

Finance - Revision Exercise – Dividends, Capital Structure, Forex, Options
- Solutions

1. Explain the following terms
 - (a) passive residual theory of dividends
 - (b) clientele effect
 - (c) signalling effects
 - (d) 'bird-in-the-hand' view

(a) The company would invest in all positive npv projects, and payout any earnings that were left as dividends – dividends would be unpredictable.
(b) The company will attract particular types of shareholders due to their dividend preferences. Companies establish a track record for paying divs, shareholders recognise this. Companies should not try to change div policy to attract new clientele.
(c) There is a problem with asymmetric information, managers can use the div to give indication about future performance of company
(d) Said that near dividends were less risky than distant payouts, a certain payment now is more valuable than an uncertain gain in the future. But discount rate values all div at the same risk adjusted rate.

2. The decision over how much to payout and how much of earnings to retain is a key decision for managers. Identify and discuss the important factors that management should consider when deciding on the size of dividend to be paid to investors.

Main factors: profitability of company (and prospects for profits over business cycle), company's need for additional finance (liquidity position), the ability of the company to raise additional finance on the markets, its shareholders dividend preferences. The dividend decision would also take into account the gearing level which might limit the company's ability to pay divs.

3. Three old lags from business school meet up to spoil a good walk by playing a round of golf. During the game they discuss the profitable companies they now run. The conversation drifts towards dividend policy...

Boss A says his dividend policy is to pay no dividends at all .
Boss B says that he always pays a dividend of 50% of earnings after tax.
Boss C says that she maintains a low but constant dividend per share, offers scrip dividends, and shareholder perks.

One of the companies is a tech company, one is a utility.

Discuss the advantages and disadvantages of the alternative dividend policies.

Boss A – high growth Co – tech co. – is using earnings to plough back into the business to speed the growth of the company. Is good policy for growing co – will probably be hungry for capital.

Boss B – paying out 50% of earnings every year as a div may not be acceptable if profits are volatile – div would be changeable, so this would be more appropriate for a mature, stable company like a utility where the 50% payout would not be subject to much fluctuation.

Boss C – low div, scrip divs suggests that the company still has growth opportunities, and needs cash to finance the growth. The shareholders have the predictability of the div, the company can retain most of the earnings to finance the growth. Scrip divs save cash flow for the co, and shareholder perks would suggest it is the kind of company that might appeal to small shareholders – retailers, transport, leisure companies (perks = discount vouchers to use on company products, stores etc).

Which boss runs the tech company, the utility, and which sector would you think the other company might come from (for the third company - more of a judgement call)? Which type of shareholder would be attracted to these companies?

4. What are the agency concerns surrounding the dividend decision?

The div payment represents cash flow leaving the company and going to s/holders. In certain situations bondholders may be worried that the cash leaving the company might impair the company's ability to service its debt obligations. As a result there are clauses in debt contracts that will limit the amount companies can payout in cash to shareholders.

5. Do flotation costs favour high dividends or low dividends – discuss.

If flotation costs (fees for selling new equity, and the discount at which new shares might have to be sold at) are high, companies will not want to be raising cash by this method unless they can help it. That would mean they would pay low divs, and they would retain earnings for investment in the business.

6. When using debt and equity weights to calculate the wacc, do we use book values or market values, and explain why.

Use market values – these will reflect the current required rate of return on the assets, the market's perception of the risk of the company. It reflects the value of these assets today. The book value is likely to be out of date, may reflect decisions taken years ago and not be relevant today.

7. The majority of high growth companies do not use debt to finance new projects, but some do. Which type of high growth company would be more likely to use debt than equity to finance expansion?

Companies that may need heavy capital expenditures, for example, telecom companies – they use the debt markets to finance the investment in new infrastructure- they are profitable and can take advantage of the tax shields available.

8. (a) What are the direct costs of bankruptcy? What are the indirect costs of bankruptcy? Which are more of a burden on companies? Can you illustrate with an example.

(b) How much protection should companies in Chapter 11 Bankruptcy (US) or in Administration (UK) be given to carry on their business? – talk through with an example to back up your argument.

(a) Direct costs are the fees charged by the lawyers, accountants etc which actually only make up a small part of the costs of financial distress. The indirect costs are the costs of not being able to carry on business normally – credit drying up, suppliers and customers cancelling orders, loss of reputation, management time spent trying to resolve financial distress, asset sales at low prices. The indirect costs are far more damaging to the company. The company can go into administration (or Chap 11 bankruptcy in US) to get protection from creditors while it reorganises the business.

(b) When companies are given protection from creditors in the bankruptcy process they are given considerable scope to reorganise the business and start winning back market share from rivals. They are given protection from creditors and can renegotiate contracts (labour). They can reduce costs dramatically. They can undercut non-bankrupt firms, putting them under pressure. The bankruptcy process does not seem to remove capacity from an industry – it tries to preserve the industry set up. This may not be the healthiest outcome for the long run.

9. What are the agency concerns surrounding the capital structure decision? What impact would the following have on the decision; managers are rewarded largely by earning per share growth, managers are rewarded by economic value added created, managers rewarded largely by share options.

A company might have a capital structure that does not maximise wealth for shareholders. A company may be too conservatively financed, ie they have too little debt. This would be a very safe company. They would not face the discipline of debt and they would not be maximising the interest tax shield.

If managers are rewarded for meeting eps targets, then the managers might look to do share buybacks, which will reduce the equity (number of shares) in the company. By buying back shares, the share price does not suffer the fall when shares go ex-dividend when dividends are paid. Instead of equity financing managers should use debt finance. This means relative to a company that finances with equity, the geared company should grow eps faster under reasonable to good economic conditions (but underperform when the economy performs poorly). Managers can take actions that will grow eps quicker – share buybacks and fund with debt.

Managers are rewarded on the basis of Economic Value Added (EVA). EVA is an economic charge on the invested capital of the company. The company WACC is calculated (this is the basis for the economic charge) and the net operating profits

after tax (NOPAT) are established – these are the operating profits of the company (revenues minus expenses, don't include interest), then take off taxes. This gives you NOPAT. Invested capital is the capital employed by the firm, this is all short term and long term assets. The invested capital is multiplied by the WACC to give the economic return the company should make to satisfy shareholders. This is then subtracted from the NOPAT. If the answer is positive, the managers have added value (created wealth), if it is negative they have destroyed wealth.

If managers are rewarded on the basis of EVA, they can increase EVA by focussing on operating efficiency; they have to make more profit without using more capital, or they use less capital, or they invest capital in high return projects.

If the EVA is worked out on a year by year basis, managers may be reluctant to invest in long term projects that take some time to deliver their full value – because the EVA will be low or negative in the early years.

If managers are rewarded with executive options, they are more likely to cut back on dividends – the option holder does not get the dividend – so they will favour share buybacks (in the US the value of buybacks was recently running at double the value of dividends, twenty years ago, buybacks were about a fifth of the level of dividends). With options the managers may be more likely to finance with debt, expecting eps to grow quicker and the managers would think that the price earnings ratio (P/E) would rise with growing eps. With a rising P/E ratio the share price will be moving up, making the options more valuable.

10. Raeburn plc currently has 10m shares outstanding, with a market price of 500p per share. It also has £20m of 7% debt outstanding, which are trading at par. Raeburn is considering a £40m investment program that it will finance either with (a) all equity sold at 500p per share, or (b) all bonds issued at par with a 9% coupon.

If the project is undertaken, Raeburn believes it can attain £10m per annum in earnings before interest and tax.

The tax rate is 30%.

Calculate the earnings per share for each financing method.

Draw an EBIT-EPS graph for your results.

If the EBIT for the project turned out to be £6m, which form of financing would you recommend?

Remember that the company has an existing debt issue outstanding, so even if it decides to finance the new project with equity, it still has an existing debt obligation to meet ahead of the shareholders. (ongoing interest payments = $7\% \times £20m = £1.4m$).

tax	0.30	
existing debt £m	20	new int rate 0.09
existing int rate %	0.07	new debt 40

With £10m EBIT:	<u>all equity</u>	<u>all debt</u>
ebit	10	10
interest	<u>1.4</u>	<u>5</u> (£1.4m existing interest + £3.6m new interest)
ebt	8.6	5
tax @ 30%	<u>2.58</u>	<u>1.5</u>
after tax	6.02	3.5
No. of shrs	18	10 (10m shares originally, but if equity funded extra 8m @ 500p = £40m)
eps	0.334	0.35

With £6m EBIT:	<u>all equity</u>	<u>all debt</u>
ebit	6	6
interest	<u>1.4</u>	<u>5</u>
ebt	4.6	1
tax @ 30%	<u>1.38</u>	<u>0.3</u>
after tax	3.22	0.7
No. of shrs	18	10
Eps	0.179	0.07

levels where you would have zero eps would be:
ebit of 1.4m and 5m for the all equity co and debt co respectively.

You would favour equity financing for an EBIT of £6m as the eps will be higher than if financed with debt.

11. Why is the expected bankruptcy cost much larger to the owner of a private company than it is to the shareholders of a stockmarket listed company?

When private companies go bankrupt, the owner's personal wealth may be at risk (if there is no limited liability). The owner is also likely to be under-diversified and will be worse hit by the loss in value at the company. For shareholders in stockmarket listed companies – the s/holders have limited liability and they are likely to be diversified.

12. If a company has too high a level of gearing, how can they quickly reduce their gearing – how easy is this to do?

To reduce gearing a company needs to retire or repay debt. The dividend could be sacrificed to free up cash to pay off debt. A rights issue or other equity issue could raise cash, which could be used to pay off debt. Divisions, subsidiaries, assets could be sold for cash. Capital expenditure could be cut to release cash for debt repayment.

Shareholders would complain about the dividend being cut but the company can push that through if it means reducing pressure on the company. The equity issues may be more difficult, because the company may be perceived as being in trouble already and the share price would have fallen. A rights issue may have to take place at a very low price. Again selling assets may be difficult. If the company is seen to be in trouble they will not fetch good prices for assets in the market – they will be seen as a distressed seller.

13. It is argued that debt adds discipline to management. Why?
Which of the following types of companies will most benefit from debt adding this discipline?
- a) conservatively financed, privately owned companies
 - b) conservatively financed, stock market listed companies, with a wide and diverse group of shareholders
 - c) conservatively financed, stock market listed companies, with an activist and primarily institutional holding

Co. with wide and diverse shareholders. Private Cos. Invest their own money, and institutional investors have their own ways of disciplining managers.

14. Rank the following companies on the magnitude of bankruptcy costs from most to least, taking into account both direct and indirect costs:
- a) supermarket company
 - b) aeroplane manufactures
 - c) construction company
 - d) photocopier company

b),d),c),a)

The plane manufacturer has high indirect bankruptcy costs, because their contracts with buyers tend to be very long term. Photocopier firms have constant service agreements as part of their operating characteristic, would be adversely affected by the perception of default risk.

Construction companies have a greater volatility in their operating income because of the cyclical nature of their business leading to a higher probability of default.

Supermarkets have strong cash flow generation capabilities so would have the lowest bankruptcy costs.

15. Both Reckitt and Pearson have large cash balances, you are a shareholder in both companies. The managers claim to hold the cash because they

need flexibility. Which of the two managements are you most likely to accept this from?

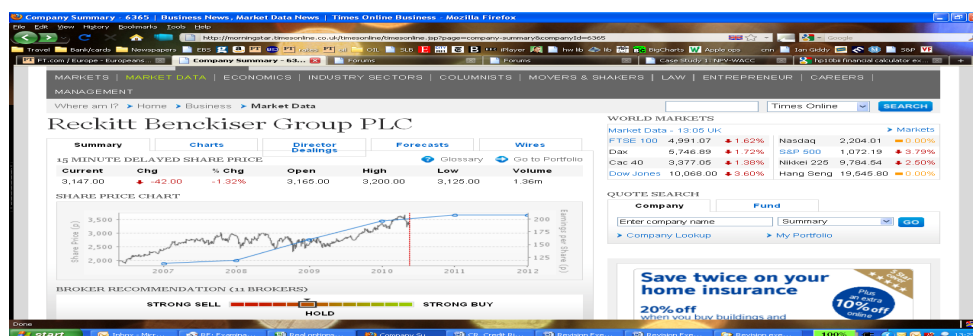
Pearson owns the FT, Penguin books, Pearson education. It is heavily involved in multimedia. Over the past years it has owned TV stations, investment banks, a crockery company (Royal Doulton), Madame Tussauds, internet companies. The Pearson share price chart is shown below.



The line with the circles on it represent past and prospective future earnings per share figures, indicated on the right hand axis.

Reckitt Benckiser is an Anglo – Dutch household goods firm, owning brands like Dettol, Nurofen, and Lemsip. Since the merger in 1999, Reckitts have

continued to acquire, the latest acquisition being the Boots Healthcare division for nearly £2bn in 2006. The share price chart is shown below.



Reckitts after an initial period of suspicion over the merger, has continually impressed the financial markets. Acquisitions have been in the core area and have added value. The firm is now the world's number one household cleaning products company. Pearson have invested in a lot of shareholder value destroying projects and takeovers, whereas Reckitts has consistently delivered value over the last few years. In the past 12 months Reckitts have performed strongly after a flat period around the Credit Crunch (they have been caught up in the recent sell-off though). Pearson have also recovered some ground in the past year, but overall in the past 5 -6 years their performance has been pretty flat and the shares are still only just about half the level they were 10 years ago, whereas Reckitts shares have multiplied by about 7 times over the last 10 years. They have created huge amounts of shareholder wealth. In 2000 Reckitt Benckiser was valued at around £3.5bn, in 2010 their value is around £25bn. There have been other takeovers along the way, but shareholder wealth of nearly £20bn has been created. The CEO, Bart Becht was paid £92m in 2010, most of this being the exercising of executive options. His pay packet created a row in the UK, with 'fat-cat' accusations being thrown about. But from a shareholder's perspective, he is worth every penny (he has been number 1 or number 2 since the original deal was done).

16. In the period 2002 – 2004 companies like BT, Marconi, NTL, Granada, SMG, British Airways, France Telecom, Deutsche Telecom, Vivendi, Scottish Power, Lucent, Nortel, Alcatel, TXU, Invensys, British Energy, Leeds United, Colt Telecom, faced huge debt problems and financial distress. Why was the amount of debt a problem and what were their options to get out of the financial mess?

The companies took on too much debt believing that the economic backdrop would remain favourable to their business. They wanted to use the leverage to expand rapidly, to outpace rival firms. By 2000 when the debt was been ratcheted up, the economy was in the 8th or 9th year of an expansion, the financial markets were at the peak of the dotcom bubble. Things could not continue at that pace. They didn't.

To reduce debt the firm has a number of options;

Rights issue, but share prices are depressed, high cost in that will incur extra div payments. Shareholders would demand a price for this.

Cut the div. BT did this, saving £1.4bn, but it will be under pressure from shareholders to reinstate it as soon as possible, as BT has an army of small shareholders who hold the share for the big div that they get.

Sell a division, eg. Yell or BT mobile (now 02), difficulty is that there are not many willing buyers, so they would get a poor price – may be more damaging to BT in long run. Both BT and Marconi did this, getting very poor prices in the process.

Sell one of their joint-venture stakes, eg. BT with Japan Mobile, which was sold to Vodafone. Granada closed down their joint venture with Carlton – ITV Digital – losing £1bn + in the process (after being put out of business by BSkyB).

Takeover a cash rich company, eg. BT could have tried to takeover Cable & Wireless. Not likely to be supported by the markets.

Do nothing. If they do nothing their debt will be downgraded and they will pay higher interest charges as a result of bond covenants. But if they can see light at the end of the tunnel, it may be better paying the higher charges in the short term rather than sacrificing some of its assets in such a poor market (This is what France Telecom & Deutsche Telecom did – but 8 years on their share prices are still 80 -85% below their highs of 2000).

Debt for equity swap – this is what NTL have done and virtually wiped out the original shareholders – they will only get a share in the company if the value rises above £10.5bn.

17. If the interest rate in the UK is 2.5% and in Japan it is 0.5%, and the current spot exchange rate is 128.1 yen to the pound, what is the six-month forward exchange rate?

interest rates				
UK	2.5%	6 month fwd rate =	$(1 + \text{forn (Jp)})^{0.5}$	* spot rate
Japan	0.5%		$(1 + \text{home (UK)})^{0.5}$	
sp x/r	128.1			
		6 month fwd rate =	126.8441	

18. With regard to foreign assets, what should a company hedge?

Foreign assets will either be real assets (land, buildings etc) or financial assets (cash flows). Real assets will be protected in that they will rise with any inflation in the foreign country so they don't need to be hedged. Financial assets will be affected if the foreign currency weakens – resulting in less £ when converted back, so businesses need to hedge their cash flows in overseas markets.

19. Ford wants to build a car plant in Spain, does it make sense for Ford to raise debt finance in euros? Explain your answer.

Yes. Ford can hedge some of the risk on the project by matching the financing cash flows with the cash flows of the project. If the euro fell against the dollar from current levels the factory will be worth less, but so will be the loan (in \$ terms) used to finance it. If the loan had been financed in \$ and the euro fell, there would be less cash flow coming in (once converted into \$) to service the debt.

20. The expected annual inflation rate in Columbia is 10% and in Chile it is 3%. The current spot exchange rate is 3.48 Columbian pesos to a Chilean peso. What is the expected spot rate in one year's time?

$$\text{exp spot} = \frac{1 + \text{forn inf}}{1 + \text{dom inf}} * \text{spot forn} / 1 \text{ dom currency}$$

$$\text{exp spot} = \frac{1.10}{1.03} \quad 3.48$$

$$\text{exp spot} = 3.716505$$

21. The annual interest rate in Switzerland is 2.5%, in Russia it is 9%. The Swiss franc trades at 19.58 roubles on the spot market, what is the 6 month forward exchange rate?

$$\text{fwd} = \frac{1 + \text{forn i/r}}{1 + \text{dom i/r}} * \text{spot forn} / 1 \text{ dom currency}$$

$$fwd = \frac{(1.09)^{0.5} * 19.58}{(1.025)^{0.5}}$$

$$fwd = 20.19129$$

22. If a call option has an exercise price of 700p and the share price is 725p, is the call option 'in-the-money' or 'out-of-the-money'?

The call option is in the money ($S_0 - X = 725p - 700p = 25p$ in the money)

23. If a put option has an exercise price of 45p and the share price is 44p, is the put option 'in-the-money' or 'out-of-the-money'?

The put option is in the money (for puts to be in the money $X - S_0$ must be positive; $45p - 44p = 1p$, so the put is in the money).

24. What are the payoff possibilities for a call option seller (writer)? Draw the payoff diagram.

Horizontal line above the x-axis, starts sloping down from the point of the exercise price. The call option writer will keep the premium (the option price) if the share closes at expiry (of the option series) at or below the exercise price (X in the diagram). As the share price rises the option writer's position will lose value, and as the share price continues to rise the option seller is exposed to potentially unlimited losses (how high can the share price go).

25. If you buy a HSBC June 600 call option for 9.5p today, with the share price at 595p, what will be your profit/loss at expiry if the shares are close at 605p at the expiry of the option series?

If the shares are 605p at expiry the option will be worth 5p ($S_0 - X$; $605p - 600p$), you paid 9.5p originally for it, so you lose 4.5p.

26. The current share price of BP is 550p. Over the next year the share price will either go to 750p or 450p, with equal probability. The risk free rate of interest is 4%.

What is the price of a call option using the binomial pricing model, if the exercise price is 500p? What is the put option price?

Exercise pr (X) =	500		
1 yr up price =	750		
1 yr down price =	450		
risk free rate (1 + rf) =	1.04		
share price So =	550		
upward multiplier 'u' =	1.3636		
Downward mult. 'd' =	0.8182		
Cu, (up price - ex.price)	250	0	max of
Cd, (down price - ex pr)	-50	0	max of
Y = (Cu - Cd) / So*(u - d)	0.8333		
Z = (uCd - dCu) / [(u - d)*(1+rf)]		Z-top =	-204.545
		Z-bot =	0.567
		Z =	-360.577
Co = Y*So + Z =	97.76		

Put price:

Put = Call + PV Ex price - Underlying share price
 Put = 97.756 + (500/1.04) - 550

28.53

27. Give examples where you might encounter options in your everyday life

Insurance policies are put options. When you buy a put option, your option will gain in value if the underlying falls in value. If your car crashes its value goes down, you exercise your option and you get a car to the value of your insurance policy. The difference is that with financial options (American) you can exercise at any time, with European options you exercise at expiry. With an insurance policy you would exercise when the unexpected event happens. A deposit on a new house is like a call option. You have the first right to buy that house, you can let your option lapse or you can sell it on to someone else for a higher price if you can. The exercise price is the price offered to you by the house builder. If the housing market is rising, then the value of that new house will rise too. If it is currently being built, it may well be worth a lot more than your exercise price by the time it is finished.

The equity in a geared company is like a call option. The amount of debt the firm has is the exercise price, the value of the assets is the underlying asset value (S0), the interest rate is the coupon on the debt, etc.

28. What does it mean when you 'exercise' an option?

When you exercise an option you are buying the underlying asset at the exercise price you fixed at the outset. Eg take the case of Tesco (from Q.31), if the company was facing a take over bid for say 500p, you might decide that you want to own the shares

– the bidding might go on past the June expiry, there might be another bidder. Your original option purchase gave you the right to buy Tesco shares at 430p each (– you paid 9.5p for that right), by exercising you will be able to buy Tesco shares at 430p even though they are trading at 500p in the market place (this means a call option seller has lost out as a result).

Most of the time options are not exercised – they are simply traded in the market place.

29. Today you have bought a 750p June put option on WPP for 30p with the current share price at 762p.
- a. If WPP's share price at the end of June is 785p what will your put option be worth, and what is your profit or loss on the position?
 - b. If the share price closes at 710p at the end of June what is the option value and your profit and loss on the position?

(a) Put value at expiry = $X - S_0 = 750 - 785 = 0p$ (option cannot have a negative value). You have lost your initial premium, the 30p.

(b) Put value = $750 - 710 = 40p$ value at expiry. Your profit is 40p – original cost of 30p = 10p.

30. Why would you not exercise an option early? When might you exercise early?

The option price is made up of exercise value and time value during its life. At expiry it will only have exercise value. If you exercise early you will lose the time value (which has a value up to the point of expiry, because potentially anything could happen to the share even one day before expiry – a bid might come along, an accounting black hole may be discovered).

Early exercise may be worthwhile if the company announces a special dividend (eg, shares at 500p announces a 100p special dividend, which would reduce the share price to 400p). The option holder does not receive the special dividend, the shareholder does, by exercising their option the option holder becomes a shareholder.

31. If you owned a business and needed to borrow £1m in 3 months time and there was considerable uncertainty over the direction of the next moves in interest rates, what would you do?

You would take out an interest rate option, this would enable you to benefit if interest rates went down (in your favour), while protecting you if interest rates went up. With forwards and futures you would be locked into the set rate whether rates went up or down. So you would not benefit if rates went down.

32. What are the arguments against hedging?

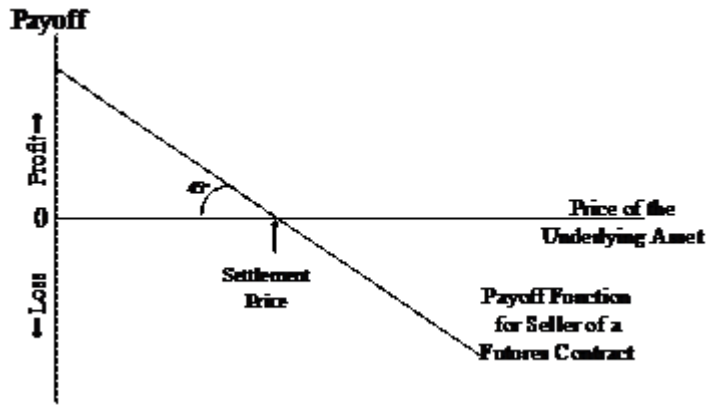
It can be costly in terms of the expertise needed to manage the hedging over time. If the underlying asset moves favourably for you, you will not be able to take advantage because you are locked in. This can give rivals who do not hedge an advantage over your company.

33. Who are most happy for a company to hedge, bankers, shareholders, bondholders, managers? How does a hedge work?

Bondholders and bankers would be most happy. They would see certainty over the cash flows that the company generates. If the company was unhedged they may be lucky or they might be unlucky. It makes for a riskier company. Shareholders would prefer it when the company is lucky and unhedged, they will be angry if it is the other way round. Managers jobs will be safer if there are no big mistakes, but they may lag behind companies that do not hedge at times.

Hedging will lock in a fixed price for the hedger. It may be an airline that is worried about the price of aviation fuel. It is exposed to the rising oil price. If they do nothing they pay the higher oil price. If they hedge they take a position that will have the opposite effect to their exposure. With the rising oil price they face a loss, so the position they take would result in a profit, so they would buy oil futures. If the oil price rises, they lose out on the underlying, but they gain on the futures contract, locking in a fixed price.

Similarly, if you have a company that sells a product and they want to protect the selling price they can use the futures market to lock in a fixed price. Eg. Rio Tinto Zinc (RTZ) may want to hedge its copper output. RTZ is exposed to falling copper prices. If the copper price falls they will lose money. To hedge they take a position that would gain when there is a price fall, so RTZ should sell futures contracts. If they sell the future and the price falls they will be able to close out the contract (by buying the future) and they will make a profit (eg, sell future at \$1000 and then later buy the future at \$900 closing the transaction, making a profit of \$100. They have locked in a price of \$1000 – they have lost \$100 on the underlying, but gained \$100 on the future). The future sale is shown below. This gives firms more certainty over their cash flows.



34. The share price is 225p, the exercise price is 200p, the risk free rate of interest is 5%, the volatility is 30% , what are the prices of a one year call option and put option, using the Black-Scholes option pricing method?

The Black Scholes formula is;

$$C = S_0 N(d_1) - Xe^{-rt} N(d_2)$$

$$\text{Where } d_1 = \frac{\ln(S_0/X) + rt}{\sigma\sqrt{T}} + 0.5 \sigma\sqrt{T}$$

$$d_2 = d_1 - \sigma\sqrt{T}$$

$$d_1 = \frac{\ln(225/200) + 0.05*1}{0.30 * \sqrt{1}} + 0.5 * 0.30 * \sqrt{1}$$

$$d_1 = \frac{0.11778 + 0.05}{0.30} + 0.15$$

$$d_1 = 0.559277 + 0.15$$

$$d_1 = 0.709277$$

$$d_2 = d_1 - \sigma\sqrt{T}$$

$$d_2 = 0.709277 - 0.30$$

$$d_2 = 0.409277$$

We need to find $N(d_1)$ and $N(d_2)$ now. These are the probabilities of getting a number less than d_1 or d_2 from the Normal Distribution tables (Table 5 & 6 from the appendix).

For d_1 we can't look up 0.709277 directly, but we can look up 0.70 and 0.71 and our value is in between the two values.

$$0.70 = 0.7580$$

$$0.71 = 0.7611$$

$$N(0.709277) = N(0.70) + 0.9277(N(0.71) - N(0.70))$$

$$N(0.709277) = 0.7580 + 0.9277(0.7611 - 0.7580)$$

$$N(0.709277) = 0.75800 + 0.002876$$

$$N(0.709277) = 0.760876$$

For d_2 , we repeat the process;

$$d_2 = 0.409277$$

From the tables; $0.40 = 0.6554$

$$0.41 = 0.6591$$

$$N(0.409277) = N(0.40) + 0.9277(N(0.41) - N(0.40))$$

$$N(0.409277) = 0.6554 + 0.9277(0.6591 - 0.6554)$$

$$N(0.409277) = 0.6554 + 0.9277(0.0037)$$

$$N(0.409277) = 0.6554 + 0.003422$$

$$N(0.409277) = 0.658832$$

Now we can price the option;

$$C = S_0 N(d_1) - Xe^{-rt} N(d_2)$$

$$C = (225 * 0.760876) - 200e^{-(0.53 * 1)} * 0.658832$$

$$C = 171.197 - 200 * 0.951229 * 0.658832$$

$$C = 171.197 - 190.24588 * 0.658832$$

$$C = 171.197 - 125.34$$

$$C = 45.8569$$

(Using Excel the call value works out at 45.8678)

Having worked out the call price, you can calculate the put price using the put-call parity relationship;

$$Put = Call + PV X - S_0$$

$$Put = 45.8569 + 190.24588 - 225$$

$$Put = 11.103$$

(Using excel will generate a more accurate answer; using excel the call is 25.912 and the put is 2.957.)

35. If the share price is 330p and the exercise price is 350p, the risk free rate of interest 4% and the volatility 40%, what are the six month call and put prices using the Black-Scholes option pricing model?

Using the same method as in Q.34;

$$d_1 = 0.0041$$

$$d_2 = -0.2787$$

$$N(d_1) = 0.50164$$

$$N(d_2) = 0.3922$$

$$PVX \text{ (this is } Xe^{-rt}) = 343.0695$$

$$Call = 31.667$$

$$Put = 44.736$$

36. Using the data from Q.34, but changing the volatility to 80%, holding everything else the same, what are the call and put prices using the Black-Scholes model?

Using the same method as in Q.34;

$$d_1 = 0.2142$$

$$d_2 = -0.3515$$

$$N(d_1) = 0.58480$$

$$N(d_2) = 0.36261$$

$$PVX \text{ (this is } Xe^{-rt}) = 343.0695$$

$$Call = 68.58$$

$$Put = 81.65$$

37. Using the data from Q.34, but changing the time to 1 year (volatility going back to 40%), what are the call and put prices using Black-Scholes?

Using the same method as in Q.34;

$$d_1 = 0.1529$$

$$d_2 = -0.2471$$

$$N(d_1) = 0.56076$$

$$N(d_2) = 0.40241$$

$$PVX \text{ (this is } Xe^{-rt}) = 343.0695$$

$$\text{Call} = 49.728$$

$$\text{Put} = 56.00$$

38. Using the data from Q.34, but changing the interest rate from 4% to 8% (time is 6 months and volatility is 40%), what are the call and put prices using Black-Scholes?

Using the same method as in Q.34;

$$d_1 = 0.0748$$

$$d_2 = -0.2080$$

$$N(d_1) = 0.52982$$

$$N(d_2) = 0.41760$$

$$PVX \text{ (this is } Xe^{-rt}) = 343.0695$$

$$\text{Call} = 34.41$$

$$\text{Put} = 40.686$$

39. Compiling all the prices from Q.35 to 38 and putting them in a table, what comments would you make on the prices that you have generated?

See next page

Q.39 A table has been created below, which shows the option price for changes in one variable at a time. The changed variable is shown in **bold**. The call price is in the row under the table. The line under the call price shows the variability in the option price to the change in the variable. From the table, it can be seen that volatility is the most sensitive variable, followed by time to expiry. The interest rate is seen to be quite insensitive. On the right hand side of the table, option prices for different exercise prices and share prices are shown. From this it can be seen that time value (the excess of the option value over the $S_0 - X$ exercise value, is the greatest when the share price is at the money, ie, $S_0 = X$). When the share price is at the money, all the option price is time value, as the $S_0 - X$ is 0. The aim of the table is to help you understand how the Black-Scholes option variables affect the option price, you would not be asked to do this in an exam, if there was a Black-Scholes calculation, you would just price one call option, given the relevant variables. You could also be asked to price the put using the put-call parity relationship.

	<u>Q.35</u>	<u>Q.36</u>	<u>Q.37</u>	<u>Q.38</u>	Change exer			
	<u>original</u>	<u>vol*2</u>	<u>vol*0.5</u>	<u>T*2</u>	<u>T*0.5</u>	<u>rf * 2</u>	<u>rf * 0.5</u>	<u>price</u>
So	330	330	330	330	330	330	330	330
X	350	350	350	350	350	350	350	400
T	0.5	0.5	0.5	1	0.25	0.5	0.5	0.5
rf	4.0%	4%	4%	4%	4%	8%	2%	4%
vol	40%	80%	20%	40%	40%	40%	40%	40%
Call option price	31.67	68.58	13.15	49.73	19.48	34.41	30.34	16.81
% change in option price		116.5%	-58.5%	57.0%	-38.5%	8.7%	-4.2%	$S_0 - X =$
							$S_0 - X =$	0
							Time value	16.81
							=	
- Volatility is the most sensitive variable								
- Time is a sensitive variable also, but								
- the interest rate is a very insensitive variable								