

Institute of Actuaries of India

Subject SP5 –Investment and Finance

November 2020 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.

Solution 1:**i) benefits of diversification**

Suppose we invest total amount in equal proportions in all the four assets.

The expected return is

$$\left(\frac{1}{4} + \frac{1}{4} + \frac{1}{4} + \frac{1}{4}\right) 10\% = 10\% \text{ p.a.} \quad [0.5]$$

Since the assets are independent, there will not be any covariance terms and variance of return is

$$\left(\frac{1}{16} + \frac{1}{16} + \frac{1}{16} + \frac{1}{16}\right) \sigma^2 = \frac{\sigma^2}{4} \quad [0.5]$$

Generally, if we invest in 'n' independent identical assets variance of return is $\frac{\sigma^2}{n}$ [0.5]

Clearly, there is lower risk (measured by variance: decreases as 'n' increases) for a given expected return when we diversify our investments in many assets rather than investing in few assets. [0.5]

[2]**ii) Other key factors influencing investment decision:**

- the suitability of the asset(s) for an investor's liabilities
- the marketability or liquidity of the asset(s)
- higher moments of the distribution of returns such as skewness and kurtosis
- taxes and investment expenses
- restrictions imposed by legislation
- restrictions imposed by the fund's trustees.
- the length of the time horizon, which is likely to vary between investors
- Any hedging considerations
- Duration of assets and potential need to match with liabilities

[0.5 each, **Max 3**]**iii) key factors in managing credit risk are**

- the creditworthiness of the counterparties in a deal [0.5]
- the maximum exposure to each counterparty [0.5]

[1]**iv) Credit risk is the risk that a counterparty to an agreement will be unable or unwilling to fulfill their obligations. [0.5]**

Credit risk can be controlled

- By placing limits on the credit ratings of counterparties with which an institution may deal
- In the absence of credit ratings, place limits on credit scores based on term, rank, sector and cover ratios of counterparties
- limits might be imposed depending of the potential length of exposure
- Dealing in derivatives on a recognized exchange with a central clearing house rather than over-the-counter
- Alternatively collateral or margin payments may be demanded from a counterparty as protection [0.5 each point]

It is important to monitor and place limits on the credit exposure to any single counterparty depending upon its credit rating [0.5]

Particular attention needs to be paid to aggregation of exposures in different areas. For example, a pension fund may hold both equity and debt issued by a bank as well as having cash on deposit with the same bank and having them as a counterparty to a derivatives deal. [1]

It will also be necessary to be aware of the particular relationships between different companies within the same group. [0.5]

Finally, credit risk can be hedged using the credit derivatives. [0.5]

[Max 4]
[10 Marks]

Solution 2:

- i) Contents in presentation of the ALM exercise results are:
- ALM results are often summarized into tables and/or in graphs. They provide information in three dimensions. We may include any conclusions, recommendations or alternative courses of action for decision makers.
- providing projections into the future (time dimension): asset and liability values, ALM mismatch reserves, any shortfalls, return to investors and fund house at different time horizons

The values of above variables at different percentile levels (like multiples of 5 or 10) at monthly, quarterly or annual intervals could be presented in tables or graphs

- providing some estimate of the range of likely outcomes (probabilistic dimension): probability of having any shortfalls and probability of any shortfalls not being covered by ALM mismatch reserves
- indicating the effect of changing investment strategy (asset mix dimension) or effect of changing any other parameters like in this case X % and FMC

We can summarize the results in a table: for each given X and FMC, the amount of shortfall and ALM mismatch reserves at various percentile levels

Highlight the combinations of X and FMC that will produce ALM mismatch reserves greater than VaR (Value at Risk) to the fund house.

We could recommend values of X and FMC that would be marketable to prospective investors. In addition, provide any comparison with similar values of competitor fund houses.

[1 each, **Max 6]**

- ii) Use of dynamic liability benchmarks

Dynamic liability benchmarks are benchmarks given to an investment manager that vary continually with the nature of the liabilities.

Unlike static liability benchmarks, they are closely linked to the liability portfolio at all times.

As such they represent an intermediate position between conventional "static" benchmarks and full liability hedging.

They are usually used in situations where the nature of the liabilities (and market conditions) can change rapidly and are unpredictable, eg in the context of currencies.

Here historical benchmarks would rapidly become inappropriate and would need to be modified continually as the nature of the liabilities is altered.

Where dynamic liability benchmarks are seen to be necessary, this will influence the choice of assets – in particular, the liquidity of the chosen assets.

[0.5 each, **Max 2**]

iii) Hedging without using options

We may synthetically prepare a portfolio of cash and the underlying instrument that replicates the value of a put option over short time periods. Synthetic portfolio requires frequent rebalancing of cash and the underlying instrument. [1]

This dynamic hedging requires adjusting of the portfolio on a daily basis. For each put option to be replicated we need to sell delta equity index. [1]

[2]

iv) Advantages and disadvantages of dynamic hedging using synthetic puts

Advantages:

Low cost: Since options are less liquid, transaction costs for options may be higher than the underlying instrument [1]

Flexibility: Options can be replicated using underlying instrument whereas an option at desired strike price may not be available or is hard to purchase, [1]

More control: It is easier to change the delta of the portfolio over time and there is no need to unwind an option and purchase new option, [1]

Disadvantages:

Dynamic hedging using synthetic puts may not work well under scenarios when markets suddenly jump or fall, and you incur additional cost to adjust the delta of the portfolio to achieve target portfolio. [1]

[1]

Governance – it may be more costly or time consuming to regularly adjust the delta of the dynamically hedged portfolio using synthetic puts by the mutual fund house and when outsourcing this there will be a new cost introduced [1]

[1]

The cost is unknown in advance as this depends on future volatility and future transaction costs of trading the underlying instrument whereas with an option there is more certainty around the cost at outset [1]

[1]

Lower than expected size of the fund will make the scheme unaffordable [0.5]

[0.5]

Higher than expected fund size will create liquidity problem and difficult to replicate the positions for big funds [0.5]

[0.5]

[Max 4]

v) Shortfall in ZCBs fund

Shortfall = $\text{Max}(0, \text{guaranteed value} - \text{current fund value})$ [0.5]

[0.5]

The term of the product is very low at five years. Hence, we may expect most of the non-active investors (say >85% of investors) to stay put and avail maturity benefit. [1]

[1]

The shortfall will be nil, i.e. actual fund value at maturity will always be greater than any new guaranteed value recorded as long as yields remain positive. [1]

- We know that the fund value was restored to guaranteed value as on the date the fund was switched to 100% maturity matching ZCBs. [0.5]
- If yields fall, even up to 0%, the maximum fund value recorded will be the face value of the ZCBs, and the maximum possible new guaranteed value to be paid at maturity would still be lower at X % of face value of ZCBs. The fund value at maturity, of maturity matching ZCBs, would be face value of the ZCBs. [1.5]

If yields fall close to 0% and you suspect that yields may fall further into negative territory, then just sell out all the ZCBs and sit on cash up to maturity. This will restrict possibility of recording any new higher guaranteed value. Anyway, the new guaranteed value recorded around the cashing day would be lower at X % of cash value. This action will take care of having nil shortfalls at pre-mature exits and at maturity. [2]

Pre-mature exit may be done by two types of investors which constitute a low proportion (say <15%) overall since the product term is low (5 yrs). [0.5]

- Few investors have need for liquidity: They do pre-mature exit anytime. Therefore, there may be some exits when shortfall is nil and some exits when there is positive shortfall. [1]
- Very few investors will actively anti-select against fund house. They do pre-mature exit especially when shortfall is positive. This will happen on days when yields are higher. [1]

Pre-mature exit load is formulated as a proportion of a benchmark yield index on the date of exit. This will act as market value adjustment applied to benefit payable and discourages anti-selection. [1]

In both types of exits, the exit loads collected along with remaining ALM mismatch reserve would be sufficient to meet any shortfalls. [1]

[Max 8]

[22 Marks]

Solution 3:

i) Actions based on manager's views about expected inflation:

Make policy switch by moving some of the long-dated government bonds into shorter-dated government or corporate bonds. Then if inflation and yields rise, any capital loss will be smaller.

Make policy switch by moving some part of the portfolio into cash to avoid capital loss on that part.

Sell bond futures or buy put options or any other derivative hedging. Then if inflation and yields rise the profit on the derivatives will compensate for the loss on the bonds.

Buy real assets, to the extent deviation from benchmark allows, such as index-linked government bonds or equities.

Make anomaly switch by moving some government bonds to corporate bonds. Then if inflation and yields rise, assuming spreads remain constant, capital loss will be smaller.

[1 each, Max 4]

ii) Possible reasons for current portfolio deviations are:

Stock selection: Skewed portfolio from benchmark indices might be due to deliberation of manager. He might have felt:

- investing in corporate bonds with longer term is too risky hence no long term (>10 years) corporate bonds [1]
- spread in short term corporate bonds is worth taking the risk hence no short term (< 8 years) government bonds [1]

Sector selection: Overweight in government bonds or underweight in corporate bonds might be:

- Current allocation is the manager's tactical allocation which he would revert sooner to the benchmark allocation;
- Manager might be risk averse and deliberately re-invested more proportion of asset cash flows (coupons / maturities) during the year in government bonds;
- Corporate bonds portfolio shrank due to unexpectedly high rating downgrades and/or defaults during the year; and a rebalance is yet to be done.

[1 for any one point]

The manager might be following what other fund managers are doing to reduce relative performance risk. [1]

[Max 3]

- iii) Backward-looking tracking error: is the annualized standard deviation of the relative return over the recent past.

Year	Relative return G-bonds	Relative return Corp-bonds
1	-1.4%	1.3%
2	0.3%	-0.6%
3	0.4%	1.8%
4	-0.3%	-2.4%
5	1.6%	-3.7%
Mean	0.12%	-0.74%
Std. Dev.	0.98%	2.17%

[4]

- iv) Comments on Manager's performance:

The manager generated a positive mean relative return in government bond portfolio whereas he generated a negative mean relative return in corporate bond portfolio. The manager out-performed the Government bond index but under performed corporate bond index. [1]

A higher tracking error (2.17%) suggests that he adopted a more riskier approach in managing corporate bond portfolio. In spite of that, he could not meet index returns.

[0.5]

By taking almost half the riskier approach (tracking error = 0.98%) in managing government bond portfolio, he generated higher returns than that of index returns.

[0.5]

Tracking error is a relative risk measure. If we consider the absolute risk:

- the manager achieved higher returns in government bond portfolio by taking higher risk. His portfolio duration would be higher than that of government bond index. He is taking higher liquidity premiums [1]
- the manager achieved lower returns in corporate bond portfolio by taking lower risk. His portfolio duration is lower than that of corporate bond index. The index is taking higher liquidity premiums. [1]

Above comments are based on the last five years data and assuming manager's current stock selection prevailed in past. There is no guarantee that the same will hold in the future due to change in circumstances. Moreover, the data over short terms may not be credible. Hence, past performance may be a poor guide to the future. [1]

Tax and expenses will be incurred by the fund but will not be reflected in the index performance. Hence, exact replication of index performance will never be possible. [0.5]

Normally, active managers are given a maximum tracking error, whereas passive managers are simply judged on how close to zero they can achieve the tracking error. [0.5]

[Max 4]

v) Usefulness of Forward-looking tracking error :

The backward-looking tracking error, based on historical data, gives an estimate only of the true risk taken. Also, it is an average of the relevant time period and riskiness of current portfolio might differ due to portfolio creeping. [1.5]

Therefore, we need a prospective risk measure, such as forward-looking tracking error, to assess the riskiness of the current portfolio. [0.5]

Forward-looking tracking error is an estimate of the standard deviation of returns relative to the benchmark based on current portfolio assuming that current structure were to remain unaltered. [1]

If the distribution of returns is "fat-tailed", or skewed, tracking error with its focus on the standard deviations of returns may be misleading. [1]

[Max 3]

[Marks 18]

Solution 4:

i) "A European option would always be costlier than an American option on the same underlying assets with the same strike price and same exercise date" – is an incorrect statement. [0.5]

An American option gives its holder all the same rights available to the holder of a European option. And top of this, the American option can be exercised at any time till date of maturity of the option. [1]

Accordingly, an American option would cost at least the price of European option. [0.5]

If this was not the case, then this would lead to arbitrage opportunity and investor can profit by shorting the European option and taking a long position in the American option. [1]

[3]

ii)

Stock price (S)	Payoff from call option	Payoff from put option	Overall payoff
$S < 1000$	-70	$920 - S$	$850 - S$
$1000 < S < 1100$	-70	-80	-150
$S > 1100$	$S - 1170$	-80	$S - 1250$

[3]

iii) The investor expects that there will be a large price move but is uncertain whether it will be an increase or a decrease. [1]

iv)

Stock price (S)	Payoff from long call option	Payoff from another long call option	Payoff from short call option	Overall payoff
$S < 1000$	-90	-70	160	0
$1000 < S < 1050$	$S - 1090$	-70	160	$S - 1000$
$1050 < S < 1100$	$S - 1090$	-70	$160 - 2 \times (S - 1050)$	$1100 - S$
$S > 1100$	$S - 1090$	$S - 1170$	$160 - 2 \times (S - 1050)$	0

[3]

v) The investor expects that stock price wouldn't move by much.

[1]

[11 Marks]

Solution 5:

i) Stock options are used by shareholders to align the interests of executives with those of the shareholders. [0.5]

Shareholders want the executives to maximise the market price of the company's shares on their behalf. [0.5]

This in turn increase the value of the stock options. [0.5]

However, this may not become an effective tool to motivate employees. [0.5]

Executives may focus on actions to increase short-term value, rather than on improving the company's long-term prospects. This can be to the detriment of all stakeholders. [1]

This problem may be exacerbated in case there is high level of stock options on offer. [0.5]

The design of stock option plays a significant role in aligning the interests of executives to those of shareholders. [0.5]

Stock options with longer duration may be more effective in reducing agency problem than stock options with shorter duration. [0.5]

This is because longer duration stock option would focus the executives' attention on the longer term, and they would be incentivized to work with a long-term strategy rather than focusing on increasing short-term value. [1]

Also, if the stock options require these to be surrendered on leaving, then they can help retain successful executives, by providing an incentive not to leave before the options have been exercised. [1]

[1]
[Max 6]

ii) The aim of good corporate governance is that a company should be managed in order to best meet the appropriate requirements of its stakeholders – the shareholders, employees, pensioners, customers, suppliers and others who may be affected by the company's operations whilst not having any contractual relationship with the company at any time.

Good corporate governance requires management to make decisions based on the interests of relevant stakeholders rather than on their own personal interests.

Good corporate governance can be enhanced by ensuring that remuneration incentivises management to act in the interests of stakeholders.

[1 each, Max 2]

iii)

The Company used to pay dividend distribution tax at a rate around 20%. Now it is not required to pay dividend distribution tax and thus can pay a higher amount of dividend.

The shareholder who are taxed at a lower rate as per his / her tax slabs would also benefit from this move.

The Company would also be investing in equities and hence would be earning dividend income on its equity's investments.

The dividend incomes were already taxed at the hand of distributing companies.

Hence, the Company would have been setting off the dividends received from the taxable income, thereby reducing the effective tax rate it used to pay on its profit.

The net impact on the Company would depend on the amount of dividend it receives and the profit it generates.

[1 each, Max 5]

iv) The investor sentiments and herding impact the macro market. These can be better described the Behavioural finance.

[0.5]

The volatility of stock prices is much higher than that can be explained by the models.

[0.5]

This implies that the stocks may be undervalued or overvalued relative to the price calculated by model.

[0.5]

Research shows that the performance of stocks with different characteristics depends considerably on investor sentiments.

[0.5]

In particular, when sentiment is low one would expect high future returns on:

- Small stocks
- Highly volatile stocks
- The stocks of unprofitable companies
- Non-dividend paying stock
- Extremely high growth stocks
- Distressed stocks

[2]

In contrast, when sentiment is high these patterns reverse or reduce.

[0.5]

A number of quantitative measures are used as proxies to measure sentiment including:

- The average discount on closed-ended funds
- Share turnover
- The level of activity in the IPO market
- The level of issue of new equity
- The level of the dividend premium

[2]

By researching on these features, researchers can assess whether the stock market was in positive or negative mood during particular periods in the past.

[1]

Investors also make decisions based on what they observe others to be doing. This is called as Herding.

[1]

Herding could be explained by:

- The idea that investors may perceive other investors to be better informed and hence they copy them
- An intrinsic desire to confirm
- The incentives facing fund managers

[2]

Herding is rather difficult to measure directly as it is hard to know an individual's true motives for an investment decision.

[1]

[Max 10]**[23 Marks]****Solution 6:**

- i) We can take a long position in two 3% coupon bond and a short position in 6% coupon bond. [1]

The cashflows would be:

At the time of investment: $2 \times 75 - 85 = 65$ [0.5]

After investment but before maturity: 0 [0.5]

This is because, we would receive 6% coupon for our long position in two 3% coupon and we would pay 6% coupon for our short position in 6% coupon. [0.5]

At maturity: $2 \times 100 - 100 = 100$ [0.5]

That is, 65 today would become 100 in 5 years time.

Setting this in equation, we get:

$65 \times \exp(5R) = 100$ [0.5]

Or, $R = 8.62\%$ [0.5]

[4]

- ii) The equation would be:

$C \times \exp(-0.06 \times 0.5) + C \times \exp(-0.0625 \times 1.0) + C \times \exp(-0.065 \times 1.5) + C \times \exp(-0.067 \times 2.0) + C \times \exp(-0.0685 \times 2.5) + [100 + C] \times \exp(-0.07 \times 3.0) = 100$ [1]

This gives, $C = 3.54$ [0.5]

Which implies par yield of 7.08%. [0.5]

[2]

- iii) Continuously compounding forward rate for the half-year period starting in 2 years
 $= (2.5 \times 6.85\% - 2 \times 6.7\%) / 0.5 = 7.45\%$. [0.5]

Annual compounding forward rate for the half-year period starting in 2 years, R

$= 2 \times [\exp(0.0745/2) - 1] = 7.59\%$ [0.5]

Value of the forward agreement = $1000 \times (8\% - 7.59\%) \times (0.5) \times \exp(-0.0685 \times 2.5)$

= 1.73 crore. [1]

Value of the forward agreement to the borrower = - 1.73 crore. [1]

Alternative solution:

Value of forward rate agreement = Value of notional cash flows [1]

= $1000 \times \exp(-0.067 \times 2.0) - 1000 \times (1 + 8\% \times 0.5) \times \exp(-0.0685 \times 2.5)$ [1]

= 874.59 – 876.32 [0.5]

= -1.73 crore [0.5]

[Max 3]

[9 Marks]

Solution 7:

Commodity futures were originally devised to reduce the risks to which farmers and others were exposed. [0.5]

The uncertainty to which a farmer growing a commodity is exposed would be substantially reduced if he could guarantee the price that he might obtain in advance. [0.5]

This can be done by selling futures on their commodity and a farmer can lock-in a price. [0.5]

Similarly, it may be advantageous for a consumer of that commodity to ensure his future supplies at a fixed price in advance. [0.5]

The reduction in uncertainty has a cost in reduced flexibility, particularly for consumers who are likely to be less certain of the amount of raw materials they will require in the future than producers are of the amount they will wish to sell. [1]

Also, anyone involved in the production chain, eg transporters, wholesalers and retailers of the commodity might also hedge their risk by entering into commodity future. [0.5]

This will help in greater investment in that commodity's ecosystem. [0.5]

Commodity provides real returns: Further, commodity futures are real assets whose value is determined by short-term economic factors rather than expectations over the longer term. [0.5]

Investor can invest in a new asset class and also can diversify their investments from the traditional institutional real assets of property and equity shares. [0.5]

Commodities offer significant real returns that are produced by doing real economic work within the economy. [0.5]

Also, the returns accrue to the long-only investor without the need for active management. [0.5]

Specifically, in those environments that have produced the worst results from financial assets – rising inflation, excessive global demand, supply disruptions – commodities have produced higher returns than any other asset class used by institutional investors. [0.5]

More importantly, those returns have been based on real underlying economics, suggesting that a similar pattern of returns is likely to recur in the future.

[0.5]

[Max 7]
