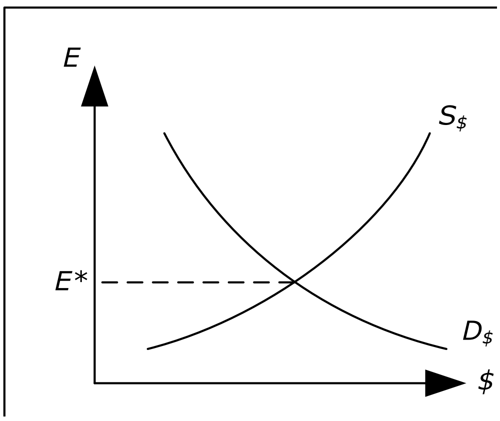


Fig. 16.2: Exchange rate determination.

E^* is the *equilibrium exchange rate*, the exchange rate where $S_\$$ is equal to $D_\$$. If the currency market is a free market, E will be equal to E^*. With a fixed exchange rate, the central bank must be prepared to buy and sell currency at the predetermined exchange rate.

16.3.6 Factors affecting E^*

A large number of factors may affect E^*. Some examples:

- Higher growth in domestic productivity. This would make domestic products cheaper and the demand for € would increase. This would increase the supply of \$ and E^* would fall (stronger currency).
- Higher domestic inflation. This would make domestic products more expensive and the domestic currency would depreciate.
- Higher domestic interest rates. This would increase the demand for € and the currency would strengthen.

16.4 Mundell-Fleming model

One of the main assumptions in the MF model is the assumption of interest rate parity. We begin by explaining this assumption.

16.4.1 Interest rates within in the same currency area

A *currency area* is a geographic area where the same currency is used. United Kingdom is one example of a currency area and all the countries using the euro is another (France, for example, is not a currency area, as they use the euro).

Within a currency area, at a certain point in time, there can be no significant differences in the interest rate geographically. With large differences, there would be arbitrage possibilities (the argument is similar to that of the law of one price). If it was possible to borrow/lend at interest rates 6%/5% in Paris and at the interest rates 4%/3% in Athens, you could become very wealthy.

16.4.2 Interest rates between currency areas

Between currency areas, it is not as simple. Even if you can borrow at 4% in one area and lend at 5% in another, you cannot be sure that you will make a profit. The reason, of course, is that the exchange rate may change and what you gain from the interest rate differential, you lose from changes in the exchange rate.

However, if you somehow *knew* that the exchange rate would be the same in the future, then the interest rates would have to be the same. But even with fixed exchange rates, you cannot know this for sure as exchange rates may be devalued or revalued.

16.4.3 Expected depreciation

To figure out the relationship between the domestic interest rate R and the foreign interest rate R^U we introduce the concept *expected depreciation*: π_E^e. The expected depreciation indicates how much investors expect the domestic currency to lose against the foreign currency within a given period.

For example, if $E = 0.8$ €/$ today and it is expected that $E = 1$ €/$ in one year, the expected depreciation is equal to 25%, $\pi_E^e = 0.25$. If you expect an appreciation of say 10%, we write $\pi_E^e = -0.1$.

16.4.4 Interest rate parity

An important assumption in the Mundell-Fleming model is the assumption of interest rate parity:

$$R \approx R^U + \pi_E^e$$

The domestic interest rate should be approximately equal to the foreign rate plus the expected depreciation. If the foreign one-year interest rate is 3% and you expect our currency to lose 2% to the foreign currency, then, according to the interest rate parity, the domestic one-year interest rate should be approximately 5%. The exact result is $1 + R = (1 + R^U)(1 + \pi_E^e)$ or $R = 5.06\%$.

Interest rate parity can be justified using arbitrage arguments. *If* interest rate parity holds, the expected return abroad will be the same as the domestic return and there will be no major flows of capital in either direction.

Say again that R = 5%, R^U = 3%, π_E^e = 2% and E = 0.8 €/$ initially. If you invest 1000 in the euro area, you have 1050 after 1 year. If you invest them abroad, you invest $1250. At 3%, you have $1287.5 a year later. If the actual depreciation is equal to the expected, E = 0.816 one year later. $1287.5 at the rate 0.816 €/$ is approximately equal to 1050.

Note that the actual rate of return may differ between countries if the actual depreciation differs from the expected depreciation. However, as long as expected returns are the same, there will be no major movements affecting the current exchange rate.

16.4.5 Modeling expected depreciation

Fully extending the neoclassical synthesis to an open economy is not simple. The main reason for this is that we need a model for how expectations on the exchange rate are formed. A simple solution to this problem is to assume that expectations are *exogenous*. In more advanced models, expectations are endogenous. Fortunately, a simple model with exogenous expectations leads to results that are similar to more complex models with endogenous expectations.

We assume that $\pi_E^e = 0$ *if the exchange rate is fixed*. In practice, this means that we do not expect any devaluations or revaluations. With $\pi_E^e = 0$, $R = R^F$.

We assume that $\pi_E^e = \pi - \pi^F$ *in the long run if the exchange rate is flexible*. If the domestic inflation is 4% above the rest of the world, we expect a 4% depreciation of the exchange rate. In the short run, π_E^e is assumed to be fixed (and equal to the inflation differentials in the last period).

If our country is small in relation to the rest of the world (the foreign country), it is reasonable to assume that R^F is determined as if the foreign "country" was a closed economy while our interest rate R is affected by R^F. With fixed exchange rates, our interest rate is simply equal to the world interest rate. With a flexible exchange rate, our interest rate is equal to the world interest rate plus or minus a given constant (π_E^e).

16.4.6 The IS-LM model under fixed exchange rates

With fixed exchange rates, R is given. We can illustrate this by drawing a new curve in the IS-LM diagram called the FE-curve (FE for Foreign Exchange).

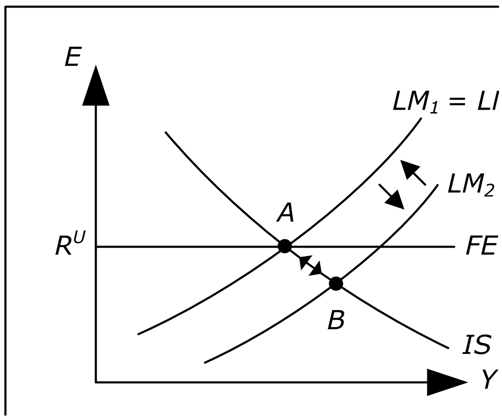


Fig. 16.3: IS-LM-FE.

We have drawn the diagram such that the IS curve intersects the LM curve at exactly the "correct" interest rate $R = R^U$. This is no coincidence – we will describe why the IS curve must intersect the LM curve at exactly this interest rate.

Let us begin by analyzing what will happen when M_S increases when we are initially in equilibrium (with say $\pi_M = \pi = 0$).

1. The LM curve shifts outwards from LM_1 to LM_2. We move from A to B.
2. Y falls and R falls. Now $R < R^F$ and the demand for foreign currency increases.
3. Our currency will depreciate and the central bank must intervene. They will sell foreign currency and buy the domestic currency which will reduce foreign exchange reserves.
4. When they buy the domestic currency, M_s *will fall*. LM_2 shifts back towards LM_1 and the process will continue until R again is equal to R^F, LM_2 is back to LM_1 and we are back at point A.

Monetary policy has no effect when the exchange rate is fixed according to the MF-model. However, as we shall see in the exercise book, fiscal policy will work. Fiscal policy will actually work better in the open economy than in the closed economy. In reality, results are not so black and white. Instead, you should conclude that monetary policy is less effective with a fixed exchange rate – not that it is completely ineffective.

16.4.7 The IS-LM model with flexible exchange rates

With flexible exchange rates we must also consider the expected depreciation, $R = R^F + \pi_E^e$. Since π_E^e is assumed to be exogenous, the FE curve is still horizontal.

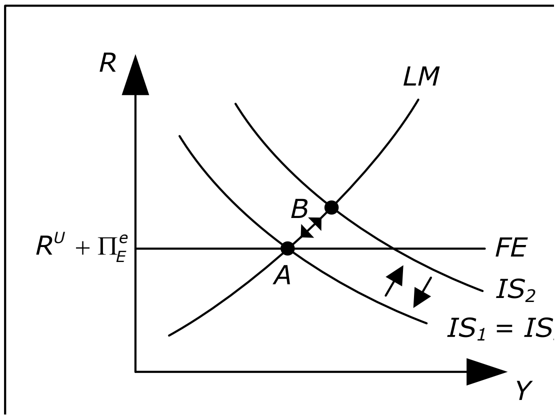


Fig. 16.4: IS-LM-FE.

In this case, we analyze what happens when G increases from an initial equilibrium (again, $\pi_M = \pi = 0$).

1. The IS curve shifts outwards from IS_1 to IS_2. We move from A to B.
2. Y increases and R increases. Now $R > R^F + \pi_E^e$ and the supply of foreign currency increases (foreigners will want to buy our currency and invest in our country).
3. Since we have a flexible exchange rate, the central bank will not intervene and the domestic currency will appreciate.
4. When the domestic currency appreciates, exports will fall while imports will increase. This will shift the IS_2 curve back towards IS_1. The exchange rate will continue to appreciate as long as $R > R^F + \pi_E^e$ and the trade balance will continue to deteriorate until R again is equal to $R^F + \pi_E^e$ and IS_2 is back to IS_1.

Fiscal policy has no effect under flexible exchange rates according to the MF model. Any attempt to stimulate the domestic economy will only succeed in stimulating the foreign economy. However, as we shall see in the exercise book, monetary policy will work (and in this case better than in the closed economy).