6 Role of interest rates

6.1 Learning outcomes

After studying this text the learner should be able to:

1. Elucidate the role: primary tool of monetary policy.
2. Explain the role: bridge between present and future consumption.
3. Discuss the role: advancing consumption / investment with debt.
4. Describe the principle underlying the inverse relationship between interest rates and asset prices.
5. Discuss the essence of the wealth effect.
6. Expound upon the role of interest rates in derivative instrument pricing.
7. Discuss the role of interest rates in respect of the foreign sector.

6.2 Introduction

The interest rate is one of the most significant prices in the economy. The following are the roles of interest rates:

- Primary tool of monetary policy.
- Part of bridge between present and future consumption.
- Advancing consumption and / or investments with debt.
- Inverse relationship with asset prices and the wealth effect.
- Interest rates and derivative instrument pricing.
- Interest rates and the foreign sector.

6.3 Primary tool of monetary policy

In 1930 Prof Iriving Fisher, famous for many issues in economics, including the quantity theory of money and the theory of interest, wrote:

> "Prof. Knut Wicksell was one of the first to recognize the influence of interest rates upon prices. See his book, *Geldzins und güterpreise;* Prof. Alfred Marshall, Prof. Gustav Cassel, Rt. Hon. Reginald McKenna, chairman of the Midland Bank of London, Mr. R.G. Hawtrey, of the Treasury of Great Britain, and many other well known economists, bankers, and business men have emphasized that business activity is influenced and may be largely controlled by manipulation of the discount rate."

The role of interest rates in monetary policy has been covered on many occasions in this text. Thus, we will not repeat it. However, we offer a synopsis:

- In normal circumstances the central bank, through open market operations (OMO), creates a liquidity shortage (LS) and, in most countries, maintains it permanently. This means it "forces" the banks to borrow from it at all times. The borrowing term is short (usually 1 day to 7 days).
- It levies its PIR on these borrowed reserves.
- The bank-to-bank interbank rate (b2b IBM), the market in which banks settle interbank claims on one another) takes its cue from the PIR.
- The b2b IBM rate has a major impact on the banks' deposit rates (wholesale call money rates in the first instance and other short-term deposit rates in the second, and so on).
- As the banks maintain a jealously guarded margin, deposit rates impact on bank lending rates.
- Thus the PIR impacts on the banks' PR (an R2 of close to 1.0 is not unusual).
- The level of PR (especially in real terms) influences the NBPS's demand for bank credit. Responsible governments tend to be interest rate sensitive, but many are not.

- Interest rate changes also have a major impact on asset prices which through the "wealth effect" influence consumption and investment (C + I = GDE; GDE + net exports = GDP) behaviour (discussed further below).
- The growth in bank credit (to the NBPS and government) is the main counterpart of growth in M3, i.e. M3 growth is largely the outcome of growth in bank lending.
- The growth rate in aggregate demand (Δnominal GDP, GDP_N), financed to a large degree by Δbank credit, and reflected in ΔM3, has a major impact on price developments (inflation).
- The inflation rate is a major input in business decisions.
- Business decisions impact on economic growth and employment.

Figure 6.1 illustrates the monetary policy route and its objectives.

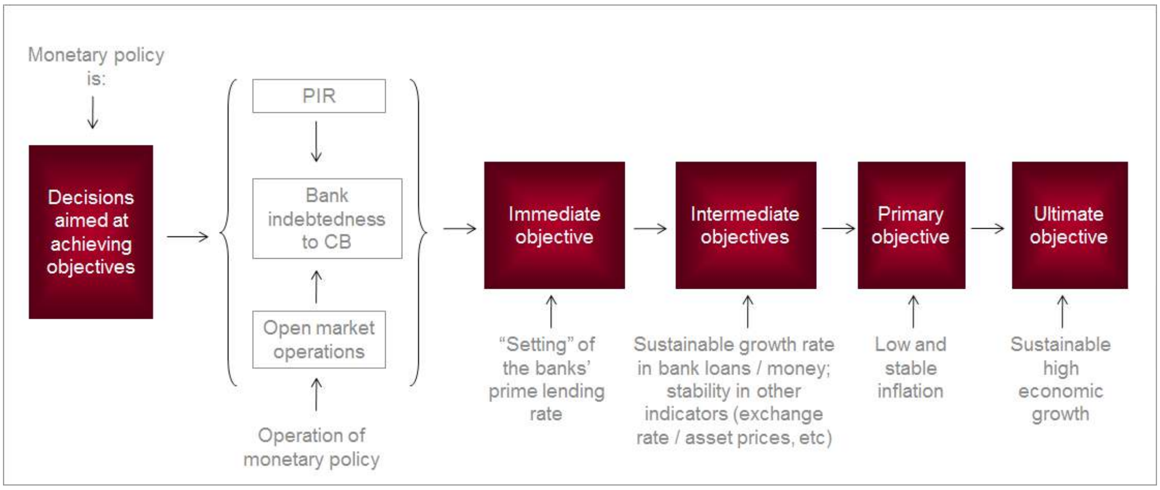

Figure 6.1: Route of monetary policy and objectives

The latter bullet points deserve a few more words. As we have seen, there is a close correlation between ΔDCE and ΔM3 (close to 1.0), because ΔM3 is (largely) the outcome of ΔDCE. The ΔDCE represents new spending; consequently one would expect a close correlation between ΔDCE and ΔGDP_N. This is shown for the US and Japan in Figures 6.2–6.3.

GDP_N translates into real GDP and inflation:

$$GDP_N = GDP_R \times P$$

and therefore:

$$\Delta GDP_N = \Delta GDP_R + \Delta P.$$

Economists, government, business, etc., are interested in the level of ΔGDP_R, because this aggregate influences income and employment. Central banks are aware that there is a trade-off between the two: low and stable ΔP brings about a higher ΔGDP_R and high and unstable ΔP dissipates the contribution of ΔGDP_N to ΔGDP_R.

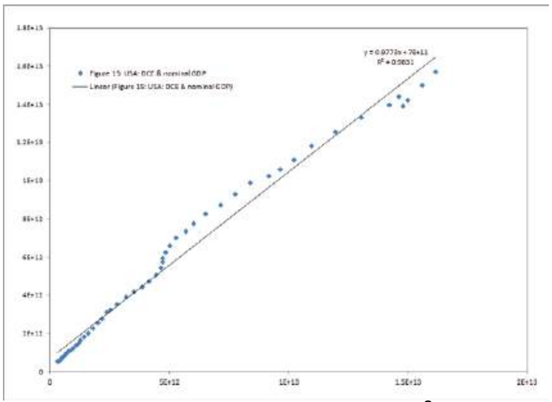

Figure 5.4: DCE & GDP_N: USA: R^2 = 0.98

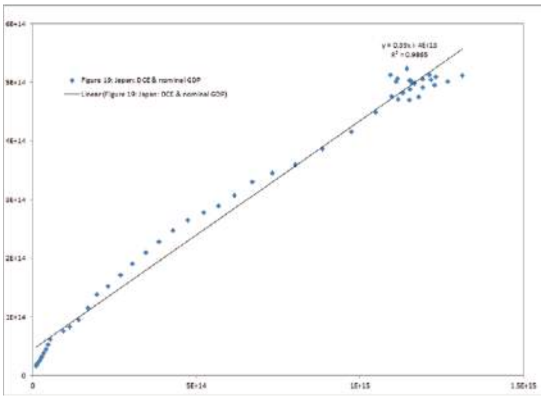

Figure 5.5: DCE & GDP_N: Japan: R^2 = 0.99

In conclusion we need to ask: is there an optimal rate of interest? The answer is yes. It is called the natural rate of interest or, more usually, the natural rate (NR), but it is a hypothetical rate. It is the rate that brings about the ideal economic situation: achievement of low and stable inflation and potential real output. It may also be seen as the ideal division of:

$$\Delta GDP_N = \Delta GDP_R + \Delta P.$$

However, it is non-measurable and therefore elusive. This does not detract from its significance and the need for central banks and academics to hunt for it. Great strides have been made, for example, the advent of inflation targeting and the almost universal agreement that a ΔP of 2.0% pa is ideal. The ideal division of GDP_N is one of the most imperative topics in economics. We discuss the NR in more detail later.

6.4 Part of bridge between present and future consumption

6.4.1 Introduction

Assets (i.e. financial and real assets) can be seen as the bridge between present and future consumption. What does this mean? It means that there is a trade-off between present and future consumption: the household and corporate sectors continually make decisions regarding spending (consuming) all income now and consuming less now and saving – in the form of assets – for consumption in the future, i.e. delaying spending now for future spending.

Prof Irving Fisher (1930) described this role in 1930:

> "The rate of interest expresses a price in the exchange between present and future goods…the rate of interest, or the premium on the exchange between present and future goods, is based, in part, on a subjective element, a derivative of marginal desirability; namely, the marginal preference for present over future goods. This preference has been called time preference, or *human impatience*. The chief other part is an objective element, *investment opportunity*."

What are the assets referred to above? Usually they are categorised as follows (a.k.a. "investment asset classes"):

- Financial assets:
  - Money market (mainly short-term debt and bank deposits).
  - Bonds.
  - Equity.

- Real assets:
  - Property (developed and undeveloped).
  - Commodities (gold coins, maize, cattle, etc.).
  - Other (furniture, rare books, rare stamps, art, etc.).

These are the forms in which households and companies are able to delay consumption. The rate of return on financial and real assets plays a role in these decisions. Interest on debt financial assets is part of this equation (the other parts are: dividends on shares, rent on property, expectations of capital gains). The higher the rate of return the higher is the incentive to delay consumption. We cover this issue under the following brief sub-sections:

- Household sector.
- Corporate sector.
- Government sector.
- Concluding remarks.

6.4.2 Household sector

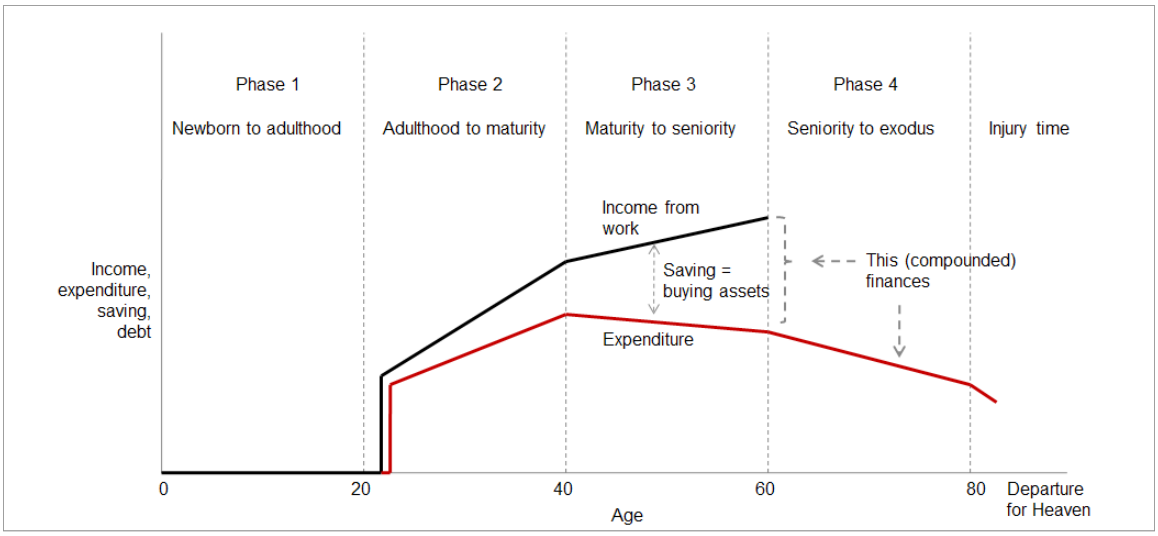

Figure 6.4: Ideal financial life cycle: income, expenditure, and saving

If we divide an individual's life into four phases and indicate income, expenditure, and saving (investment in assets), it will appear as in Figure 6.4. Obviously the working start and end dates will differ from person to person. This is the ideal situation, but few achieve it according to numerous studies. A discussion on the financial life cycle issue is provided in: http://bookboon.com/en/investments-an-introduction-ebook.

6.4.3 Corporate sector

The way in which the corporate sector delays consumption may not be obvious. The shareholders of a company (or their agents – in the form of non-shareholder directors and management) may choose present consumption over future consumption in the form of paying out large dividends. On the other hand, they may choose to delay consumption – by retaining profits in the company (in the form of "retained earnings" = equity) and investing the funds in new plant and equipment in order to make larger profits and pay out larger dividends in the future.

6.4.4 Government sector

Do central governments delay consumption? The answer is no and yes. The vast majority of governments run permanent budget deficits, and they fund the deficit by issuing securities, meaning that they borrow in order to advance consumption (see next section). They pay a rate of interest for this privilege, which is for the account of taxpayers (meaning that it will influence future deficits). The rates of interest on bonds do (or should) affect decisions in this respect.

When a government has a surplus, it will usually repay debt. This is equivalent to delaying consumption. The reduction in government debt alters the supply of government bonds, and it changes the size of future deficits (in that interest payments reduce), both of which have an interest rate reduction consequence.

6.4.5 Concluding remarks

Delaying consumption / investment (residential in the case of households and, in the main, in plant and equipment by companies) is effected in assets, mainly financial assets (i.e. lending). The rate of interest is the reward for doing so; it is a significant variable in the choice in decisions to delay consumption.

What is the other side of the coin? It is borrowing, i.e. the issue of financial securities, by those who wish to advance consumption. We cover this next.

6.5 Advancing consumption / investment with debt

6.5.1 Introduction

The converse of postponing consumption is advancing consumption: households, corporate entities and central government do so by issuing financial obligations (debt and equity[46]; the latter applies only to companies) in order to advance consumption (C) and / or investment (in plant and equipment) (I). Recall that: C + I = GDE; GDE + NE = GDP (NE = net exports), and that there is a close relationship between DCE and GDP_N, meaning that borrowing (from banks, the outcome of which is bank deposit money creation) reflects additional demand for goods and services (GDP_N growth). As we are interested in interest rates, we ignore equity and focus on debt. This section has 3 sub-sections:

- Household sector.
- Corporate sector.
- Government sector.

6.5.2 Household sector

Members of the household sector have assets (loans by them) and liabilities (loans to them), and astute older members just have assets. A typical balance sheet of a young member of the household sector (in phase 2 of life: 20–40) appears as in Balance Sheet 6.1, and that of an older astute member (in phase 4: 60-80+) in Balance Sheet 6.2.

BALANCE SHEET 6.1: YOUNG MEMBER OF HOUSEHOLD SECTOR (LCC)			
Assets (A)		Liabilities (L)	
Deposits (current account) Property (residential) Furniture Motor vehicle PI[1] (retirement fund)	1 000 200 000 25 000 60 000 110 000	Bond (on residence)	150 000
Total	396 000	Total	150 000
Negative net worth (when L > A)	0	Net worth (when A > L)	246 000
Total assets	396 000	Total liabilities + net worth	396 000
1 PI = participation interest.			

BALANCE SHEET 6.2: OLDER MEMBER OF HOUSEHOLD SECTOR (LCC)			
Assets (A)		Liabilities (L)	
Deposits: Current account Savings account Property (residential) Furniture Motor vehicle PI[1] (retirement fund) Shares Bonds (government bonds)	 5 000 10 000 400 000 50 000 60 000 900 000 150 000 100 000		
Total	1 675 000	Total	0
Negative net worth (when L > A)	0	Net worth (when A > L)	1 675 000
Total assets	1 675 000	Total liabilities + net worth	1 675 000
1 PI = participation interest.			

Most educated young people when in phase 2 ensure a budget condition of $I > E = S+$ (income = I; expenditure = E; increased savings = $S+$), in order to have the funds as a deposit on a residence (inter alia). This enables them to raise a mortgage loan from a bank, as indicated in Figure 6.5. The budget condition, $I > E = S+$, alters in that the rate of interest on the bond becomes part of E. The rate of interest on the mortgage, which is benchmarked on PR, plays a major role in the decision to borrow.

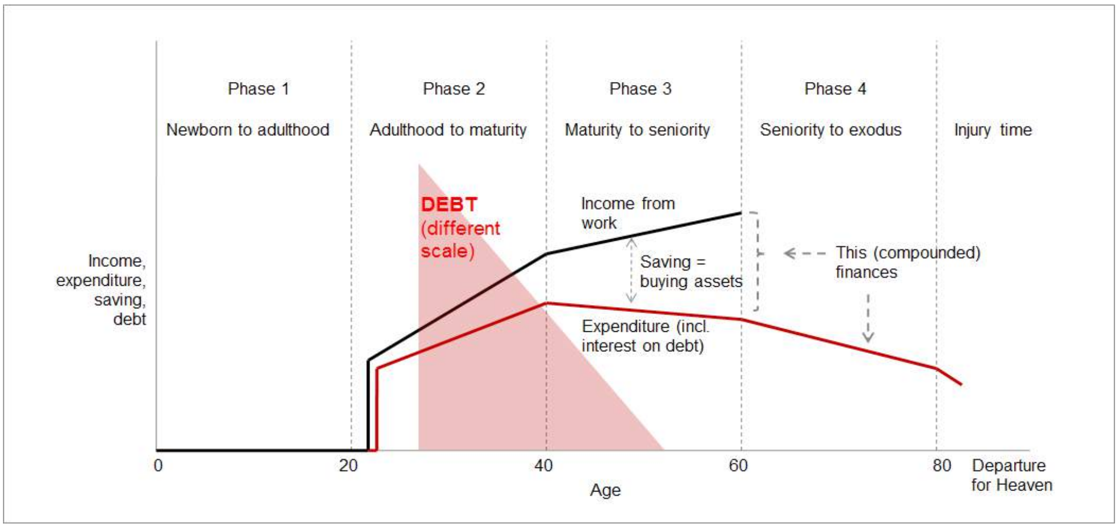

Figure 6.5: Ideal financial life cycle: income, expenditure, debt, and saving

Figure 6.6 shows DCE (bank credit to NBPS and government) growth and the real prime rate (PR_R) for a period of almost 60 years[47] (monthly data). It will be evident that DCE growth never becomes negative (except for one short period); just the growth rate varies. It is clear that interest rates (in real terms) play a role after some time (in this case PR_R has been forwarded by 24 months). The expected inverse correlation is not good but it does show that interest rates do influence DCE. As we know, interest rates are largely controlled by the central bank.

The lack of a robust inverse correlation should not cloud the issue, because the levels of PR_R were perhaps at times not optimum in this particular country. We discuss the issue of the optimal rate of interest (the natural rate) later.

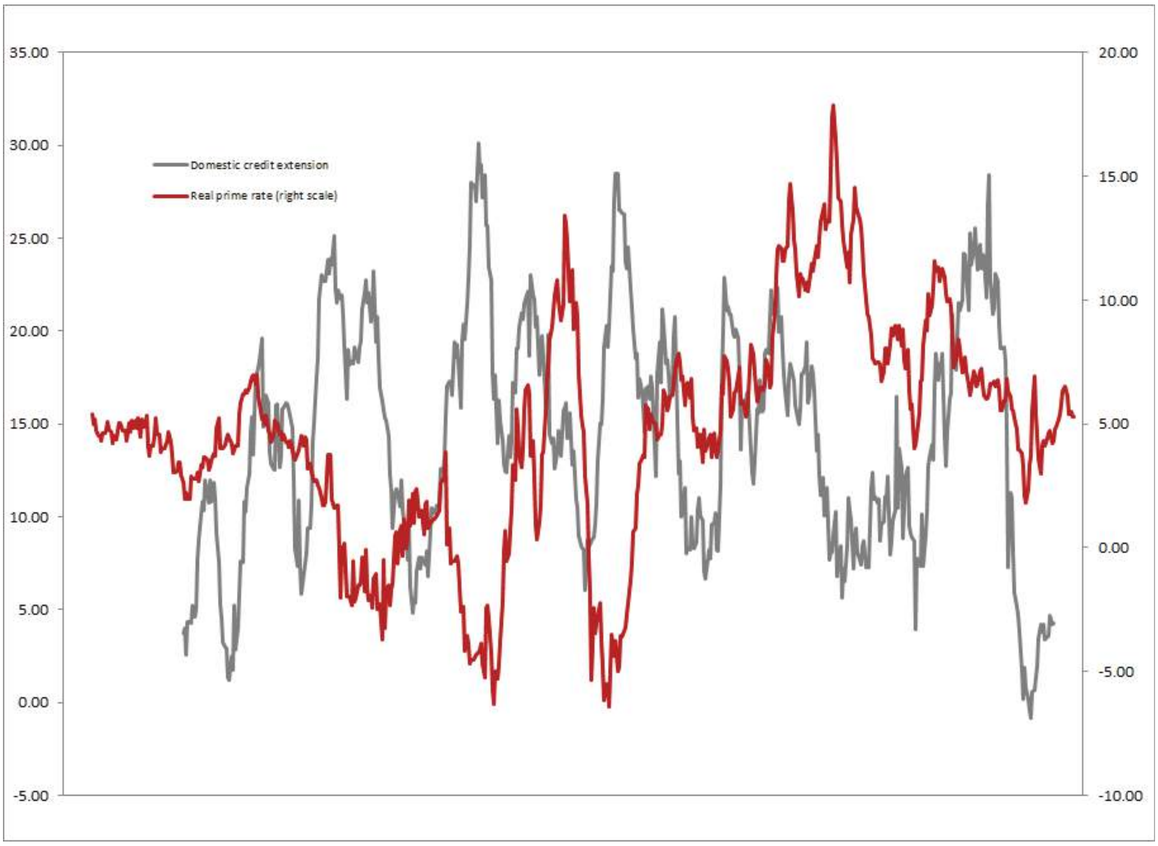

Figure 6.6: Real prime rate (+24 months) & DCE

Figure 6.7 shows the relationship between credit to the NBPS and household debt to disposable income (yoy% growth) for over 5 decades. As household debt rises, debt service costs rise (see Figure 6.8), and disposable income falls, leading eventually to a cut-back in expenditure, which leads to a recessionary period.

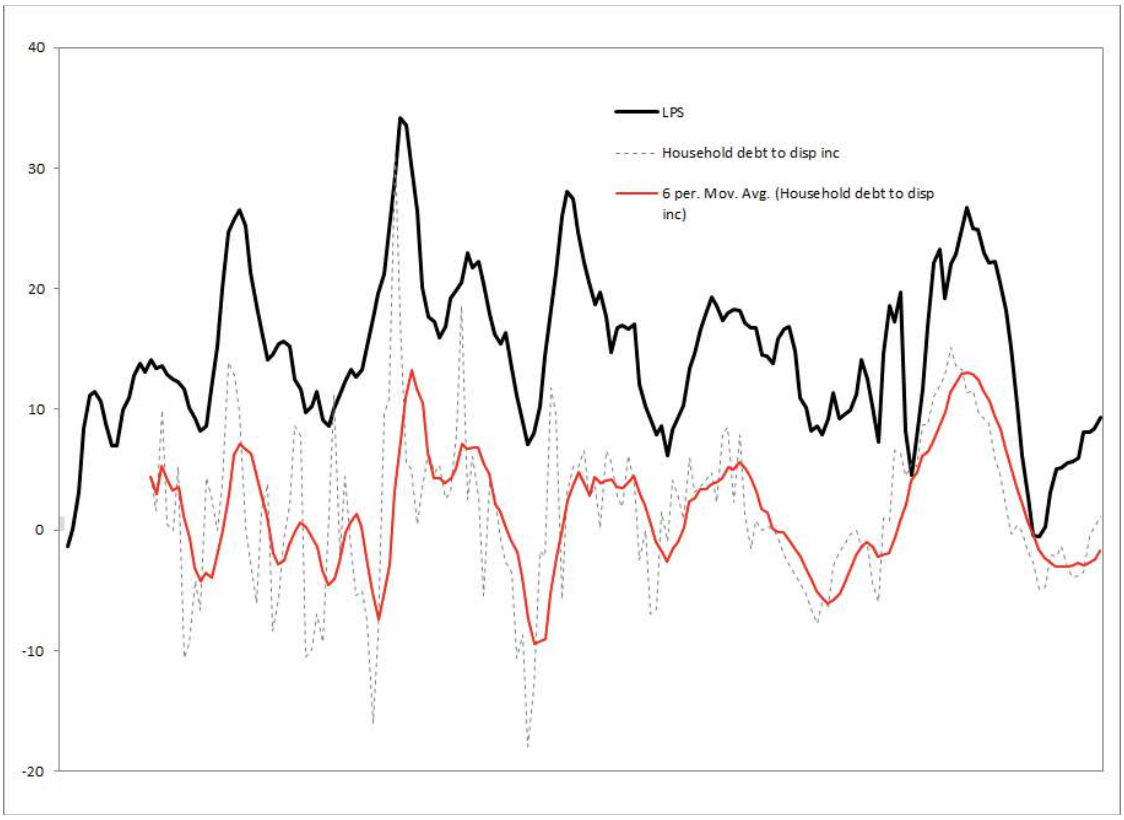

Figure 6.7: Change (yoy%): Bank credit to NPBS & household debt to disposable income

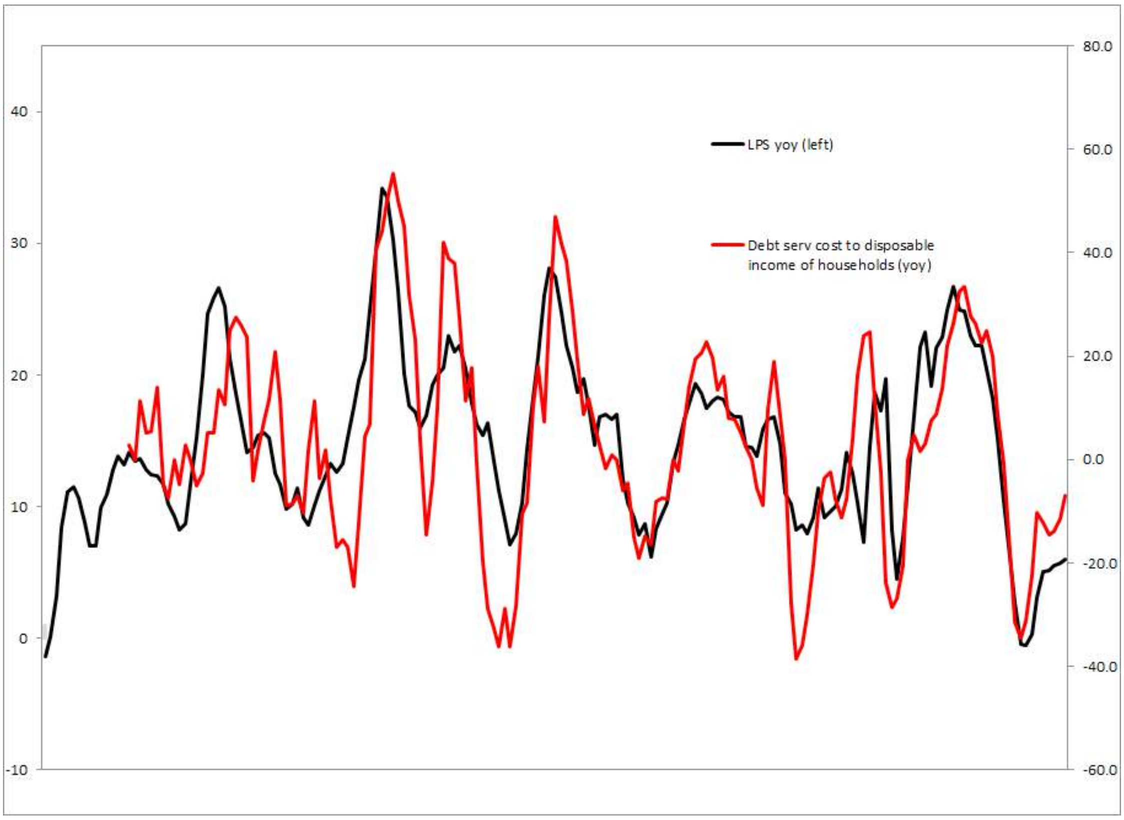

Figure 6.8: Change (yoy%): Bank credit to NBPS & debt service cost to disposable income (households)

6.5.3 Corporate sector

As we saw earlier, companies can delay consumption by increasing retained profits which can be used for additional investment in plant and equipment in order to reap higher profits for consumption purposes in the future. Companies also have a choice, when capital is limited, to borrow, by the issue of new debt securities, for this purpose. The rate of interest on debt plays a major role in the choice to borrow or not.

If a company decides to fund a new project which has a lifespan of 5 years by the issue of 5-year bonds (projects have a lifespan of 10-30 years, but we use this term for illustration purposes), the net present value (NPV) and internal rate of return (IRR) concepts are employed to determine the project's financial viability. A planned project has an estimated outlay cost (OC = the cost of a factory and required equipment) and future cash flows or profits (FVs). As we know from the PV-FV discussion, the PV is:

$$PV = FV / (1 + ir / not)^{y.not}.$$

The NPV is the same, except for the OC: it is the PV of future cash flows minus the OC [CF_1, CF_2, etc. = annual future cash flows (FVs)]:

$$NPV = -OC + [CF_1 / (1 + ir)^1] + [CF_2 / (1 + ir)^2] + [CF_3 / (1 + ir)^3] + [CF_4 / (1 + ir)^4] + [CF_5 / (1 + ir)^5].$$

The bond interest rate (ir = ytm) to be paid by the company is (recall: rp = risk premium):

ir = 5-year rfr + rp.

If we assume:

- the 5-year rfr = 4.0% pa, and the market demands an rp of 2.0% pa (ir = 6.0% pa);
- the forecast cash flows are (pa, LCC millions): 20, 25, 30, 35, and 40;
- OC = LCC 120 million,

the NPV of the project is:

$$NPV = – OC + [CF_1 / (1 + ir)^1] + [CF_2 / (1 + ir)^2] + [CF_3 / (1 + ir)^3] + [CF_4 / (1 + ir)^4] + [CF_5 / (1 + ir)^5].$$
$$= – 120 + (20 / 1.06^1) + (25 / 1.06^2) + (30 / 1.06^3) + (35 / 1.06^4) + (40 / 1.06^5)$$
$$= – 120 + (20 / 1.06) + (25 / 1.12360) + (30 / 1.19102) + (35 / 1.26248) + (40 / 1.33823)$$
$$= – 120 + 18.868 + 22.250 + 25.188 + 27.723 + 29.890$$
$$= +3.919$$
= +LCC 3 919 000.

The project is viable at this corporate bond funding rate. It delivers a cash flow higher than the OC. At 8.0% it is not:

$$NPV = – 120 + (20 / 1.08^1) + (25 / 1.08^2) + (30 / 1.08^3) + (35 / 1.08^4) + (40 / 1.08^5)$$
$$= – 120 + (20 / 1.08) + (25 / 1.16640) + (30 / 1.25971) + (35 / 1.36049) + (40 / 1.46932)$$
$$= – 120 + 18.519 + 21.433 + 23.815 + 25.726 + 27.223$$
$$= -3.284$$
= -LCC 3 284 000.

The IRR is the discount rate which makes the NPV = 0, that is, the PVs of the cash flows (FVs) of the project are equal to its OC. The IRR of the project is higher that 6.0% pa and lower than 8.0% pa.

It will be clear that, in a tight monetary policy environment when interest rates are increased by the central bank, more and more new projects become non-viable and are put on ice.

Often, companies decide to fund a project by issuing bonds, but regard bond funding as part of their funding mix: ordinary shares, preference shares, bonds, etc. The interest rate on debt then becomes part of a company's *weighted average cost of capital* (*wacc*). If we assume simply that a company has two sources of funding, shares and bonds, the inputs are as follows (assume the project has a life of 5 years):

(1) Cost of equity (rrr) = rfr + rp

where

rrr = required rate of return
rfr = risk-free rate (the rfr is known; assume 4% pa)
rp = risk premium (the rp is "arbitrary"[48]; assume 5% pa).

Cost of equity (rrr) = rfr + rp
= 4.0 + 5.0
= 9.0% pa.

(2) Cost of bond debt (ir) (ytm) (% pa) = rfr + rp
= 4.0 + 2.0 (assumed)
= 6.0% pa.

With these inputs, the wacc can be established:

Wacc = {[D / (D + E)] × ir} + {[E / (D + E)] × rrr}

where

D = total bond debt = LCC 100 million
E = shareholder equity (issued + retained income) = LCC 200 million.

Wacc = {[D / (D + E)] × ir} + {[E / (D + E)] × rrr}
= {[100 / (100 + 200)] × 0.06} + {[200 / (100 + 200)] × rrr}
= [(100 / 300) × 0.06] + [(200 / 300) × 0.09]
= (0.33333 × 0.06) + (0.66666 × 0.09)
= 0.02 + 0.06
= 0.08
= 8.0% pa.

As we saw above, the NPV is the same as the FV-PV calculation, except that there is an OC:

$$NPV = -OC + [CF_1 / (1 + wacc)^1] + [CF_2 / (1 + wacc)^2] + [CF_3 / (1 + wacc)^3] + [CF_4 / (1 + wacc)^4] + [CF_5 / (1 + wacc)^5].$$

Example [with CF numbers as above (LCC millions): 20, 25, 30, 35, 40]:

$$NPV = -OC + [CF_1 / (1 + wacc)^1] + [CF_2 / (1 + wacc)^2] + [CF_3 / (1 + wacc)^3] + [CF_4 / (1 + wacc)^4] + [CF_5 / (1 + wacc)^5].$$

$$= -100 + (20 / 1.08) + (25 / 1.16640) + (30 / 1.25971) + (35 / 1.36049) + (40 / (1.46933)$$

$$= -100 + 18.52 + 21.43 + 23.82 + 25.73 + 27.22$$

$$= +16.72$$

$$= +LCC\ 16\ 720\ 000.$$

As we saw above, this means that the project is viable: it delivers a positive NPV, and the IRR of the project is higher than 8.0% pa.

Note that the above is simplified. We have, for example, ignored taxes on profits, the important "hurdle rate" (an arbitrary minimum rate of return that a company will accept for a project), and the corporate finance-related disadvantages inherent in the analysis. We have done this to keep the exposition simple, in order to demonstrate the principle.

The principle is that new company projects have an estimated OC and future cash flows (CFs = FVs), and these cash flows are discounted to PV (total FVs – OC = NPV) by an interest / discount rate: wacc or bond rate. This wacc contains the rfr and the bond rate, and the bond rate is an interest rate (ytm). This means that when rates rise, projects have a lower value (NPV), and when rates fall the opposite is the case. Thus, interest rates have a significant influence on investment spending (I) by corporate entities. Recall that: C + I = GDE; GDE + NE = GDP.

6.5.4 Government sector

BALANCE SHEET 6.3: CENTRAL GOVERNMENT (LCC BILLIONS)			
Assets (A)		Liabilities (L)	
Deposits at central bank	10 000		
Property	100 000	Bonds in issue	150 000
Buildings	50 000	Treasury bills in issue	10 000
Shares in state-owned enterprises	30 000		
Salaries payable	100		
		Total liabilities	160 000
Total assets	190 100	Net worth	30 100
		Total liabilities + net worth	190 100

Governments also have a balance sheet (but few publish it). An example is presented in Balance Sheet 6.3. As we discussed earlier, most governments run a budget deficit and issue securities in the form of TBs and bonds to fund it, resulting in an outstanding amount of securities, as shown.

Interest rates do play a role in decisions with respect of borrowing. Higher rates do (or should) deter borrowing, mainly because the bonds carry fixed rates, which have to be paid in the future until the bonds mature.

6.6 Inverse relationship with asset prices and the wealth effect

6.6.1 Introduction

We have discussed the PV-FV concept at some length and the reader will know that the interest rates on, and the prices (PVs) of, fixed interest securities are inversely related: when rates increase the prices (PVs) of securities decrease. The reverse obviously also applies, and it applies also to non-financial securities, specifically rent-producing property. This means that any asset which has future cash flows is influenced by interest rates.

This does not only apply to assets, but also goods and services. Prof Irving Fisher (1930) puts it as follows:

> "Interest plays a central role in the theory of value and prices and in the theory of distribution. The rate of interest is fundamental and indispensable in the determination of the value (or prices) of wealth, property, and services…the price of any good is equal to the discounted value of its expected future service… If the value of these services remains the same, a rise or fall in the rate of interest will consequently cause a fall or rise respectively in the value of all the wealth or property. The extent of this fall or rise will be the greater the further into the future the services of wealth extend. Thus, land values from which services are expected to accrue uniformly and indefinitely will be practically doubled if the rate of interest is halved, or halved if the rate of interest is doubled. The value of dwellings and other goods of definitely limited durability will fall less than half if interest rates double, and will rise to less than double if interest is halved. Fluctuations in the value of furniture will be even less extensive, clothing still less, and very perishable commodities like fruit will not be sensibly affected in price by a variation in the rate of interest."

Our interest here is with the effect of interest rates on assets. The asset categories have future cash flows as shown in Table 6.1.

Financial assets	Cash flows
Money market	Usually one payment at maturity
Bonds	Multiple, regular, fixed future payments
Equity	Dividends
Real assets	Cash flows
Property	Rent in the case of rental properties
Commodities	None
Other	None

Table 6.1: Cash flows on assets

We discuss the following:

- The principle.
- Money market.
- Bonds.
- Equities.
- Property.
- Wealth effect.

6.6.2 The principle

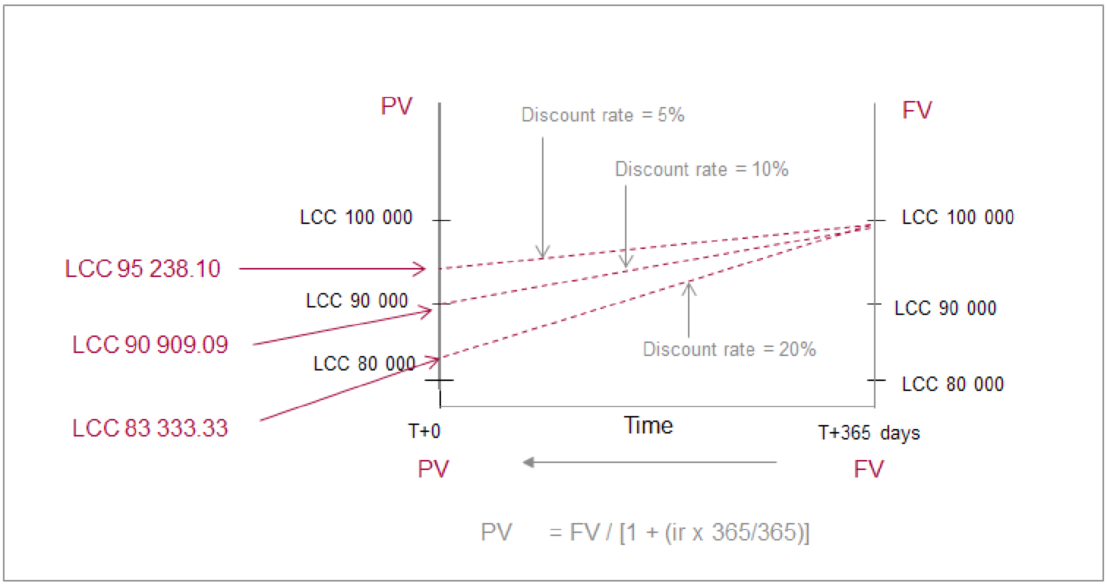

Figure 6.8: FV to PV

The principle is the time value of money: discounting from FV to PV at the relevant rate for the period:

One payment in a year: PV $= FV / [1 + (ir / 365)]$

Multiple payments over years: PV $= FV / (1 + ir / not)^{y.not}$.

The case of one payment in a year is shown clearly in Figure 6.8. The higher the rate the lower is the PV of the FV. If the FV of a financial asset that has 365 days to maturity is LCC 100 000, the following PVs apply at the rates shown:

FV = LCC 100 000	5.0% pa	PV = LCC 95 238.10
FV = LCC 100 000	10.0% pa	PV = LCC 90 909 .09
FV = LCC 100 000	20.0% pa	PV = LCC 83 333.33.

6.6.3 Money market

The best example is that of a newly issued short-term NCD: a buyer of a new NCD (i.e. a depositor) deposits at the bank LCC 1 000 000 at a rate of 8.25% pa for 182 days. The maturity value of the NCD is:

Maturity value (MV = FV) = PV × [1 + (0.0825 × 182 / 365)]
= LCC 1 000 000 × 1.04113699
= LCC 1 041 136.99.

If the rate on this NCD happens to rise to 16% pa on the day of purchase, its consideration (price, PV) will be:

PV = MV / [1 + (0.16 × 182 / 365)]
= LCC 1 041 136.99 / 1.0797808
= LCC 964 211.41.

The holder / depositor will make a capital loss of LCC 35 788.59 (LCC 1 000 000.00 – LCC 964 211.41). If the rate falls to 4.0% pa:

PV = MV / [1 + (0.04 × 182 / 365)]
= LCC 1 041 136.99 / 1.01994522
= LCC 1 020 777.36

The holder / depositor will make a capital gain of LCC 20 777.36 (LCC 1 020 777.36 – LCC 1 000 000.00). It will be clear that the FV is discounted to PV by the relevant market interest rate, and that interest rates are inversely related to prices.

6.6.4 Bonds

The relationship between rate and price is best demonstrated with an (unreasonable) example relating to perpetual bonds (which were issued in the distant past). A perpetual bond is one that has no maturity date and therefore no repayment of the principal amount, and it pays a fixed annual (or more frequent) coupon rate (cr). The price of such a bond is determined as follows:

$$\text{Price (PV)} = [cr / (1 + ytm)^1] + [cr / (1 + ytm)^2] + [cr / (1 + ytm)^3] + \ldots\infty$$

Because infinity is involved here, the formula simplifies to the following:

$$\text{Price (PV)} = cr / ytm.$$

It should be clear that when cr = ytm, the price is 1.0. For example, if the coupon rate is 10.0% pa and the ytm is 10.0% pa, the price is 10 / 10 = 1.0. If the market rate moves up to 20.0% pa, the price is 10 / 20 = 0.5. If the rate moves down to 5.0% pa, the price is 10 / 5 = 2.0.

The principle is clear: when the market rate falls from 10.0% pa to 5.0% pa, the buyers are prepared to earn 5.0% pa in perpetuity. This means that they are *prepared to pay a price* for the security that will yield them 5.0% pa (= 200%). On a 10.0% pa coupon LCC 1 000 000 nominal value perpetual bond the annual income is LCC 100 000. Thus, the buyers are willing to pay LCC 2 000 000 for the bond (LCC 100 000 / LCC 2 000 000 × 100 = 5.0% pa).

Bonds today have a fixed term to maturity; therefore infinity does not apply. Bonds have multiple but equal cash flows in future (coupons), plus a nominal value, both of which terminate / mature on a specified date in the future. These cash flows are discounted at the market rate (ytm) to PV and added. An example:

Settlement date:	30 / 09 / 2014
Maturity date:	30 / 09 / 2017
Coupon rate (cr):	9% pa
Nominal / face value:	LCC 1 000 000
Interest date:	30 / 09
Market rate (ytm)	8% pa (payable annually in arrears).

The cash flows and their discounted values (the ytm is used) are as shown in Table 6.2.

Date	Coupon payment (C)	Nominal / face value	Compounding periods (cp)	Present value C / (1 + ytm)^{cp}
30 / 09 / 2015	LCC 90 000	-	1	LCC 83 333.33
30 / 09 / 2016	LCC 90 000	-	2	LCC 77 160.49
30 / 09 / 2017	LCC 90 000	-	3	LCC 71 444.90
30 / 09 / 2017	-	LCC 1 000 000	3	LCC 793 832.24
Total	LCC 270 000	LCC 1 000 000		LCC 1 025 770.96
C = coupon payment. cr = coupon rate. cp = compounding periods (years).				

Table 6.2: Cash flows and discounted values

The value now of the bond is LCC 1 025 770.96, and the price of the bond is 1.02577096. The price is calculated according to:

$$\text{Price (PV)} = [cr / (1 + ytm)^1] + [cr / (1 + ytm)^2] + [cr / (1 + ytm)^3] + [1 / (1 + ytm)^3].$$

If the ytm fals to 4.0% pa, its value (PV) is:

Price (PV) $= [cr / (1 + ytm)^1] + [cr / (1 + ytm)^2] + [cr / (1 + ytm)^3] + [1 / (1 + ytm)^3]$
$= [90\,000 / (1 + 0.04)^1] + [90\,000 / (1 + 0.04)^2] + [90\,000 / (1 + 0.04)^3] + [1\,000\,000 / (1 + 0.04)^3]$
$= (90\,000 / 1.04) + (90\,000 / 1.0816) + (90\,000 / 1.124864) + 1\,000\,000 / (1.124864)$
$= 86\,538.46 + 83\,210.06 + 80\,009.67 + 888\,996.36$
= LCC 1 138 754.55.

Compare this to the LCC 1 025 770.96 when the ytm was 8.0% pa. When the ytm decreases, the denominator decreases, and the discounted value (PV) increases. The converse also holds.

6.6.5 Equities

Equities / shares pay dividends, which are often irregular. However, many companies have a policy of a healthy dividend which grows annually at the constant rate. These companies' shares can be easily valued. For the other companies, various other valuation methods (other than the one below) are used.

In the case of companies with a constant growth dividend policy the discounted cash flow technique, *Gordon constant-growth dividend discount model* (CGDDM), is generally used. There is another: the *free cash flow technique*, but we will discuss the former because it demonstrates the principle well and is easy to follow. The CGDDM formula is:

$$PV = \{[D_0 \times (1 + D_g)^1] / (1 + rrr)^1\} + \{[D_0 \times (1 + D_g)^2] / (1 + rrr)^2\} + \{[D_0 \times (1 + D_g)^3] / (1 + rrr)^3\} + \ldots \infty$$

where

D_0 = past dividend
D_g = growth rate in dividends
rrr = required rate of return (= rfr + rp).

Because we have a condition of infinity, this formula simplifies to:

$$PV = [D_0 \times (1 + D_g)] / (rrr - D_g)$$
$$= D_1 / (rrr - D_g).$$

For example, if we have (share XYZ):

D_0 = LCC 6.0
D_g = 8.0% pa (based on past growth rates)
rrr = 14.0% pa = rfr + rp = 10.0% pa + 4.0% pa,

then

$$D_1 = D_0 \times 1.08 = \text{LCC } 6.0 \times 1.08 = \text{LCC } 6.48.$$

The fair value price (FVP or PV) of share XYZ is:

$$\begin{aligned} PV &= \text{LCC } 6.48 / (0.14 - 0.08) \\ &= \text{LCC } 6.48 / 0.06 \\ &= \text{LCC } 108.00. \end{aligned}$$

The role of interest rates is clear: the rfr is a major component of the rrr. If the rfr decreases from 10.0% pa to 8.0% pa (assuming the rp remains unchanged at 4.0% pa), the share's value rises:

$$\begin{aligned} PV &= D_1 / (rrr - D_g) \\ &= D_1 / [(rfr + rp) - D_g] \\ &= 6.48 / [(0.08 + 0.04) - 0.08] \\ &= 6.48 / (0.12 - 0.08) \\ &= 6.48 / 0.04 \\ &= \text{LCC } 162.00. \end{aligned}$$

As we have said before, the *rp* ingredient of the *rrr* is difficult to establish. There are models to establish it, such as the capital asset pricing model (CAPM). We will not discuss these here because the above sufficiently demonstrates the inverse relationship between interest rates and prices.

6.6.6 Property

In the case of rental property, rental flows (net after tax and costs) (= FVs) are discounted to PV at the so-called *capitalisation rate* (a.k.a. *cap rate*, *yield*, and *return*). Because property is a risky asset, the capitalisation rate is nothing else than a required rate of return (rrr):

$$rrr = rfr + rp.$$

Because property is a long-term asset the rfr used is the long-term bond rate, and the rp is usually made up of factors such as:

- Liquidity-sacrifice premium (+).
- Market risk premium (+).
- Potential for capital gain (-).

For example, in the case of a rental property with the following data:

net rental (NR) pa	= LCC 150 000
rfr	= 6.0% pa
rp	= 2.0% pa,

the PV (a.k.a. the *fair value price* – FVP) will be:

PV (FVP)	= NR / rrr
	= LCC 150 000 / (rfr + rp)
	= LCC 150 000 / 0.08
	= LCC 1 875 000.

It will be clear that if rates increase the PV will fall. For example, if the rfr increases to 8.0% pa, and the rp required by the investor remains unchanged:

PV (FVP) = NR / (rfr + rp)
= LCC 150 000 / 0.10
= LCC 1 500 000.

If a constant growth rate (g) in NR is expected, the CGDDM principle applies:

PV (FVP) = NR / (rrr – g).

In some cases, peer-related transactions are used to determine the rrr. For example, if a similar property to the one envisaged was recently sold for LCC 1 200 000 and it delivers a NR of LCC 85 000, the rrr is:

rrr = LCC 85 000 / LCC 1 200 000
= 0.0708
= 7.1%.

In the case of a farm, the PV / FVP is equal to the discounted value of the (net) production output of the land. Prof Fisher (1930) put it as follows:

> "The value to a farmer of the services of his land in affording pasture for sheep will depend upon the discounted value of the services of the flock in producing wool."

6.6.7 Wealth effect

What does this relationship mean for the real economy? It means that interest rate changes have an impact on asset prices. Assets are held by individuals and companies (and government, but government is not a factor here), and increases in asset prices lead to an increase in demand / expenditure [Δ(C + I + NE) = ΔGDP]. It is termed the "wealth effect". As there is voluminous literature supporting this contention, we will not discuss it further here.

6.7 Interest rates and derivative instrument pricing

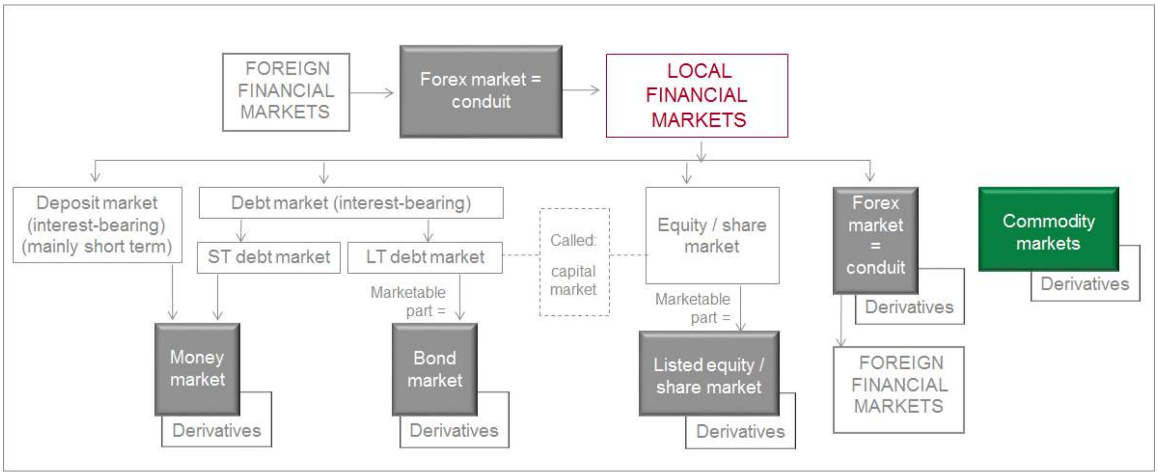

Figure 6.9: Financial (spot & derivative) markets

Earlier we explained the difference between spot and derivative markets: in both markets the transaction is done now (T+0) at a price agreed now (T+0), but the settlement dates are different. In spot markets transactions are settled as soon as is practically possible (T+0 to T+5), whereas in derivative markets transactions are settled in the future, usually way beyond T+5 (there are exceptions).

Figure 6.9 depicts the financial and commodity markets, as well as the derivative markets, i.e. all the markets have derivatives. Figure 6.10 depicts the categories of derivative instruments (pure and hybrid).

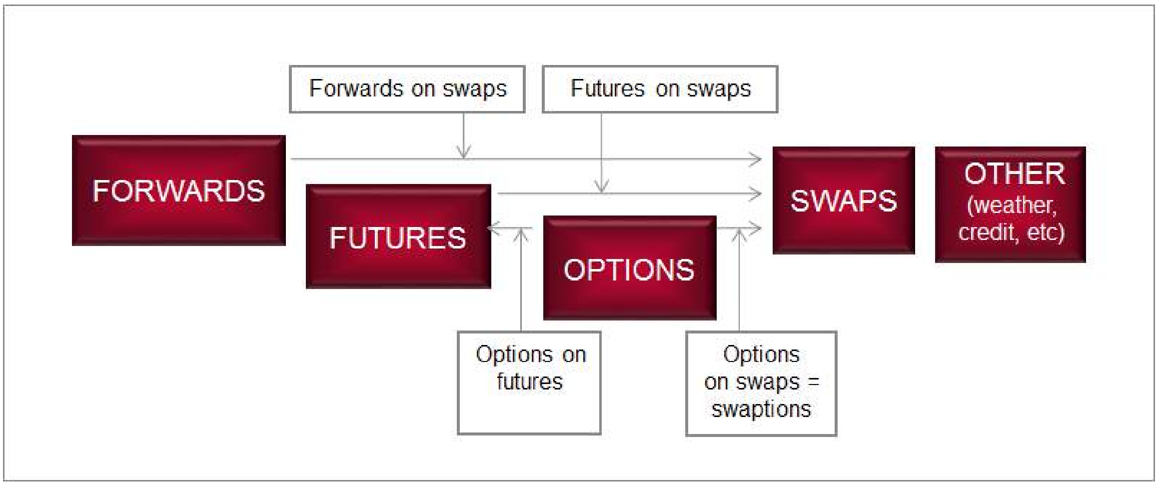

Figure 6.10: Derivative instruments / markets

Interest rates play the major role in the pricing of derivative instruments, because they deal with settlements in the future. Thus, the *fair value price* (FVP = PV) is equal to the spot price of the (financial market or commodity) "underlying instrument" plus the rate of interest for the relevant period. This requires further elucidation.

Derivatives are called as such because they are contracts that are "derived" from the spot rates on the "underlying instruments". An example of an underlying instrument is a specific share or bond or commodity such as gold. The underlying can also be a share index, such as the All Share Index, or a bond index, such as the Government Bond Index.

How is the FVP of a futures contract determined? There are four (or some of) factors involved:

- Current (or "spot") price of the underlying asset.
- Financing (interest) costs involved.
- Cash flows (income) generated by the underlying asset.
- Other costs such as storage and transport costs and insurance.

The FVP of a future is determined according to the *cost-of-carry model* (CCM): the FVP is equal to the spot price of the underlying asset, plus the cost-of-carry of the underlying asset to expiry of the contract:

$$\text{FVP} = \text{SP} + \text{CC}.$$

where:

SP	= spot price	
CC	= cost of carry	= {SP × [(rfr – I) × t]} + OC
rfr	= risk-free rate[49] (i.e. the financing cost for the period)	
I	= income earned during the period (dividends or interest)	
t	= days to expiry (dte) of the contract / 365	
OC	= other costs (which apply in the case of commodities: usually transport, insurance and storage).	

Thus, in the case of financial futures:

FVP = SP + CC
= SP + {SP × [(rfr – I) × t]}
= SP × {1 + [(rfr – I) × t]}.

An example will be useful: a 319-day futures contract on the All Share Index:

SP	= index value now	= 15357
t	= dte / 365	= 319 / 365
rfr	= assumed for 319 days	= 8.0% pa
I	= assumed dividend yield	= 2.0% pa

FVP = SP × {1 + [(rfr – I) × t]}
= 15357 × {1 + [(0.08 – 0.02) × (319/365)]}
= 15357 × [1 + (0.06 × 0.873973)]
= 15357 × 1.052438
= 16162.

It is clear that the difference between the spot price (15357) and the FVP of the futures contract is the rate of interest less the income for the period. This principle applies to all derivatives, except that options pricing contains other factors as well, such as volatility, and currency derivatives are priced using two interest rates: local and foreign (following the principle of covered interest rate parity).

We will not detail the pricing of all derivatives here, as they can be easily accessed at http://bookboon.com/en/derivative-markets-an-introduction-ebook.

Derivatives are used for (1) hedging a spot market position, (2) speculation (no spot market position) and, (3) investment (as an alternative to a spot market position). Is there a wealth effect attached to derivatives? Yes, in the case of speculation and investment.

6.8 Interest rates and the foreign sector

How does the foreign sector fit in with domestic interest rates? Domestic interest rates in relation to the rates prevailing in other countries has a major effect on foreign demand for domestic assets (inflows of capital) and domestic demand for foreign assets (capital outflows). We need to add here that capital flows do not necessarily affect the money stock or bank liquidity; this depend on whether the central bank or the private sector banks buy or sell foreign exchange. We do not have space to discuss this in detail.

Capital flows also have a major effect on the exchange rate, which influences the attractiveness or otherwise of exports and imports.

6.9 References

Faure, AP (2012–2013). Various which can be accessed at http://ssrn.com/author=1786379.

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