June 2008

Question 1

You run an investment company and an interesting proposition has arrived on your desk. There is a property investment company that is about to invest £2.3m in a project. They do not have all the funding in place. You offer to provide them with the cash they need to complete the funding by buying a call option, with an exercise price of £2.2m from them on the development. You have researched the proposal and believe that the project will pay off either £2.7m or £2.1m in six months time; with each outcome having a probability of 0.5, no other outcomes are possible. The annual interest rate is 4.25%.

Required:

a. How much should you pay for this option?
   (6 marks)
b. If there was a put option available on this project, how much should it cost?
   (4 marks)
c. Draw a payoff diagram for the original option strategy in part (a).
   (3 marks)
d. Identify and discuss examples of the main categories of real options and explain how you would use and analyse real options.
   (7 marks)
e. It is often said that the equity in a geared company resembles a call option. Using the Black–Scholes variables discuss how the model works in general.
   (6 marks)
f. Your company also uses large amounts of cocoa in producing chocolate products. Describe how you could use the futures market to protect yourself as a buyer of cocoa and draw the payoff diagram for your futures strategy.
   (4 marks)

Case Solution 1

(a) **How much should you pay for this option?**
   (6 marks)

$S0$	2 300	
up price =	2 700	
down price =	2 100	
u	1.174	
d	0.913	
Cu	500	$\max(0, [u \times S0] - X)$
Cd	0	$\max(0, [d \times S0] - X)$
X	2 200	
rf	0.0425	
t	0.5	
Y =	0.833333	
Z =	− 1 713.96	
C0 =	**£202 710**	

The figures above are in thousands. You would pay £202 710 for this six-month option.

(b) **If there was a put option available on this project, how much should it cost?**
   (4 marks)
   The put is priced by using the put–call parity relationship. This relates the price of the put to the price of the call and the price of the underlying share and the present value of the exercise price. The calculation is shown below:

Put =	Call	+	PV of exercise price	–	underlying share price
Put =	Call		PVX	–	S0
Put =	202.71	+	2154.69		2300
Put =	**57.40**				

(c) **Draw a payoff diagram for the original option strategy in part (a).**
   (3 marks)
   The diagram below shows the payoff from this strategy. The area of loss represents the premium paid for the option (£202 710). The strike price is the exercise price (£2.2m), and the area of gain would be the payoff if the project were successful £500 000 (£2.7m – £2.2m). This would result in a near 150% gain on the original investment in the option.
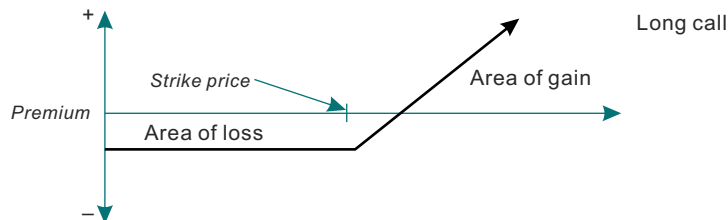
(d) **Identify and discuss examples of the main categories of real options and explain how you would use and analyse real options.**
   (7 marks)
   Real options are options to alter, abandon, or extend a project's cash flows at some future point. Because of the nature of real options, conventional capital budgeting is not appropriate for their evaluation.

   Companies sometimes undertake projects that appear to have negative NPVs. The project is often undertaken because the company sees a future opportunity to expand the project which would make it much more valuable. So the company is willing to put up with early losses until the point in time comes when they have the option to expand the business. Examples are some of the early investments in the internet. These were loss making for parent companies but allowed the company to have a presence in that market which made it easier to expand when that market had grown sufficiently. To have not invested would have meant the company would have to do an awful lot of catching up.

   There is also the option to abandon a project. These are effectively put options. You would re-evaluate the project at different time points and if alternative strategies have more value, they would be adopted, e.g. selling the project, or switching the project. The abandonment (and switching) option gives the company more flexibility.

   Another real option is the timing option. This gives the holder of the option the option to wait a period of time before taking up the investment. It may be an option on an oil field and you wait to see what happens to oil prices. It may be a development plot of land when you wait and see what happens to residential prices and commercial prices before you exercise the option.

   The NPV of the conventional project would be calculated, then the value of the real option(s) would be calculated using the binomial or Black–Scholes option pricing model. The values for the options would then be added to the basic NPV of the project to give a true indication of the NPV of the project.

(e) **It is often said that the equity in a geared company resembles a call option. Using the Black–Scholes variables discuss how the model works in general.**
   (6 marks)

   If you have equity in a geared company, it is like a call option. The nominal value of the debt is the exercise price (X), the value of the underlying assets of the company is the S0 value, the time until the expiry of the debt, the maturity is the time (t) of the option, the variability of the cash flows of the company is the volatility (v) of the asset, and the interest rate on the debt, the coupon, is the (r) in the model.

   If the value of the underlying assets is greater than the value of the debt at maturity, then the shareholders will buy the company back off the bondholders. If it is less than the value of the debt, the shareholders will let the option lapse, as is their right under limited liability. For the shareholders to buy the company back, S0/X must be greater than 1.0. The longer the maturity of the debt, the more valuable the company will be as there is more time for something beneficial happening. The more volatile the cash flows, the more valuable the company will be. If interest rates are higher, the equity value will be higher as the present value of the debt is lowered, due to the higher interest rate.

(f) **Your company also uses large amounts of cocoa in producing chocolate products. Describe how you could use the futures market to protect yourself as a buyer of cocoa and draw the payoff diagram for your futures strategy.**
   (4 marks)

   If you were a buyer of cocoa, you would be worried that the price of the commodity would rise before you could buy it. You could buy futures contracts that would lock in a fixed price for your company. If the commodity rises in value, you will have to pay more than you did if the price had stayed the same, so you have a loss at this point. The future that you bought will rise in value offsetting the loss you suffer on the underlying as a result of the price rise. You will have hedged your commodity price risk. The payoff diagram is shown below. The buyer has to take a position opposite to the position he has at the time of inception. At inception, the cocoa buyer is effectively short because he needs to make a purchase at some point in the future. So the opposite of the short transaction is to take a long (buy) position.

   The dotted line represents the payoff to the underlying as the market price of cocoa rises. The buyer loses out as the price rises. The solid line represents the payoff to the future. It gains as the cocoa price rises. The net effect is to cancel each other out and fix the price that the buyer will pay for cocoa, no matter what happens to the underlying price.
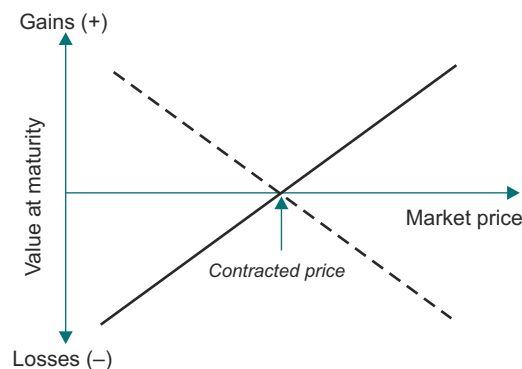
Question 2

1. In capital budgeting, describe how the following items are treated in the project appraisal:
   – Product cannibalisation
   – Depreciation
   – Interest charges
   (9 marks)
2. How does capital rationing affect a company and how can capital budgeting techniques help resolve the problem?
   (6 marks)
3. What is the problem with IRR and mutually exclusive projects, and how can it be overcome?
   (5 marks)

Case Solution 2

1. **In capital budgeting, describe how the following items are treated in the project appraisal:**
   – **Product cannibalisation**
   – **Depreciation**
   – **Interest charges**
   (9 marks)

   Product cannibalisation refers to the situation where a company launches a new product or service and that affects the existing range of products and services. This can steal sales away from the existing offering thus lowering cash flows. This has to be taken into account when estimating the cash flows when evaluating the project. A cash flow loss would have to be built in to reflect the loss in sales. This would be the case unless the company was involved in a very competitive sector where they would have lost sales whether they introduced a new product or not, as in, for example, the mobile phone market and the personal music player market. If you don't launch a new product, you will lose sales to the new product from the other company.

   Depreciation is not a cash flow, but it does have an impact. The company will benefit through the depreciation tax shield, so they will pay lower taxes as a result. When the company buys new machinery, the cash is gone at the start. Depreciation recognises this over a longer time frame. Depreciation can be straight line or accelerated. If accelerated, the company benefits because they will receive a greater time value benefit.

   Interest charges are ignored in the cash flows; they are built into the discount rate that is applied to the project. The after tax cost of debt is used. The interest tax shields are excluded from the analysis.

2. **How does capital rationing affect a company and how can capital budgeting techniques help resolve the problem?**
   (6 marks)

   Capital rationing can be internal or external. External capital rationing should not exist. This is the capital markets effectively not supplying the company with capital. If the company has identified good projects (positive NPV) to invest in, the market will provide the company with capital, but the company might not like the price the markets are charging for the capital. The market might decide the company is too high a risk and charge a substantial premium for debt or equity capital. The capital markets may disagree with the figures that the company is producing, thus hiking the price of capital.

   Internal capital rationing is when the company itself imposes restrictions on the number of projects it will fund. The company will have an annual budget for projects and the different parts of the company will have to bid for the money.

   The way the company will decide on which projects to invest in will be on the basis of NPV. The company will use NPV in conjunction with the profitability index (PI) to see which projects will generate the largest total NPV for the company. The PI will indicate to the company which projects produce the greatest return per £ invested, but this will not reflect the scale of the project. The NPV itself will tell which projects together will deliver the largest NPV.

3. **What is the problem with IRR and mutually exclusive projects, and how can it be overcome? (5 marks)**

With mutually exclusive projects, we have to choose among competing projects. Ideally, we want to choose the projects with the highest NPVs. With IRR, projects will have their quoted IRRs, but it would be wrong to rank the projects on the basis of their IRRs. This is because the IRR does not reflect the scale of the project. Also the IRR may be higher for one project than another, but when analysed using the company cost of capital the results are the other way round. This is due to the pattern of the cash flows over the life of the project.

One way of overcoming this problem is to do an incremental cash flow analysis of the two projects. This is the defender and challenger analysis. The project with the highest nominal cash flow is the defender and the other is the challenger. Subtract the challenger cash flows from the defender and find the IRR of the remaining cash flows. If the IRR is greater than the hurdle rate, keep the defender. If not, keep the challenger. This will choose the project that will deliver the greatest NPV.