

# EXAMINATION

April 2007

## Subject SA5 — Finance Specialist Applications

### EXAMINERS' REPORT

#### Introduction

The attached subject report has been written by the Principal Examiner with the aim of helping candidates. The questions and comments are based around Core Reading as the interpretation of the syllabus to which the examiners are working. They have however given credit for any alternative approach or interpretation which they consider to be reasonable.

M A Stocker  
Chairman of the Board of Examiners

June 2007

#### Comments

No comments given.

- 1** (i) Tax — A firm's profits and losses may be taxed differently. For example, there may be restrictions on losses carried forward. Further, capital gains/losses may be taxed separately from income gains/losses.

Economies of scale — The firm may be able to hedge financial risk more cost effectively than the shareholder.

Asymmetric information — The shareholder might not know the financial risks that could be hedged.

Customer requirements — The firm's customers might require it to be financially strong and/or stable. For example, banks and insurance companies.

Employment uncertainty — A firm may be able to attract and retain staff more cheaply if the firm is financially strong and stable.

Bankruptcy costs — Bankruptcy costs the shareholder money. The shareholder is economically incentivised to prefer a firm which hedges sufficient risks to avoid unnecessary bankruptcies.

Loan costs and covenants — A firm may be economically motivated to hedge financial risks in order to borrow more cheaply and/or with more favourable terms and conditions.

- (ii) USA — The Chicago Mercantile Exchange trades index and option products. Trading is effected by auction system, open outcry, pit trading and the Globex system. Trades are matched and cleared by the Clearing House. Contracts are marked to market twice daily.

UK — Euronext LIFFE trades futures and options contracts in four asset classes including non-financial products. All trades are electronically based with simultaneous clearing and regular margin calls if necessary.

Japan — The Osaka Securities Exchange trades equity options and could be approached to see if it will trade commodity based options. Trades are fully automated using a computerized trading system. Regular margin calls are made if necessary.

- (iii) Foreign exchange risk. The goods are manufactured in GBP and 80% of the goods are sold in USD. Some of the remaining 20% of goods sold may also be sold in foreign denominated currencies. For the trade debtor receipts denominated in foreign currency and for the expected foreign sales of stock where the company fixes prices in advance this risk is a direct FX risk. If the company sets prices at the time of shipment then the FX risk from stock is less direct and to a large degree depends on the price movement of competition from other whiskies and other alcoholic beverages to determine whether the foreign purchasers are willing to pay the GBP equivalent price set by the company.

Interest rate risk. The major asset is stock which is expected to go up in line with retail price inflation and as such should keep relatively close to floating interest rates. However the company has a substantial fixed rate loan. If inflation falls in the future then interest rates might also fall and the fixed rate loan will be relatively expensive. The service cost of the loan will be being borne by the increasing value of the stock which will of course be increasing at a slower rate. Also, the link between retail price inflation and floating interest rates might break down, at least in the short term leaving the company exposed to short term interest rate volatility.

Commodity price risk. For the whisky which is not pre-sold the ultimate value of the stock will depend on the wholesale price of whisky at the time that the whisky is bottled and sold. On average, this will be years away and the wholesale price of whisky might fall or at least not rise with retail price inflation during this time.

Trade credit risk. The company is very exposed to the possibility that the largest debtor might default. The trade debtors already have the whisky and it will be virtually impossible to get the whisky back. The company would simply stand in the queue with the other creditors hoping to recover some or all of the moneys owed in due course. Apart from the default loss, the failure of the major credit to pay on time could also put considerable cashflow strain on the whisky company.

(iv) **FX Risk**

Future or forward contract covering pre-agreed sales and foreign exchange denominated trade debtors. This is a short hedge (the right to sell the currency). This is a static (set and forget) strategy as it covers known FX trades.

Much of the future sales of the current stock in hand might not be known. They may need to be estimated based on past sales in both terms of currency and timing. The whisky company must estimate the timing and currency of future sales as well as the likelihood of being able to pass on future UK retail price inflation to the customers. Once this is done the company will be able to estimate the future FX conversion timing and amounts. This risk could be covered with a set of forwards/futures. Alternatively purchasing a set of put options covering a range of currencies and dates would also protect the

company from decreasing exchange rates. The price of the put premiums might be outweighed by the option of not having to swap currencies if the contracts are not entered in to as expected.

### **Interest rate risk**

The company's production is estimated to increase in price in line with retail price inflation. Interest rates will generally move in line with retail price inflation. Hence the floating rate debt servicing cost is already adequately hedged to production. The fixed rate debt servicing cost is not.

The company could enter into a fixed to floating rate swap with a bank. Under the swap the coupons would change hands and not the principal amounts. The company would pay floating rates at the agreed rate from time to time and receive fixed coupons in return. These fixed coupons would be used to partly or wholly meet the company's fixed rate debt servicing costs.

The company is exposed to a large fall in interest rates which will make the fixed interest debt relatively expensive. A fixed to floating swap would mean that the company is giving up the potential to profit from future interest rate rises. As an alternative the company could purchase interest rate floor protection. The derivative counterparty would receive a regular premium from the company and if rates fell below the agreed floor level then the counterparty would pay the difference between the agreed floor and the actual interest rate.

### **Commodity risk**

The bank offers whisky based commodity derivatives to its customers. Assume that the bank would be willing to sell whisky forwards to the company. Forward contracts would neutralise both the potential future loss and profit from price movements. The company would then be exposed to the credit risk of the bank assuming that the contracts were not collateralised. There would be a number of forward contracts covering the expected sales profile for the current stock in hand.

The company might prefer to keep the potential profit from increases in prices and purchase a series of put options from the bank. The company would pay a premium in return for the right to put the whisky to the bank at the exercise price. If market prices fell below the exercise price then the company would put the whisky to the bank. If not then the company would sell the whisky in the market and the options would expire worthless.

### **Trade credit risk**

The company could purchase a credit default swap for each of its trade debtors protecting the company against default for the current term of the trade credit and seek to purchase new swaps as new credits are advanced in the future. The swaps may not be readily available for one or more of its debtors and/or

the terms offered under the swap may be different from the desired terms. This might be a very expensive option.

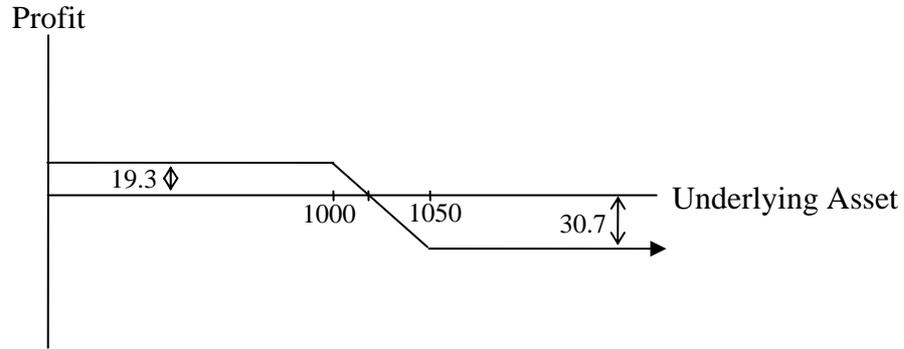
A much cheaper option might be to purchase a single longer term credit default swap on the largest debtor assuming that the average amount of moneys owing will stay constant or grow at say forecast price and volume increases in the future.

- (v) Write (sell) put options on whisky. This might be done through the bank acting as an intermediary or directly with investors. The options might be sold in, at or out of the money at differing levels of premium reflecting the likelihood of the whisky being put to the company. The company might believe that it can make these trades profitably because of its knowledge of whisky prices and its ability to on-sell any whisky put to it through its normal distribution channels. This strategy assumes that the whiskies able to be put to it under the options are of sufficient quality for the company to on-sell it as its own. The premium income received from the trade net of losses on put whisky would be additional profit for the company.

Write (sell) call options on whisky. This might be done through the bank acting as an intermediary or directly with investors. The options might be sold in, at or out of the money at differing levels of premium reflecting the likelihood of the option buyer exercising its right to purchase whisky via the option. The company might believe that it can make these trades profitably because of its knowledge of whisky prices and its ability to use its own whisky supplies to cover the risks associated with the options. This strategy assumes that the company's whiskies meet the option criteria. This strategy will be profitable if the company is confident that market prices wont rise by much more than expected. The premium income received from the trade net of opportunity losses on whisky sold under the options would be additional profit for the company.

Buy whisky forward contracts. The company would be agreeing the price today to purchase another party's whisky at a given point in time in the future. Assuming the contract is not collateralised then no moneys would change hands at the outset of the contract. The future value of the contract would depend on the future price of whisky compared with the fixed price agreed at the outset of the contract. The company might believe that it can make these trades profitably because of its knowledge of whisky prices and its ability to use its own distribution channels to on-sell the purchased whisky. This strategy is tantamount to the company becoming a larger whisky producer. The additional profit to the company would result from its ability to on-sell the purchased whisky at a profit.

(vi) **Strategy 1**

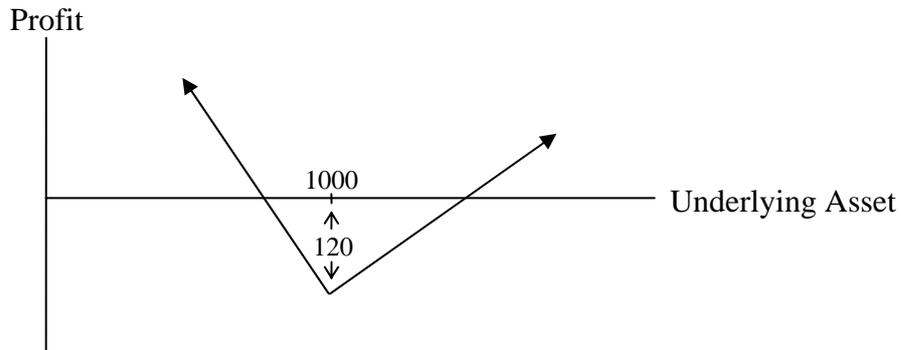


Long bear spread or put spread

Trader is seeking to hedge small price falls in the underlying asset

**Strategy 2**

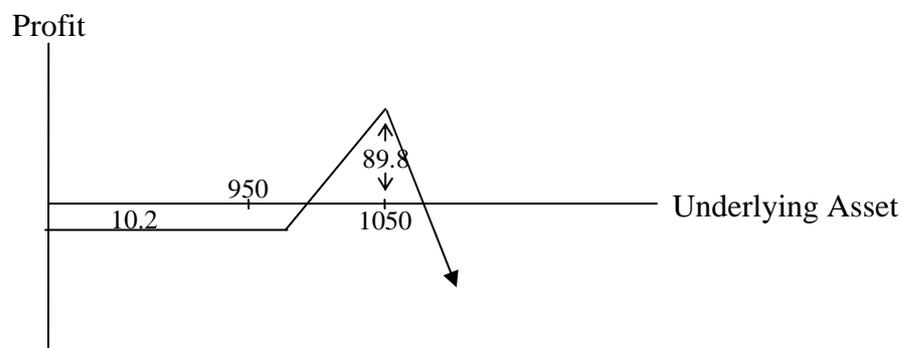
A strip (a type of straddle)



Trader believes there will be a large movement in price of the underlying asset and that a large fall in price is more likely than a large increase in price

### Strategy 3

Butterfly spread (call ratio)



Trader believes that the price variation will be low and that there is very little chance that the underlying asset price will rise by a large amount but that there is some risk of it falling sharply

- (vii) (a) Delta is the change in the premium of a call or a put option with respect to the change in price of the underlying asset.

Gamma is the change in delta of a call or a put option with respect to the change in price of the underlying asset.

Vega is the change in the option price of a call or a put option with respect to the change in volatility of the underlying asset.

- (b) Option premiums consist of intrinsic value and time value. Intrinsic value for a put option is the amount by which the exercise price exceeds the price of the underlying asset. Time value is a function of the likelihood of the option being exercised. It tends to zero as the expiry date of the option approaches.

Holding time constant a price change in the underlying asset will only affect its intrinsic value. For a put option, the premium will increase as the price of the underlying asset decreases. Hence delta will be negative. Whether the trader is short or long of the option is irrelevant to the delta.

## 2 (i) (a) **Bond**

Future income is linked to the value of the funds that the bond invests in. A fall in the value of these funds reduces the future income of the company.

There is no interest rate risk. Funds offered by the company that invest in bonds will be matched by the assets in the fund.

### **Annuity**

The company is exposed to changes in interest rates to the extent that it has mis-matched its assets and liabilities.

(b) and (c) together

### **Strategies**

To reduce the market risk the company can buy a derivative.

This will increase the counterparty credit risk.

In addition, the company will incur dealing costs and the additional costs of monitoring the derivative positions. Because it is open to new business it will need to implement an ongoing process to match the risk it is taking on (net of any business that is leaving).

The company could purchase a put option. This will not be a perfect hedge but will offset the loss caused by a market fall. The greater the protection purchased the greater the cost. However, the company can control the amount of risk it removes. It would retain the upside risk. The company could construct a swap that provides a fixed income in return for the investment fees linked to the market. This would have zero cost at outset but would remove any upside benefits. To control the amount of risk the company may decide to only swap a certain proportion of the stream.

The company could purchase a swaption. In a similar way to a put option this would have a cost dependent on the level of protection bought.

To reduce exposure to interest rate risk the company needs to match its liability outgo. Perfect matching is likely to be expensive and the appropriate assets may not exist. Therefore, the company could consider purchasing a synthetic security tailored to its needs. This could be potentially costly and, because it is open to new business, may need constant rebalancing.

- (ii) (a) The principal credit risk faced by the company lies within the corporate bond portfolio.
- (b) The structural approach uses valuation of an option to determine credit risk. As the credit risk is borne on the company's corporate bond portfolio we need to assess the credit risk of that portfolio.

Suppose that a company has a zero coupon bond outstanding.

Suppose

$V(t)$  = value of the company's assets at time  $t$

$E(t)$  = value of the company's equity at time  $t$

$D$  = Debt due to be paid at time  $T$

$\sigma(v)$  and  $\sigma(E)$  are the volatility of  $V$  and  $E$  respectively

If  $V(t) < D$  then the company will default on its debt at time  $T$  and the shareholders pass on the assets to the creditors.

Defaulting on the debt is equivalent to the exercise, by the debtor, of a put option on its assets written in its favour by the creditors. The creditors lose the difference between the value of the debt and the liquidation value of the assets..

Therefore a corporate bond can be divided into two components:

The put option

Riskless debt which has no credit risk, paid off with the funds generated by the exercise of the put option

Evaluating the put option is therefore equivalent to evaluating the credit risk. This needs to be done for each payment expected under the corporate bond.

The data required for the evaluation is generally accessible from stock market trading systems.

The economic value of the total assets of the firm cannot be directly measured but can be inferred.

The firm value  $V$  is commonly described by a diffusion process linked to the company's profitability and cashflow e.g.

$$dV = (\alpha V - Cf)dt + \sigma V dz$$

where  $\alpha$  = return on assets,  $Cf$  = cashflow,  $\sigma$  = standard deviation of returns and  $dZ$  is a Wiener process

Black-Scholes can then be used to derive  $E(0)$  since

$$E(0) = V(0)\Phi(d1) - De^{-r(T)} \Phi(d2)$$

The value of the debt today is  $V(0) - E(0)$

$\Phi(-d2)$  is the risk neutral probability that the company will default.

This requires  $V(0)$  and  $\sigma(v)$ , neither of which are observable.

However,  $E(0)$  is observable giving one equation in two unknowns.

From Ito's lemma  $\sigma(E) = \delta E / \delta V \sigma(V) V(0) = \Phi(d1) \sigma(V) V(0)$  and  $\sigma(E)$  can be more easily estimated this gives a second equation for the two unknowns.

The probability of default together with the size of the holdings can be used to assess the credit risk of the corporate bonds.

(c) Credit risk could be minimised by:

Purchasing credit default swaps. This swaps (some of) the default risk for a fixed payment. However there is a cost to this that will remove some of the advantage of investing in corporate bonds in the first place. This advantage is the higher yield these bonds achieve.

Credit default swaps usually have a term so that the portfolio of swaps will require monitoring and rolling-over to ensure that the desired level of risk transfer is maintained.

Purchasing a total return swap. This would swap the return on a group of assets for the return on another set of assets. This would have zero cost initially but may offer little advantage over changing the underlying portfolio.

Purchasing credit spread options. This is an option of the spread between yields earned on two assets, ie the corporate bond and a gilt. This provides a payoff if the spread exceeds a certain level and so this would protect against the credit spreads increasing.

Purchasing derivatives will add further counterparty credit risk.

(iii) (a) Operational risk is defined as the risk of direct or indirect loss resulting from inadequate or failed internal processes, people and systems or from external events.

(b) **Bond**

Risks are:

- Unit pricing failure because of system failure leading to servicing delays or issues with valuation
- Incorrect unit value paid on surrender
- Incorrect unit holding held on system
- Incorrect fee taken from fund

**Annuity**

- Incorrect annuity amount paid
- Annuity paid to person that is dead
- Investment matching process followed incorrectly.

**General**

- Fraud / theft
- Physical disasters

- Staff resource issues
  - IT or system failure
- (c) The advanced measurement approach allows a company to perform a risk assessment using its own models. The company must be able to demonstrate to a regulator that its models are fit for purpose and that it has adequate data.

One of three methods can be employed:

- The internal measurement approach
  - The loss distribution approach which uses statistical models to estimate losses based on observed data.
  - The scorecard approach, which scores different business lines
- (iv) (a) Liquidity risk is the risk of not having the sufficient cash to meet operational needs at all times.

For the contracts described:

- Annuities carry some liquidity risk if the assets do not precisely match (i.e. cashflow match) the liabilities. In this circumstance the company will need access to alternative funds to be able to meet annuity payments as they fall due.
- The investment bond will carry zero liquidity risk because the assets precisely match the benefit. The only risk will therefore be if there are timing delays between realising the assets and paying the policyholder.

In practice there will be other issues affecting liquidity besides the policy risks. There will be the payment of the company's expenses, principally staff costs and premises costs.

- (b) In order to control liquidity risk it is necessary to be able to measure and predict the risk.

A balance sheet model of liquidity can be constructed by allocating assets as either liquid or illiquid and liabilities as stable or volatile. The net liquid assets are the difference between the liquid assets and the volatile liabilities – the liquidity gap.

A more scientific approach is to use liquidity duration. Discount the liabilities and assets at the “cost of funds” interest rate. Then measure the change in the company's equity from a change in the “cost of funds” rate. If the change is negative then the company can control the risk by shortening the term of its assets relative to its liabilities.

The company would expect to maintain a float as part of its Treasury management to ensure liquidity. The unit funds of the bonds may also

keep some cash balances to ensure liquidity and this will be particularly important for funds investing in illiquid assets such as property.

**END OF EXAMINERS' REPORT**