

Institute of Actuaries of India

Subject SP5 –Investment and Finance

March 2022 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) The major economic objectives of a government's economic policy are
- low unemployment to utilise economic resources
 - low and stable inflation to avoid costs associated with inflation
 - manage balance of payments to achieve other objectives - stable exchange rate desirable to encourage international trade
 - high and stable economic growth leading to higher standard of living
- [1/2 mark for each point]
(Max 2)
- ii) Under a natural monopoly, economies of scale are such that the unit cost of a product is minimized only if a single firm produces the entire industry output.
Example: a large infrastructure asset company with high barriers to entry (1)
- iii) Key issues in regulating upcoming monopolies
In privatizing state monopolies where "natural" monopolies are likely to persist, the government should develop new regulatory authorities charged with the control of the pricing policies of the privatized companies. This is to protect the interests of customers (particularly individuals) and suppliers. (1)
- The regulators should encourage competition and prevent mergers that would reduce competition through the exercise of market power. (0.5)
- The regulator may face two issues while controlling pricing power:
- A multinational company may argue that a takeover resulting in a high market share in one territory will not confer unacceptable pricing power because of the potential entry of international competitors. (1)
 - Product definition is generally a second area of debate for competition decisions. A high market share in a narrowly defined product area may translate into a much lower share of a more widely defined product category that contains possible substitutes for the product under review. (1)
- The regulators should come up with fair trading controls to ensure that sellers do not exploit members of the public who may be in a weak bargaining position. (0.5)
(Max 2)
- iv)
- A potential exemption of capital gains from tax, in order to make it tax-efficient for individuals to make income from investments
 - This may encourage schemes that convert income to capital gains, reducing the level of tax paid
 - Taxes on investment income should not be too high as it may discourage individual investors
 - Dividends received by entrepreneurs are taxed as investment income, so low tax rates on investment income will be more aligned with the objectives
 - Some capital allowance limit can be considered, to give relief to poor and middle class. One option is to apply tiers of tax rates with higher tax for higher earned or investment income
 - The rate of tax on earned income will affect behaviour of investors. If this is too high, entrepreneurs will avoid large salaries for themselves and instead choose to earn through bonuses or dividends.
 - Tax rates can be lower for longer terms of investment to encourage more long term investment
 - Rates of capital gains tax can be made lower than income tax to encourage entrepreneurial activity.
 - Wealthy people are likely to structure their affairs to minimise tax liabilities, so the government should consider different tax brackets depending on income levels.

- A high rate of income tax or investment tax will likely not impact the wealthy, as they may hold their investments offshore, outside the jurisdiction of the government.
- Poor people are likely to rely more heavily on earned income, so tax rate on earned income should be set lower.
- Poorer people will have less scope to rearrange their investment income to minimise tax, so changes to rates on investment income or capital gains tax will have less impact.
- Companies and shareholders will also want to minimise the tax they pay, so separate considerations are required.
- If tax rates on investment income are too high, companies may be tempted to pay less dividends and instead reward shareholders in other ways, e.g. performing share buybacks.
- Companies may also look at whether tax liabilities are minimised by retaining profits or cash, so this should be considered.

(1/2mark for each point)

(Max 5)

v) When sentiment is LOW we would expect to observe that the:

VIX (market volatility index) increases. VIX is calculated using implied volatilities (IVs) of index options - both calls and puts. Put options have higher IVs than call options due to differences in demand and supply of options. When sentiments are low, there is higher demand for put options leading to higher VIX.

(1)

- Share turnover to fall as prospective investors having new money (both new capital and existing asset incomes) would prefer to be on side lines,
- bid-offer spread to increase due to lower liquidity i.e. fewer buyers and sellers
- IPO activity to fall as there is less demand from investors and
- the demand for high dividend paying shares to rise as these value shares become more popular which generally do not fall very far in difficult times

(1/2 mark for each point)

(Max 3)

vi) Noise traders are heavily influenced by short-term noise (such as a news article, or another trader's opinion) and they trade on that basis, ignoring other information and share fundamentals.

They create volatility, and often generate a herd mentality, which can push prices further and further from the theoretical 'rational' price.

They can push the price further in the wrong direction making the rational investor's decision go horribly wrong in the short term and markets can stay irrational longer than one can remain solvent.

(1 mark for each point)

(Max 2)

[15 Marks]**Solution 2:**

i) The Value at Risk (VaR) is an estimate of the maximum loss that could be suffered by an investor with a specified probability level over a specified period of time.

(1)

For example, an insurer might try to estimate the maximum loss that it might sustain with a 99% chance over the next year.

(0.5)

The returns and losses may be measured in absolute terms or relative to some suitable performance benchmark such as an index, an industry median fund or the value of the liabilities.

(1)

(Max 2)

- ii) The main stages of an ALM exercise include the following:
- Clarify key objectives of the investment and funding policy
 - Agree suitable assumptions to use in the study
 - Collect data to be used to carry out the projections
 - Consider the overall nature of the liabilities
 - Consider how the scheme might progress in the future if different investment strategies were adopted
 - Analyse different asset mixes in more detail
 - Summarise and present the results, usually in a graphical format

(1/2mark for each point)

(Max 3)

- iii) The following steps would need to be followed:
- Model the key features of the asset proceeds and liability outgo projections for the pension fund in the future
 - Determine realistic values for all key asset parameters including mean return, variance of return and correlation of returns across major asset classes (such as government bonds, corporate bonds and equities)
 - Determine realistic values for all key liability parameters including individual member data, contribution rates for employer and employee, salary etc.
 - If any data is missing, consider how to estimate for this, including any margins for uncertainty or prudence
 - Determine other assumptions such as salary and price inflation
 - Carry out a large number of simulations, starting with the pension fund's current asset distribution
 - Consider metrics to analyse, for e.g. number of times the fund becomes insolvent over a period of time (say 50 years) or value of fund at the end of the projection period
 - Consider how to measure insolvency, e.g. based on assets being below 100% of liabilities, or alternatively on statutory basis or including prudence margins
 - Include scenario testing, e.g. how will changes to investment strategy affect the solvency of the fund
 - Include sensitivity analysis e.g. how will changes in parameter values affect the results

(1/2mark for each point)

(Max 4)

[9 Marks]**Solution 3:**

- i) An investor managing a bond fund expecting a large cash inflow in the future can protect against a volatility in the market prices by buying bond futures with a contract value equal to the anticipated cash flow. (1)

Other derivative instruments that can be used are forwards, call options or total return swaps (0.5)

This would require identification of a set of bonds or bond indices underlying the futures that is expected to move in line with the underlying bond portfolio. (1)

Any rise in the cost of the planned bond purchase will then be matched by profits on the futures and vice versa (0.5)

By hedging, the bonds have effectively been purchased in the future at a fixed price. (0.5)
(Max 3)

ii) Such hedges will not quite eliminate all risk, and the major types of risk that remain are as follows:

Basis risk:

- While the price of a future may follow the cash price closely, the basis may not move exactly as expected.
- The exact date of the cash inflow may not be known which makes choosing the future difficult.
- There is also the risk that the expected cash flow does not materialise.
- It may therefore be required to roll the hedge forward by closing out the index futures and taking the same position in futures with a later expiry date.
- Liquid futures may not be available to hedge the risk.

(0.5 each, max 2)

Cross hedging:

- Unless the portfolio to be hedged behaves exactly same as the underlying index, the hedge will not be perfect.
- For example, while the constituents underlying the index future may be similar to the bond fund, they are unlikely to move in exactly the same way.
- The optimal hedge ratio should be determined to minimise this risk.

(0.5 each, max 1)

Counterparty risk: There is a risk that the counterparty involved may default. (0.5)

Collateral Risk: The manager may need to sell shares to fund margin payments to the counterparty. (0.5)

(Max 4)

iii) The purpose of hedging is to reduce risk and to make the financial out come more certain. Other reasons to hedge could include:

- If the fund is expecting to disinvest a large sum of money in the future and wants to protect against future risk it could sell index futures. (0.5)
- If the selected bonds outperform benchmarks in the market, a hedge using index futures reduces the risk of market movements by reducing exposure to the performance of the market. (1)
- Short-term market volatility can be managed using futures and this could be cheaper than selling the portfolio and buying it back at a later date. (1)

(Max 2)

[9 Marks]

Solution 4:

- i) This is an example of an anomaly switch. (0.5)
- Ratio of price between the two bonds can be investigated. (0.5)
 - The Price Ratio works out to be = $122.5 / 118.3 = 1.0355$ (0.5)
 - This ratio is expected to be stable over time as the nature of the bonds is similar, in particular similar duration (1)
 - If the ratio has moved from the long term average, this presents an anomaly which might reverse itself; the investor can switch back to the original bond later (0.5)
 - A similar analysis could be performed on the ratio of yields (0.5)
 - The ratio of yields in this case works out to be $1.35\% / 1.41\% = 0.9575$ (0.5)
 - The investor could also build a model of the bond prices and/or yields, considering size of issue, term, marketability, currency, and other features (1)
- The bond prices could be compared using these models (0.5)

(Max 5)

ii) Advantages of technical analysis (TA):

- It is usually not challenging to collect data required for technical analysis (0.5)
- Technical Analysis is relatively quick and easy to carry out (0.5)
- TA can be useful in making decisions around the timing of investments (0.5)
- TA can be used to make short term profits if you can find a technique that works, and profits can be large if derivatives are used [1]

Disadvantages of technical analysis (TA):

- Can distract investors from more important factors such as long term value, or dividend yield (0.5)
- Risk of making large losses instead of short term profits (0.5)
- Might encourage a more active investment strategy, hence increasing expense levels (0.5)
- Unlikely to capture trends in market which differ from past macro environment e.g. advances in technology (0.5)

(Max 4)

iii) The portfolios may differ because they have:

- Different investment strategies, e.g. targeting different indices as benchmark (0.5)
- Different asset mix due to risk appetite (e.g. more equities versus bonds in one of the funds) (1)
- Different investment currencies (0.5)
- Different investment restrictions or tracking error limits (0.5)
- Different fund sizes, leading to difference in spreading of costs (0.5)
- Different style, e.g. active versus passive management (0.5)
- Different investment management fees (0.5)
- Different cash flows during the year, affecting the money-weighted returns (0.5)
- Different tax status (0.5)

(Max 4)

iv)**a) Quarterly and yearly returns for each asset class, and for total portfolio**

Working assumptions:

- All figures provided in the question are net of expenses and taxes (0.5)
- Quarterly returns are calculated as fund value at quarter end / value at start of quarter – 1 (0.5)
- If quarterly returns are calculated as a%, b%, c%, and d% then the yearly return on the portfolio can be calculated using linked internal (quarterly) rates of return as $(1+a) * (1+b) * (1+c) * (1+d) - 1$ (0.5)
- The fund manager differed from the benchmark by attempting to achieve higher returns via more allocation in equities, with the following mix:
 - 40% domestic equities
 - 35% foreign equities
 - 15% bonds
 - 10% cash
- The portfolio's value at the start of the year in INR 5 crores. So, the allocation gives the following starting value for the portfolio (in INR lakhs):
 - 200 domestic equities
 - 175 foreign equities
 - 75 bonds
 - 50 cash

(0.5)

(0.5)

The following table shows the actual fund value at each time period in the year:

Value (INR lakhs)	Start	Quarter 1	Quarter 2	Rebalanced	Quarter 3	Quarter 4
Domestic Equities	200	205	203	156.96	170	177
Foreign Equities	175	180	187	130.8	137	145
Bonds	75	79	83	183.12	191	196
Cash	50	50.1	50.2	52.32	52.4	52.6
Total	500	514.1	523.2	523.2	550.4	570.6

The portfolio at the end of Q2 has value of INR 523.2lakhs so it rebalances based on the strategic mix in the benchmark for e.g. domestic equities is $523.2 * 30\% = 156.96$.

(2)

The following table shows the returns over each quarter and the year:

Value (INR lakhs)	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Full Year
Domestic Equities	2.5%	-1.0%	8.3%	4.1%	14.5%
Foreign Equities	2.9%	3.9%	4.7%	5.8%	18.5%
Bonds	5.3%	5.1%	4.3%	2.6%	18.5%
Cash	0.2%	0.2%	0.2%	0.4%	0.9%
Total	2.8%	1.8%	5.2%	3.7%	14.1%

The assumption is that Q2 returns are Q2 **before** rebalancing versus Q1, while Q3 returns are Q3 versus Q2 **after** rebalancing

The returns are calculated as follows, for e.g. domestic equities

For Q3 = $170 / 156.96 - 1 = 8.3\%$.

(2.5)

It is also acceptable to calculate the full year returns as the sum of the four quarters instead of the formula above. For e.g. domestic equities return would not be 14.5% but would then be 13.9% i.e. $2.5\% - 1\% + 8.3\% + 4.1\%$.

(Max 6)

b) Yearly benchmark returns for each asset class and quarterly and yearly returns for total benchmark portfolio

The annual benchmark returns can be calculated using the same formula.

Benchmark Returns	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Full Year
Domestic Equities	8.60%	2.10%	-0.10%	4.40%	15.6%
Foreign Equities	5.20%	-0.50%	3.50%	6.60%	15.5%
Bonds	5.50%	5.10%	3.20%	2.20%	16.9%
Cash	0.10%	0.30%	0.20%	0.10%	0.7%

(1)

We can use the benchmark asset mix to calculate the total benchmark portfolio. For example, Q1 return is $8.6\% * 30\% + 5.2\% * 25\% + 5.5\% * 35\% + 0.1\% * 10\% = 5.8\%$.

Total	5.8%	2.3%	2.0%	3.8%	14.6%
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(2.5)

(Max 3)

c) **Outperformance or underperformance of fund versus benchmark**

This implies an underperformance in most quarters

(0.5)

This is derived from the outperformance (calculated as the difference of actual returns versus benchmark) is as follows:

Outperformance	-3.0%	-0.5%	3.2%	-0.1%	-0.4%
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(1)

(Max 1)

[Max 23 Marks]**Solution 5:**

- If the customer demand is likely to be strong, companies that are more exposed to economic growth such as restaurants, hotel chains and distributors will perform well. (1)
- Companies which are less cyclical such as large scale food retailers are likely to be less attractive options, as their demand remains stable and they will be outperformed by cyclical stocks (1)
- Companies with a higher degree of financial gearing are likely to be more sensitive to market growth, and will perform better if the outlook is more positive. (1)
- Companies in the Indian service sector are likely to be more impacted by the national economy with less dependence on the global outlook. (0.5)
- Companies with dependency on international chains may not be that attractive given the pessimistic international economic growth. (0.5)
- Most service sector companies are labour intensive and will depend on salary inflation levels, if this is higher due to national growth this will have an impact. The degree of automation within the companies will also affect this. (1)

[Max 4 Marks]**Solution 6:**

- i) Less regulation and financial reporting
Lack of information on the hedge fund's strategy
Higher fees
Lack of liquidity: lock-in / notice periods
Lack of requisite diversification
Unacceptably high risk levels
Difficulty in assessing performance
Limited capacity of hedge funds

(1/2 mark for each point)

(Max 2)

- ii) Regulations on the operational aspects of hedge funds
1. Sales process –set cap on marketing costs (say 3% of subscriptions) and ensure that hedge funds are sold only to suitable individual investors who are:

- well-informed: sales brochures illustrating three scenarios- pessimistic, best estimate and optimistic
 - reasonably wealthy: set minimum subscription amount and
 - tolerant of risk: illustrate VaR measure for the funds' NAV (Net Asset Value)
2. Set minimum / maximum allowable lock-in periods (say minimum 1 year and maximum 5 years) and notice periods (say maximum 2months), and also the cap on exit load within lock-in/notice periods
 3. Frequent reporting to investors:
 - information that must be provided with regard to fund performance, NAV calculation method used and investment strategy – monthly fact sheet
 - frequency of NAV calculation (say daily)
 4. Fees charged – both the structure of fees charged and the overall level of fees
 - cap on entry load(say 2% of subscriptions)
 - cap on management fees (say 2.5% p.a. of AUM)and/or performance fees (say 30% on fund returns in excess of a minimum hurdle rate say 6% p.a.)
 5. Appointing hedge fund managers and other staff:
 - with regard to qualifications
 - membership of professional bodies
 - no past association with failed investment funds

(1 mark for each point)

(Max 5)

- iii) Different forms of financial / investment risks associated with the new product:
- Market risk is the risk relating to changes in the value of the portfolio due to movements in the market value of the assets held. It can be measured using Value at Risk and controlled by regular modeling and reporting. (1)
- For the new product, the major market risk (downside risk) is a huge fall in stock price far below strike price of put option. This hits fund performance in two ways. (0.5)
- Market value of the fund will fall and remain low until the stock recovers which may or may not happen. (0.5)
- The income generated in stage two by selling call options will be low as the gap between current stock price (S) and OTM strike price (K) is more i.e. $S \ll K$. (0.5)
- Hence, due care should be taken in picking the stock whose VaR considering the above two hits is in tolerable limits. Instead of operating in only one stock, pick few stocks, depending upon the size of the fund, to diversify away stock specific risk. (1)
- Another way to diversify away stock specific risk is to operate with index options and when put option is exercised in stage one buy and hold index ETF (or long far-month index futures that may require rolling over) till call option is exercised in stage two. (1)
- In stage one, we can consider an option strategy similar to bull put credit spread by buying deeper OTM put option to hedge / limit the downside risk from selling the naked put option. In stage two also, buy deeper OTM put option to hedge / limit the downside risk from the stock held. This comes with a hedging cost that may reduce fund returns under normal circumstances. (1)

Credit risk is the risk that a counterparty to an agreement will be unable or unwilling to fulfill their obligations. For the new product credit risk can be controlled by using exchange-traded options (and avoiding OTC options) to have the benefit of the clearing- house reducing counterparty risk.

(1)

Operational risk is the risk of loss due to fraud or mismanagement within the hedge fund. It is the risk of losses due to failed or inadequate people, processes or systems and external events. It is difficult to quantify this risk.

(0.5)

It can be controlled by appropriate internal reporting and by separation of front office and back office functions. OTC arrangements can be complex; increasing the chance, that senior management fails to spot the weak links in the reporting and monitoring processes, hence use exchange-traded options.

(1)

Liquidity risk is the risk of not having sufficient cash to meet operational need sat all times. Identifying and measuring liquidity risk include the cash budgeting / short-term financial planning techniques, gap analysis and duration analysis(LRE).

(0.5)

Liquidity risk can be controlled by managing the maturity of its assets and liabilities to increase liquidity. The new product has to pay monthly income so it is desirable to invest premiums received from selling options in cash / cash equivalent money market instruments.

(1)

Relative performance risk is the risk of under-performing comparable hedge funds. It can be measured and controlled in the same way as the market risk. This risk can be reduced by mimicking the competitors' fund holdings but it is hard to find the required information on time to do so.

(1)

For the new product, another market risk (upside risk) is a huge rise in selected stock price far above strike price of put option. This scenario compares poorer to some competitor who simply buys and hold the stock instead of selling put option in the first place.

(1)

(Max 10)

iv) Hurdle value (HV) above which performance fee (PF) applies = FV_{t-1} (101.00%)

PF = max (0, (FVB – MF – HV) (20%))

MI =max(0, FVB – MF – PF – Capital)

FV= FVB – MF – PF – MI

(2)

Month	FVB	MF	HV	PF	MI	FV
2	972,000	1,944.00	1,010,000.00	0.00	0.00	970,056.00
3	1,023,056	2,046.11	979,756.56	8,250.67	12,759.22	1,000,000.00
4	1,038,000	2,076.00	1,010,000.00	5,184.80	30,739.20	1,000,000.00

(1 mark for each month PF and MI)

(3)

(Max 5)

- v)
- 1) It is not fair to apply full performance fee in third month where the fund value was recovering from lows reached in month two.
 - 2) We should apply high watermark (HWM) to reflect maximum return already achieved by the fund and performance fee for that performance was charged in the past.
 - 3) Hence, apply performance fee only on any excess performance over recorded HWM. This will protect the investors from
 - paying twice for the same performance or

- paying for apparent (pseudo) performance in recovering phase.

4) $HWM = \max(\text{FVs from time 0 till time } t-1)$
 $PF = \max(0, (FVB - MF - \max(HV, HWM))) (20\%)$

5) For month three, $HWM = \max(1000000, 970056, 1000000) = 1000000$
 $PF = \max(0, (1,023,056 - 2,046.11 - \max(979756.56, 1000000))) (20\%)$
 $= 4201.98$

(1 mark for each point)

(Max 4)

(Max 26 Marks)

Solution 7:

- i) Margin is the collateral that each party to a future traded on an exchange must deposit with the clearing-house.

It acts as a cushion against potential losses (which would arise if one party to the trade defaults on the agreement), which the parties may suffer from future adverse price movements.

Clearing-house's exposure to counterparty can increase after the contract is struck through subsequent adverse price movements. Therefore, margin is changed on a daily basis through additional payments of variation margin to control counterparty risk.

(1 mark for each point)

(Max 3)

- ii) Day 1 variation margin = $17,500 (0.75\%) (50) = 6,562.50$ and
 Day 2 variation margin = $17,500 (100.75\%)(-1.25\%) (50) = -11,019.53$
A positive value means margin money is called from the trader and negative means margin is released into traders account.

(1 mark for each)

(Max 2)

- iii) Forward price volatility of a bond = (modified duration of the forward bond) times (initial forward yield on the bond) times (corresponding forward yield volatility) (1)

- iv) No, that does not mean the government bond in developed economy with lower yield has more interest rate risk.

Interest rate risk (as measured by bond price volatility) depends on duration and yield volatility. Interest rate risk can be assessed by calculating VaR.

If yield volatility in developed economy is substantially lower than yield volatility of the developing economy then interest rate risk in developed economy will be lower.

(1 mark for each)

[Max 3]

- v) Forward price of the bond six months from present date is given by:

$$F_0 = 100 e^{(-5\%(4.5))} = 79.8516$$

(0.5)

Initial forward yield of the bond (six months from present date) = $e^{(5\%)} - 1 = 5.1271\%$

(0.5)

Modified duration of the forward bond is:

(0.5)

$$D = \frac{\text{Duration}}{(1+y_0)} = \frac{4.5}{1.051271} = 4.2805$$

Forward price volatility σ of the bond (six months from present date):

(0.5)

$$\sigma = Dy_0\sigma_y = 4.2805(5.1271\%)(20\%) = 4.3894\%$$

Price of the six-month European call option on the zero-coupon bond is calculated as expected option value at the end of six months, discounted to the present time::

$$C = P(0, T) [F_0 \Phi(d_1) - X\Phi(d_2)]$$

$$d_1 = \frac{\ln\left(\frac{F_0}{X}\right) + \frac{\sigma^2 T}{2}}{\sigma \sqrt{T}} = -0.044295 \text{ and } d_2 = d_1 - \sigma \sqrt{T} = -0.075332;$$

(1)

$$P(0, T) = 0.975310; \Phi(d_1) = 0.482335 \text{ and } \Phi(d_2) = 0.469975$$

(1.5)

$$C = 0.894547$$

(0.5)

(Max 5)

[Max 14 Marks]
