Institute of Actuaries of India

Subject SA6 – Investment

November 2010 Examination

INDICATIVE SOLUTION

Introduction

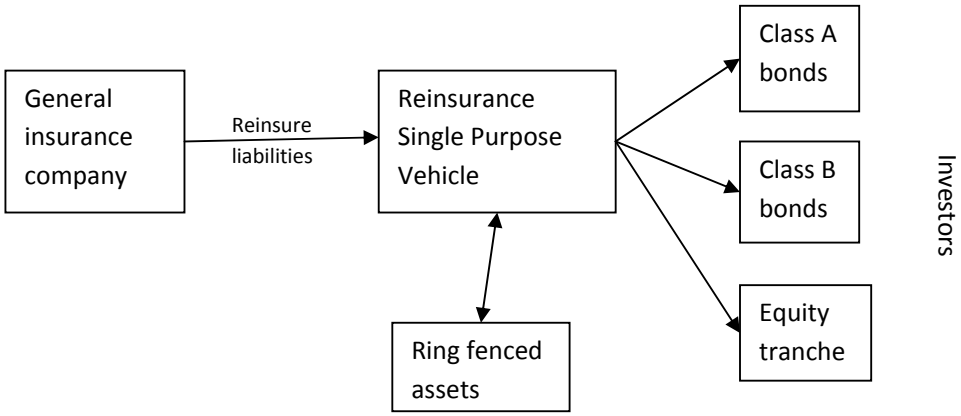
The indicative solution has been written by the Examiners with the aim of helping candidates. The solutions given are only indicative. It is realized that there could be other points as valid answers and examiner have given credit for any alternative approach or interpretation which they consider to be reasonable

Answers

a) i)

- Large frequency low severity claims quickly paid
- Small number of large claims which may have a considerable time lag prior to payment (e.g. due to court claims)
- Policies taken out for one year, and notification of claims should be completed relatively quickly
- Low severity claims paid in monetary terms, but cases going to court more long term and subject to court inflation.

ii)



The general insurance company would reinsure the motor liabilities to a reinsurance Single Purpose Vehicle (SPV). This SPV would raise capital to back these liabilities by issuing bonds to investors whose coupons and payment at maturity would depend on the performance of the motor insurance book. The bonds could be tranched so that losses would have to exceed the capacity of the equity tranche before Class B bonds were impaired and similarly the losses would have to exceed the capacity of the equity tranche and Class B bonds before the Class A bonds were impaired. Structure may be revolving for say 4 years so that the renewal of a motor insurance policy by customers automatically becomes part of the structure. This would tend to lengthen the repayment period so that bonds are medium term notes.

iii) Features to improve attractiveness:

- Tranching makes the structure appeal to a wider investor base e.g. life companies and pension funds would be more likely to invest in the safest class A bonds whilst hedge funds might invest in the more speculative (and so expected higher return) equity tranche.
- Tranches may be in different currencies (with a currency swap as part of structure) if that attracts particular investors e.g. US $
- Monoline wrap of structure or certain tranches to increase credit rating.
- Ring fenced assets so that if life insurance company becomes insolvent for some other reason, investors will still have capital returned at maturity provided block of business that was securitised has not had sufficient losses to trigger a non-payment.
- Independent agent to carry out calculation and determine if triggers are breached.

- Original general insurance company retains equity risk (or a large proportion of it) so that there is alignment of interests of the future payments of claims on the book. However, regulators may be concerned that this results in insufficient risk transfer occurring for the liabilities to become off balance sheet.
- Expenses are fixed at outset (with an allowance for inflation) so losses do not arise due to management not controlling expenses (or cross-subsidising the expenses of other lines of business),

iv)

- The structure would be innovative in India and so a more detailed analysis would be required
- Due diligence should include claims experience in the industry as well as the general insurer, as well as reviewing underwriting standards (initial and claim)
- Given a private placement there may be opportunities to have more specific details of the portfolio than would be possible in a public offering (due to general insurer's desire to restrict commercially sensitive information)
- Given first time such a structure would be used in India, the issuer may have to issue bonds at a discount to fair value to interest sufficient investors and make the placement successful(an uncertainty premium)
- Life insurance company would need to assess how the asset matched the term, nature, certainty, currency of its liabilities
- Life insurance company would need to assess any admissible asset issues
- An investor would need to consider what other opportunities are available in the market at that time
- For the life insurer there could be diversification benefits of having an asset whose cashflows are linked to general insurance

b)

i)

- The insurance company has sold a guaranteed annuity option (GAO). By regulation 2/3rd of vesting monies need to be used to purchase an annuity and the other 1/3rd can be encashed as a lump sum.
- Vesting amount to be used to purchase annuity = Present Value of future annuity payments
- If interest rates at vesting are greater than 5%pa, then a rational customer would use OMO to purchase an annuity elsewhere (or use the then current annuity rates of the life insurance company).
- If interest rates at vesting are less than 5%, then option is in the money and the rational customer would exercise the option within the contract.
- Often a lot of inertia with annuities as customers may not understand the OMO, though more sophisticated/richer customers may have financial advisers to advise them. Take up rate may be very high but if option in the money a rational customer may not take the 1/3rd cash lump sum but annuitize it as well (compare Equitable Life in UK on how customers learnt to understand the value of their benefits due to newspapers etc.)

- Hence a deferred option on interest rates is being sold by the life insurance company – a swaption. The holder has the right but not the obligation to enter into the interest rate swap transaction in the future.

ii)

- A swaption is more likely to be an Over The Counter instrument and so the credit risk of the counterparty needs to be considered or regular collateralisation posted.
- A standard swaption will have an option term and then a payment term. With an annuity book there is a longevity risk in that the actual annuity payment term may be less or more than the payment term of the swaption.
- The take up rate and the take up amount may change in the future as customers become more knowledgeable

iii)

Assume swap rate at the maturity of the option is ln normally distributed,
P(t,T) is the price at time t of a zero-coupon bond paying 1 at time T,
A is an annuity of term n years
$=\sum_{i=1}^{10} P(0,t_i)=e^{-11r_{11}}+e^{-12r_{11}}+e^{-13r_{11}}\ldots e^{-20r_{11}}$ ■
0.57695+0.516851+3.2539485 =4.34775 using spot rate of 5% in year 11 and 5.5% in year 12 and beyond.
K is the strike price =5%
F_0 is the forward rate swap =4%
σ is the volatility of the swap rate =0.3
L is the principal = 12 crore
Φ is the cumulative standard normal distribution function

$d_1 = \frac{\ln\left(\frac{F_0}{K}\right)+\sigma^2 T/2)}{\sigma\sqrt{T}}$ =0.239128

$d_2 = \frac{\ln\left(\frac{F_0}{K}\right)-\sigma^2 T/2)}{\sigma\sqrt{T}}$ =-0.70956

Value of swaption is LA[KΦ(-d_2)-$F_0\Phi(-d_1)$] = 1.1389 crore

c)

i)

- In an interest rate swap (IRS), one party agrees to pay a fixed interest rate on a notional principal for a number of years to the other party, who in return pays a floating rate on the same principal over the same time period.
- The floating rate would be based on the Mumbai Inter Bank Offer Rate Overnight rate compounded over the term of the swap (and paid at 6 monthly intervals)
- Internationally LIBOR is often used as floating rate e.g. 3 month LIBOR, but it could be 3 month commercial paper rate
- At the beginning of the swap the present value of all cashflows is zero.
- In India, IRS are liquid out to five years, although some swaps are transacted out to ten years
- IRS should be collateralised and marked to market on a regular basis or transacted through an exchange to reduce credit risk
- There is still residual risk within a swap as it is difficult to earn MIBOR without taking risk

ii) In a total return swap, the total return from one asset (or group of assets) is swapped for
ii) the return on another. These enable financial institutions to achieve diversification by swapping one type of exposure for another.

In the absence of counterparty credit risk, the value of a total return swap is the difference between the values of the assets generating the returns on each side of the swap. A total return swap is normally structured so that it is worth zero initially.

In a longevity swap one party might agree to pay annuity payments on a book of business for a period of time in exchange for MIBOR + x% on a notional principal amount during that period.

Alternatively one party may pay the annuity payments on a book of business for a period of time and receive annuity payments based on a longevity index (e.g. Lifemetrics)

Invariably such a bespoke derivative would be an Over The Counter derivative and so counterparty credit risk would be required e.g. daily mark to market collateral under an ISDA (having defined what is meant by mark to market of longevity payments)

iii) Transaction could be structured as:

- reinsurance of longevity risk – primary responsibility resides with life insurance company who has credit risk to reinsurer (mitigated potentially by deposit back arrangement)
- sell business – no risk to seller if annuitants live longer than expected (except reputational if purchaser becomes insolvent) but means loss of customers and so opportunity to cross sell but may not be such a large issue for pensioners
- securitisation - bonds issued to cover contingency of annuitants living longer than expected, but cover is finite, and if insufficient, life insurer has to pay excess

d)

i) Customers have a European put option on the assets backing their policies.

Amount required in 5 years = 20*(1.03)^5

Government bonds will be worth in five years (20/5)*(1.04)^5

Equities need to be worth in 5 years K= 20*(1.03)^5 - (20/5)*(1.04)^5

Equities currently worth S_0 =20*80% =16

Risk free = 4%, maturity time is 5 years, σ=0.4

Φ is the cumulative standard normal distribution function

$$p = Ke^{-rT}\Phi(-d_2) - S_0\Phi(-d_1)$$

$$d_1 = \frac{\ln\left(\frac{S_0}{K}\right)+(r+\sigma^2/2)T}{\sigma\sqrt{T}} = 0.519502 \qquad d_2 = d_1 - \sigma\sqrt{T} = -0.37492$$

P=4.86 crore

ii)

- There are no transaction costs and taxes
- Risk-free interest is constant
- Market is efficient
- Underlying security pays no dividends
- Volatility of underlying security is constant
- Distribution of share prices at maturity of option is ln normal

[50]

Q2)

1) (i)

Credit derivatives are contracts on financial instruments like corporate bonds, debentures or other securities like MBS/ABS or loans where the credit risk can be transferred from one party which is holding such corporate bond or loans etc but does not want the credit risk to another willing party for a price. The risk transfer may be for the sovereign credit, group of companies, a single company, a pool of assets, a part of the assets, for the whole period of the bond/loan or a part of the period.

Credit derivatives express credit views of different companies and their instruments.

Credit derivatives are mainly used for credit risk transfer.

Credit derivatives may help in reducing credit risk exposure to specific counterparties.

In the risk capital regime it may be helpful to transfer credit risk if capital is a constraint since the risk capital requirements will reduce with such transfer.

For banks it is useful if one bank is overexposed to a particular company and wants to transfer the credit risk through such derivative without disturbing the basic financial contract (i.e. the loan or investment in debentures etc of that company).

For many investors who are looking for exposure to particular companies they may use the credit derivatives to gain such exposure.

(ii) The other credit derivatives which are popular (apart from Credit Default Swaps which are most popular) are given as follows:

1. Credit Linked Noted
2. Total Return Swaps
3. Credit Spread Forwards
4. Credit Spread Options

2) (i) The main risks in OTC derivatives are given below:

- Counterparty risk
- No limit on risk exposures, high built-up of speculative positions
- Complexity concerning actual risk exposures
- Lack of transparency in the positions
- Interconnectedness of large market participants
- Not so well regulated as compared to exchange traded transaction

(ii) The main risks in CDS are:

- Happening of a credit event
- Concentration of risk in a few entities
- Increase in credit spreads and the mark to market losses (as a result of increase in spread)

- Counterparty risk
- Basis risk
- Jump to default risk
- Large built up of speculative positions leading to systemic risks

(iii) The main benefits of using CDS instruments are as follows:

- CDS provides means to hedge credit risks and/or transfer credit risks
- It allows the corporate to manage their credit exposures to different entities and diversify their risks.
- It expands the market for the underlying securities
- The CDS spreads given an indication of the credit conditions in the market and also provide a benchmark for the price of new bonds to be issued by companies.
- CDS helps reduce the borrowing costs by broad basing the distribution of risk.
- Increases capital efficiency. The risk adjusted capital can be improved provided transfer of excessive credit risk is done to entities who can take the credit risk in their books.

3) CDS are highly popular credit derivative contract between two parties where CDS buyer avails credit insurance / protection (protection against risk of default by a company) for the period of the contract.

The buyer of the CDS contract has the right to sell bonds (reference assets) issued by the company (reference entity) at face value to the seller of the contract on the happening of a default (credit event) by the company.

For the credit insurance the buyer of the CDS contract makes periodic payments (quarterly, yearly etc where total yearly payment is referred to as the credit spread) to the seller of the contract for the term of the contract or till the occurrence of default. The settlement if a credit event occurs can be in cash or through physical delivery of the reference asset.

The following elements of the contract are clearly specified :

- a reference entity (the company etc which carries the risk of default)
- a reference asset / obligation (bonds etc which are agreed to be purchased at face value by the seller of the CDS contract (the buyer has the right to sell the bonds at face value in the event of default (credit event)).
- credit event (a default by the concerned entity)
- the term /maturity of the contract (standardized contracts usually have 20th of March, June, September, etc)every quarter like March, June etc)
- notional principal is the total face value of bonds which will the purchaser of CDS has the right to sell to the seller of CDS.
- Credit spread which is also called the coupon, price or fixed rate is the total yearly payment expressed as a percentage of the notional amount. It is the cost paid by the credit protection buyer to the seller. The cost is quoted in basis points paid annually but payments are usually made quarterly (for standardized contracts and use the actual/360 days basis.

4) The industry and the regulator had started taking the following initiatives:

- Standardization of CDS contracts
- Centralized clearing platform for CDS contracts
- Information on volumes of trade, registering of trades with a centralized agency
- Trade volume compression wherein the market participants brought gross exposures closer to net risk positions leading to a drop in the net risk positions and outstanding notional CDS contracts
- Imposing position limits
- Straight through processing of trades
- Efficient back-office
- Price transparency
- Streamlining of trading and settlement procedures
- Standardization of the CDS settlements, documenting the auction settlement
- Default handling procedures

5) There can be numerous underlying instruments on which CDS can be issued. The following can be underlying reference assets/obligations.

1. Corporate Bonds
2. Mortgage Backed Securities / Asset backed Securities
3. Loans
4. Equity backed Securities

The loans are difficult to transfer and may not have standardized documentations. Pricing of such loan transfer can be difficult. The trading volumes in CDS on loans are much lower than the CDS on corporate bonds. The CDS on loans may be introduced as a second step after the CDS on corporate bonds start doing well and also when some of the issues related to transfer etc have been addressed.

6) The arguments against allowing CDS to be purchased without having an underlying are as follows:

- Worldwide many countries are disallowing CDS without an underlying since it lead to very high leveraged positions in the market resulting in market/corporate collapses and in many cases it is causing borrowing difficulties even for the governments.
- If the market participant does not hold the security on which the CDS is issued then he has a short position in the credit risk. This allows the participant to speculate on the credit events which may occur.
- Large open positions in CDS without an underlying may have systemic implications.
- If the outstanding amount of CDS far exceeds the total amount of corporate bonds (the underlying) then it may lead to risks in the settlement.
- If the speculators are allowed to hold large buy positions in CDS of corporate whose bonds etc they are not holding they may act to bring down the company since they are not holding the corporate bonds and have vested interest in triggering a credit event for the company. Such speculators may simultaneously short the bonds (the

underlying) to make the CDS spread go up and make. Such activity of buying the CDS and selling the bond simultaneously leads to a wrong market perception of something wrong with the underlying entity and may completely distort the pricing.

The arguments for allowing CDS to be purchased without having an underlying are as follows:

- Allowing CDS without underlying leads to high liquidity and depth in the market for such instruments. Counterparties who hold such instruments may not want to trade and restricting the exposure to such parties only will impact the liquidity.
- It helps the participants to find other proxy hedges which may be more liquid but similar in credit risks (perhaps of the same industry or group company etc).
- Higher liquidity may help since it may lead to lower price of hedge.
- It helps in making the price discovery process more efficient.

7) The important benefits of standardized contracts are mentioned below:

- It helps to increase the liquidity / tradability of contracts.
- It helps in reducing disagreements over the loss amounts due to lack of consistency in the frequency, maturity time of the contracts.
- Leads to better regulation
- Increases the transparency and better understanding of the markets
- It helps in moving to a centralized clearing system

The advantages of centralized clearing system are as follows:

- It helps by reducing counterparty risks
- It helps in implementing good risk management controls and increases the effectiveness of regulations.
- It enhances the liquidity in the market
- It reduces systemic risks
- The standardization of the settlement process leads to less disagreements over the definition of credit events and conduct of auctions.

8) The following events may be regarded as credit events which may adversely affect the ratings of the reference entity and may trigger CDS payments. It may lead to a significant lowering of the market price of the corporate bonds etc (reference assets).

i) Insolvency or bankruptcy
ii) Non-payment of the coupon/interest or principal outstanding on due dates
iii) Non-payment of any loan or bonds/debentures which are higher in priority than the underlying (reference asset).
iv) Restructuring of loan etc wherein the reference entity was not able to meet the payments on the required dates due to liquidity or other problems.
v) Government imposes lien or moratorium on the reference asset and payments related to the same.

9)

Assumed that the notional principal is equal to Re1 and periodic payments are equal to "Re p" per annum. The period for the CDS contract is taken as 5 years.

Periodic Payment for CDS (end of year)	Expected payment	PV of payment	Default Time (middle of year)	Default probability	Recovery rate	Expected payoff	PV of payoff	Accrual payment
1	0.9700p	0.9044p	0.5	0.0300	30%	0.0210	0.0203	0.0145p
2	0.9409p	0.8180p	1.5	0.0291	30%	0.0204	0.0183	0.0131p
3	0.9127p	0.7398p	2.5	0.0282	30%	0.0198	0.0166	0.0118p
4	0.8853p	0.6691p	3.5	0.0274	30%	0.0192	0.0150	0.0107p
5	0.8587p	0.6051p	4.5	0.0266	30%	0.0186	0.0136	0.0097p
		3.7364					**0.0838**	**0.0598**

Total PV of payments for CDS	3.7364 p + 0.0598 p= 3.7963 p
Credit Spread	(0.0838 / 3.7963) × 10000 basis points = 221 basis points

Row three calculations are as shown below:

Expected payment = (1-3%)× (1-3%)× (1-3%)=0.9127 (where 3% is the conditional default probability)

PV of payment = 0.9127 × exp(-3×7%)

Default probability (unconditional)= 3% in first year, 3%*(1-3%) in second year and 3% ×(1-3%)× (1-3%)=2.82% in the 3rd year

Expected payoff = 0.282 × (1- recovery rate) =0.282 × 70% = 0.0198

PV of payoff = Expected payoff × exp(-2.5 × 7%) = 0.0166

Accrual payment is the payment which has become due from buyer of protection to seller. In case of default in the middle of year the seller will make good the losses (balance of principal, net of recovery rate) whereas the buyer has to make payment for the half year (accrual periodic payment which has become due at the time of default).

Thus accrual payment due at 2.5 years = default probability (0.0282) × 0.5p × exp (-2.5 × 7%)= 0.0118p.

10) The two main modes of settlement are Cash settlement and Physical settlement.

In cash settlement the CDS buyer , on occurrence of a credit event , receives a payment from the seller to compensate for the loss arising due to such event.

In the physical settlement the delivery of the reference asset or equivalent amount of similar assets needs to be delivered by the buyer to the seller and the buyer receives the face value (notional principal)

11) The nth to default CDS provides payoffs only in the case of nth default. Thus the second to default CDS would provide a payoff only in the event of second default.

12) The CDO structure allows creation of different tranches from a portfolio of bonds etc. The first tranche (having say x% of the total bond principal) bears all the credit losses till such loss reaches x% of the principal. The second tranche (having say the next y% of the bond principal) will bear the next set of default (after x% upto a maximum of (x+y)%).

The first tranche is referred to as the equity tranche. The rate of interest paid will be highest for the first tranche (bearing the maximum risk) and will reduce for subsequent tranches. The interest rate will apply on the remaining principal in the tranche (after losses have been paid).Generally the creater of the CDO retails the equity tranche and sells the remaining tranches. If the first tranche is of 10% and if there is a loss equivalent to 2.5% of the total bond principal then the loss to the equity tranche is to the tune of 25% of its principal and interest will be paid on the balance 75% of the tranche principal.

In a synthetic CDO where the creator sells a portfolio of CDS the credit risk is passed on to the holder of the synthetic CDO tranche. The payoffs will be similar to the CDO payments as above wherein the first tranche will be responsible for payoffs on the CDS until they have reached x% of the principal.

[50]

[Total Marks 100]

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