

Institute of Actuaries of India

Subject ST5 – Finance and Investment A

May 2010 Examinations

INDICATIVE SOLUTIONS

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.

Q1

1 (a) If the economy is moderately buoyant and profits are fairly stable, both defensive and cyclical companies might be similarly rated in terms of the P/E ratios.

As the economy starts to move into recession P/E ratios for cyclical companies are likely to fall while those of defensive companies will remain stable or may even rise slightly.

At the bottom of the cycle P/E ratios of cyclical companies will probably have risen from their low point as earnings have fallen, but defensive stocks will still be more highly rated.

As the economy starts to recover, the P/E ratios of cyclical companies will rise in anticipation of future earnings growth. P/E ratios of defensive companies may now be lower than those of cyclical stocks.

As growth continues, the earnings of cyclical companies will catch up with the share price and P/E ratios will fall back towards their long-term average level.

(b)

- **Risk Management:** The contract would hedge longevity risk in the fund, and give more certainty to the fund's financial position. The volatility would be reduced. Therefore, the scheme may be able to better tolerate the risk of any large equity allocation
- **Term:** The scheme probably needs to make payments to pensioners stretching many years into the future. The contract only provides protection for 10 years.
- **Credit Risk:** The bank could default in full (or in part) on payments it is obliged to make to the scheme. Examine the credit rating of the bank and how it has fared in this global crisis. Buying credit protection on the bank could be relatively expensive in this economic climate. Spreading of credit risk may be considered.
- **Collateral** – will be likely in this OTC contract. This will provide some credit risk protection. However, collateral may be calculated infrequently, because of infrequent valuations. Investigate methodology used to calculate collateral.
- **Illiquidity:** What happens if trustees wish to terminate the contract early?
- **Due Diligence:** Further due diligence to that described above should be conducted; how does the bank hedge longevity risk it takes on (warehousing, reinsurance etc)? What is the bank's expertise in writing longevity-linked contracts?

- **Behavioural Issues:** Trustees may be nervous about entering such an exotic contract if they have no experience of derivative positions in the fund. They may be more inclined to enter the contract if similar funds have already entered similar contracts.
- **Competitor:** Consider other de-risking solutions offered by competitors (bulk -buyouts, other swaps)

(c)

- **Interest Rates:** Interest rates could decrease i.e. rates used to discount the liabilities fall. This increases the present value of the liabilities.
- **Inflation:** Inflation increases are higher than allowed for. Higher inflation will increase projected benefits and the present value of liabilities.

[13]

Q2

- (a) Admissibility restrictions encourage investment in certain classes without the restriction of a more prescriptive policy.

It will be more acceptable to the funds as they are less prescriptive to the outright restriction on holding.

The impact depends upon the degree to which scheme's current investments are admissible and on the solvency position of the fund. A well-funded fund will be less bothered about the restrictions while a less funded will move to hold admissible assets.

- (b) The government/regulator may consider derivatives as risky investments (particularly if used for speculative purposes) and hence are unsuitable.

However, derivatives can also be used for hedging purposes, so as an alternative regulations can be framed just to exclude use of derivatives for speculative purposes.

Sometimes, derivatives market may be more liquid than the underlying assets, for example in commodities. So it may be more appropriate to use derivatives.

- (c) To avoid concentration of risk i.e. risk that company gets into trouble and employees lose their job and also that also jeopardize the security of fund.

Self-investment includes not only investment in the sponsor's shares and debt, but also loans, but also property that the company rents from the scheme.

The impact on the fund depends upon the level of self-investment and the ease with which it can be disposed (in case of share and debt).

[6]

Q3

(a) The final result of an ALM study will be a recommended investment strategy for the scheme in the form of:

- A benchmark consisting of fixed percentages allocated to each asset class
- Extraction of a “core” portfolio (typically bonds) with the remaining assets invested in a balanced fashion.

(b)

1. The key objectives that investment and funding policy should aim to achieve need to be clarified. These involve objectives such as:

- Future ongoing funding levels
- Future solvency levels
- Future company contribution rates

2. Suitable assumptions to use in the study need to be agreed

3. Data needs to be collected to carry out the projections

4. The overall nature of the liabilities is considered – a broad brush analysis of current funding level, maturity and cashflow is carried out

5. An analysis would be carried out to identify how the scheme might progress in the future if different investment strategies were adopted

6. Different asset mixes would then be analysed in more detail to assess the risks (relative to the liabilities) and the rewards of each alternative under consideration.

7. The results would be summarised and presented

(c) (i) **Marking to Market:** The practice of revaluing an instrument to reflect the current values of market variables

(ii) **Arbitrage:** The simultaneous buying and selling of two economically equivalent but differentially priced portfolios so as to make a risk free profit.

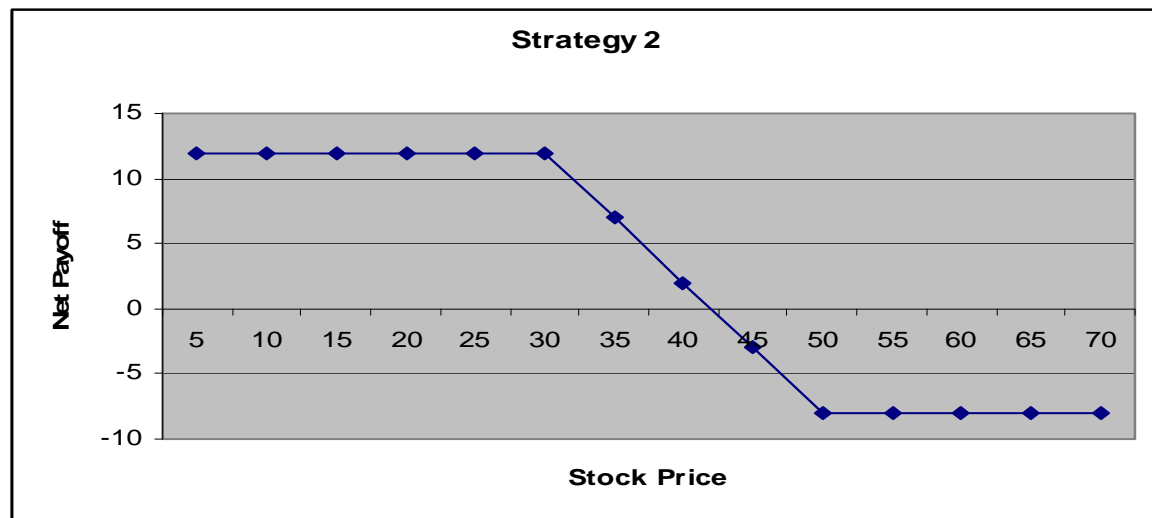
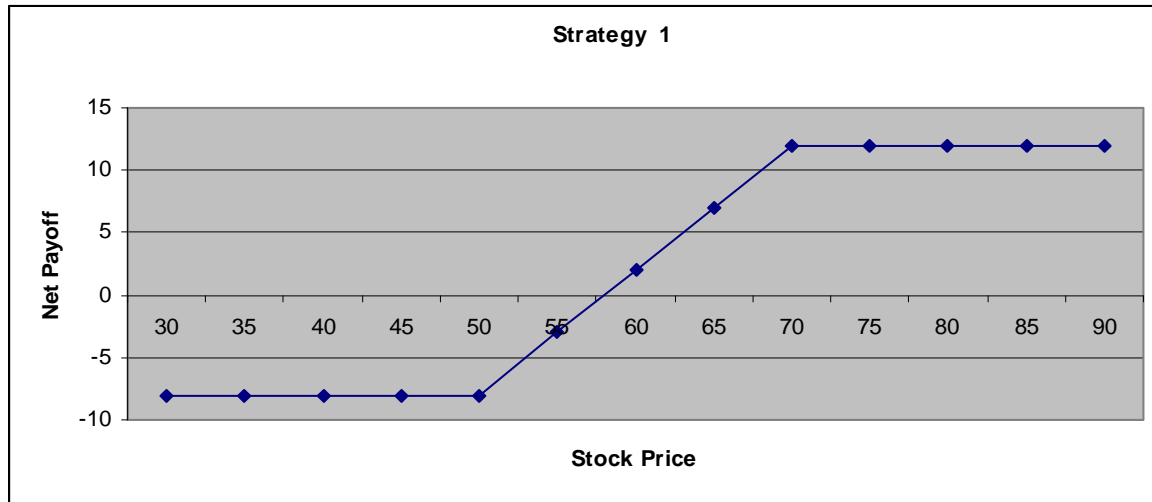
(iii) **Par Yield Curve:** A plot of coupon value on the y-axis against the term to redemption on the x-axis. For each term, the coupon that would be required for a fixed interest bond of that term to be issued at par is plotted.

(iv) **Reversion Interest:** The interest of a freeholder or long term leaseholder, to whom the property will revert on expiry of a lease.

[10]

Q4

(a)



(b)

Current price of the underlying security must be Rs. $\frac{2}{3}$ lower than Rs. 50 as put prices are a bit higher than the call prices.

[5]

Q 5 Process used to determine price range

Firstly a financial model of various cashflows (revenue and cost items) needs to be built.

Revenues will be mainly from estimated future sales which will depend upon company's current capacity, future expansion plans, current prices of various grade of coal, future expectation of prices, changes in company's competitive environment etc.

Cost items will be mainly derives from current expenses, expected increase in expenses (wage inflation, normal inflation), management ability to control expenses, interest on loans and overdraft etc.

The forecast P&L accounts will provide estimates of earnings to which expected payout ratios will be applied to derive estimates of future dividend streams to the shareholders. The payout ratios will depend upon:

Previous distributions to Govt. of India
Payouts of similar listed companies
Estimates made by the company itself.

The dividend streams would be valued using either:

$$V = D_1/(i-g)$$

$$\text{Or } V = \sum D_t * v(t)$$

Where:

V = Estimated price of the share

D_t = Estimated dividend at time 't'

$v(t)$ = t-year discount factor

i = Required rate of returns

g = Continuous rate of growth of dividends (derived from the financial model)

The price range would be obtained by considering lower and upper estimates of earnings, payout ratios, i and g.

Otherwise, next year earnings could be estimated using above analysis and price can be determined by applying market P/E ratio.

(2) Generally, the recommended price range should be below the fair market value to facilitate the full subscription of public offering. Positive public sentiment could be created by the price rise upon listing. This will also help future public offering by Government owned companies.

It may be possible that during period of subscription, economic or market conditions turn negative. To avoid that, it is better to recommend a lower price range.

[8]

Q 6

For with profit policies, the reversionary or annual bonus declared in the past are guaranteed and because future bonuses can't be negative even if the assets produce negative returns in future, the investment risk due to declared past bonuses is on the shareholders.

The asset portfolio consists of 50% equities, 40% bonds and 10% cash. We can assume that the market value of cash investments will not fall, but equities and bonds can fall in market value.

To mitigate against the fall in market value of equities and bond portfolio, the insurer can buy a put option with the strike price of current unit value if the option is of one year and strike price will be the rolled up (rolled up by assumed future bonus rate) unit value at maturity, if option is of remaining term of the policy.

Black-Scholes formula can be used to calculate the value of put. The risk free rate can be the government bond yield either for one year or yield corresponding to the remaining term of the policy. The implied volatility for equities and for bond portfolio can be estimated by using financial economics.

The sum of the value of the put options for all policies can be considered as cost of guarantee.

[4]

Q 7

(a)

- **Switching:** Need details on the size of portfolio, the assets (and their size) which are intending to be liquidated, and the size of the potential investment in CDOs. Any large sales could result in a sizeable capital gains tax liability. A sizeable switch could incur large transaction costs plus costs of market impact. Seek methods to minimise these costs as far as possible.
- **Tactical:** Market conditions – is this the best time to switch?

- **Liability Matching:** Need to understand company's liabilities in detail. Ideally want the new portfolio to hedge liabilities at least as well (if not better) than the current portfolio. Assess how the new investment strategy affects risk/capital position within the company. Investigations from asset liability models (ALM) and other risk metrics are useful for this.
- **Risk/return:** These CDOs are alternative assets – the desired allocation could increase yield and expected return of the portfolio. Low correlation of CDOs with mainstream asset classes could decrease portfolio volatility.
- **Business:** Any increases in expected return could benefit policyholders via lower premiums or higher benefits, thereby increasing business volumes. Marketing literature may need to be updated with new investment strategy.
- **Concentration:** Portfolio may already have sizeable concentration to CDOs, as it has sizeable exposure to hedge funds, and hedge funds may invest in these exotic instruments.
- **Risks:** Need to examine the assets underlying CDO structures to fully assess potential credit risk. May be difficult to purchase effective credit protection on these securities. CDOs are relatively illiquid instruments.
- **Expertise:** Company may need considerable external investment management expertise, as company has never invested in CDOs. Extra fees will be incurred and this could reduce potential returns

Other issues to investigate:

- The CDOs may not be fully admissible (or at least admissible to the same extent compared to conventional corporate bonds) when assets are valued for statutory purposes
 - Examine the ratings of each CDO tranche, seniority of the tranches the company is investing in, any degree of overcollateralisation, any guarantees third parties may offer
 - Investigate peer group (similar life offices) allocation to CDOs
- (b)
- Hedge fund index could have suffered from several data biases which has artificially improved performance statistics.
 - Survivorship Bias –if survivors only included in the index, average returns overestimated and volatility underestimated.
 - Selection Bias – Funds with good history more likely to apply for inclusion in index. “Backfilling” causes significant upward bias.
 - Marking to Market Bias –underlying securities typically illiquid, so funds use latest reported price or their own estimates of market value. The use of “stale” prices can lead to underestimation of true variances and correlation.

- Other factors - past performance may not be repeated in future; further allocation increases hedge fund concentration risk in portfolio

(c) (i)

- Decide VaR to be calculated - need timescale for measurement (e.g 1 month) and confidence level (e.g 95%)
- Collect data – need current asset values, asset allocations and historical data on investment returns for asset classes within portfolio
- Fit data to a normal distribution – estimate standard deviation of returns, correlations between returns.
- Calculate standard deviation of entire return distribution.
- Estimate the point on the distribution, where there is only a 5% chance of falling below this point.
- The VaR is the level of underperformance which is equated to this 5% tail.

(ii)

- VaR is potentially subject to large error – it is an estimate that is highly dependent on method of calculation, the period of data extraction.
- Estimates - Biases in the hedge fund data and use of “stale” prices (as mentioned above) could bias estimates of volatilities and correlations in the VaR calculation.
- Non-Normal Distributions – VaR assumes normal distribution of returns, but portfolio contains hedge funds (which have non – normal returns)
- Market crisis- VaR does not allow for simultaneous increase in correlations and volatility in extreme market events. The hedge funds could well become more correlated with the mainstream asset classes in the portfolio during market stress
- Stress Testing - needed to identify weak areas in this portfolio, the sensitivities to a variety of risk factors, and possible losses in a market crisis.
- Portfolio analysis - need to fully investigate portfolio composition e.g concentrations, perform due diligence on hedge funds and strategies employed
- Analyse other risk indicators – vs market benchmarks (indices) and appropriate liability benchmarks.

[20]

Q8 (a)

Interest rate floors can be valued as a portfolio of call options on zero-coupon bonds.

Interest rate floorlet provides a payoff at time t_{k+1} of:

$$L \cdot \lambda_k \cdot \max (R_x - R_k, 0)$$

Where:

L	:	Principal amount
λ_k	:	Tenor of the contract
R _X	:	Floor interest rate
R _k	:	Variable interest rate

R_k is the floating rate and effective rate from t_{k+1} to t_{k+1} is R_k* λ_k. Thus the above payoff at t_{k+1} has same present value as payoff at t_k of:

$$L*\lambda_k*\max (R_x - R_k, 0)/(1+ R_k* \lambda_k)$$

$$\text{Or, } \max [(R_x - R_k)* L*\lambda_k / (1+ R_k* \lambda_k), 0]$$

$$\text{Or, } \max [((R_x - R_k)* L*\lambda_k + L - L) / (1+ R_k* \lambda_k), 0]$$

$$\text{Or, } \max [L(1 + R_x* \lambda_k) / (1+ R_k* \lambda_k) - L, 0]$$

Now $L(1 + R_x* \lambda_k) / (1+ R_k* \lambda_k)$ is value at t_k of a zero-coupon bond that pays $L(1 + R_x* \lambda_k)$ at t_{k+1}.

Therefore, this is equal to the value of pay-off from a call option with an exercise date and price of t_k and L respectively on a zero-coupon bond with a principal of $L(1 + R_x* \lambda_k)$ payable at time t_{k+1}.

(b) Value of swaption is:

$$LA (R_x*N(-d2) - F_o*N(-d1))$$

$$L = 50m$$

$$\text{Sigma} = 0.15$$

$$T = 2$$

$$A = \exp(-0.0303*3) + \exp(-0.0306*4) + \exp(-0.0308*5) = 2.6517554$$

$$R_x = 0.03$$

$$F_o = \text{forward swap rate} = \exp(-0.0296*2) - \exp(-.0308*5) / A = 0.0321057$$

$$d1 \quad 0.4258467$$

$$d2 \quad 0.2137147$$

$$N(-d1) \quad 0.3351098$$

$$N(-d2) \quad 0.4153848$$

Hence swaption value is:

$$50 * 2.6517 * (0.03 * 0.4153 - 0.0321057 * 0.3351098)$$

$$= \text{USD } 0.226037 \text{ Million (i.e } 226,037 \text{ USD)}$$

[10]

Q9

(a) At $T = 0$,

$$I(0) = (\sum N_{i,0} * P_{i,0}) / B(0)$$

$B(0)$: Base value or divisor at $T = 0$

$I(0)$: Index value at $T = 0$

$N_{i,0}$: No. of outstanding shares of i th company at $T = 0$

$P_{i,0}$: Share price of i th company at $T = 0$

$$\text{Therefore, } 1000 = (1,00,00,000 * 1,000 + 50,00,000 * 800) / B(0)$$

$$\text{So, } B(0) = 1,40,00,000$$

Value of capital index before bonus and rights issues:

$$I(1) = (\sum N_{i,1} * P_{i,1}) / B(0)$$

$$I(1) = (1,00,00,000 * 1,200 + 50,00,000 * 1,000) / 1,40,00,000 = \mathbf{1,214.29}$$

Theoretical ex-bonus share price of RIL should be = $1,200/3 = 400$

Theoretical ex-rights price of ICICI Bank should be = $(5*1,000 + 1*600)/6 = 933.33$

At no gains/losses, the index value at $T = 1$, should remain the same as increase in market capitalization just because of Rights issue doesn't change the index value.

Bonus issue doesn't change the market capitalization.

$$\text{So, } I(1) = (3,00,00,000 * 400 + 60,00,000 * 933.33) / B(1)$$

$$\text{So, } B(1) = 1,44,94,050$$

Now, actual ex-bonus share price of RIL = 320

Actual ex-rights share price of ICICI Bank = 900

So, capital index value at $T = 2$

$$I(2) = (3,00,00,000 * 320 + 60,00,000 * 900) / 1,44,94,050 = 1,034.91$$

(b)

Total Returns Index :

Total return index is a measure of not only the movement in capital values but also includes income received.

Total returns can be calculated using ex-dividend adjustments or yields.

Ex-dividend adjustment or XD adjustment is calculated by assuming that the dividend or interest payments are reinvested back into the index on the ex-dividend date.

$$\text{So, } xd_{i,t} = (N_{i,t} * D_{i,t})/B(t-1)$$

$$\text{And } XD_{it} = \sum xd_{it}$$

XD_{it} = Accumulated dividend by ith share over the full calendar year.

$$XD_t = \sum XD_{it}$$

XD_t = Total XD adjustment for all the constituents of the index

Therefore, the value of total returns index will be the value of capital index combined with the total dividend adjustment.

$$\text{So, } TRI(t) = TRI(t-1) * (I(t) + XD(t) - XD(t-1))/I(t-1)$$

(c) Property Indices:

Portfolio-based indices:

They measure rental values, capital values or total returns of actual rented properties. Different indices of this type will give different results because the underlying portfolio of properties will vary in size, regional spread and sector weighting.

The rate of returns will typically be money-weighted.

The main shortcoming is that the current rentals are fixed until next review, the response to the movement in rentals is sluggish.

Barometer Indices:

They are designed to act as barometer of current market conditions.

They aim to track movement in property market by estimating the maximum full rental values of a number of hypothetical rack-rented properties.

Therefore, the values underlying the indices are based on valuers' estimate of current rack rent rather than actual rents.

The main use of these type of indices is in measuring short term changes in the level of the market in terms of rents and yields. These indices can't be used for portfolio performance measurement.

[12]

Q 10

Though the assets are valued monthly, liabilities are valued on quarterly basis and these quarterly valuations are the basis of MVA factors used for adjusting the surrender values.

If we assume that quarterly valuations take around 2 weeks of time to be completed, the MVA factors are around 2 to 15 weeks out of date.

Firstly, it is important to value the unit liabilities more frequently particularly on daily basis by applying some conservative bonus rate for the current year (if we are assuming that bonus is declared in arrears) and then try to actually value the assets more frequently (if possible on daily basis) or at-least estimate the asset values on daily basis. Based on the actual valuation of assets or estimates of assets, MVA factors can be estimated on daily basis. In this way, adverse selection against the UWP fund could be avoided.

Now, the actual investment performance of the UWP fund will depend on:

- the actual asset mix at any point in time, and
- the actual investment performance of each separately managed fund

The actual investment mix at any time will depend on the relative investment performance of each separately managed fund and the net inflow/outflow of money from each fund.

To avoid very frequent trades and money movements most fund operate an account for everyday cash movements, for example premiums, claims and expenses, and on a periodical basis will transfer larger amounts between the account and the investment funds.

The investment manager may make a tactical investment switch of money between individual funds that could significantly alter the investment mix. A procedure is required for the investment manager to notify where money is moved

into or out of the individual funds. This will allow the reported investment mix to be adjusted on a more frequent basis.

The investment performance of each fund, and fund valuations are not known on a daily basis, so more frequent data is not available. Therefore it will be necessary to estimate the investment performance between valuations and to update the performance when the actual investment mix and performance data becomes available.

The investment performance needs to be monitored on a daily basis.

The required accuracy of the fund performance estimate depends on importance of the sub-fund, and the volatility of the investment performance, i.e. there is a need to be more accurate for equities and fixed interest bonds that forms 53% of the UWP fund than the Commercial mortgage forms 2% of the fund.

Similarly, floating rate notes and cash investments exhibit very little volatility, therefore, very frequent estimates of the funds managing these investments are not needed.

For each of the segregated fund, it is important to investigate appropriate index. Compare the actual past performance of the segregated funds with the movements of the chosen index to determine the suitability.

Indian Equities

Indian equities constitute 15% of the total UWP portfolio assets. Given the volatility of Indian market, it is important to estimate the performance on daily basis. An insurance company is likely to have a broad spread of equity investment covering both small and large companies.

Therefore the BSE - 500 Share index investment performance should be investigated. It will be necessary to compare the actual investment held by the Indian equity fund to BSE - 500 in order to verify that this is a suitable index, rather than using a weighted combination of sub-indices.

Non-Indian Equities:

This fund holds 5% of the total portfolio and therefore its volatility may not affect the movement of overall fund, but never-the-less this fund is also very important given its volatility. But based on the size of this fund, the actual investment performance for each country can be avoided for estimation purposes and available international equity indices FTSE World Indices series and Morgan Stanley Capital International Indices series could be investigated as they both cover both developed and emerging markets.

It is important that the price indices and XD adjustments are in the domestic currency, i.e. already adjusted currency fluctuations.

Fixed Interest long term corporate bonds (AA rated):

This fund is around 23% of the whole portfolio. Because of the long term nature of the bonds, the interest volatility will be relatively high. Similarly being AA rated, additional volatility will be induced due to the changes in credit risk perception.

It will be difficult to find a suitable benchmark as they are constructed subject to specific constraints such as duration or credit rating, but the fund can have bonds having duration in a wide range and similarly having varying credit rating, though the average could be AA.

To estimate the fund performance between valuations it would be suitable to construct a benchmark using combination of indices to reflect the actual portfolio.

Fixed interest medium term GILTs

Due to medium term duration of bonds, the interest rate volatility is not very high, but as this fund constitutes 10% of the whole portfolio, the impact of movement in bond values on the overall portfolio can be substantial particularly when interest rates movements are significant.

Government securities indices are there, but they are sub-divided by term. Investigate the current holdings and amounts of those holdings and compare these with each category of the price indices to determine appropriate weights.

Fixed Interest medium term corporate bonds (AAA rated):

The yield on these bonds will be a bit higher than the corresponding government securities due to some additional credit risk and due to this these bonds are more volatile than the government bonds.

A benchmark can be constructed by combining various indices to reflect the actual portfolio or alternately, appropriate government securities can also be used after some moderation to reflect the credit risk.

Property:

Investigate the current holdings of the property fund to determine the level of direct property holding to indirect property holding (property shares).

For the indirect property proportion a property sub-index of BSE or NSE is likely to be appropriate.

Direct property investment tends to have a stable performance over a short period because valuations are carried out periodically for each property.

Investigate the recent monthly past performance and, say calculate an average performance for use.

If the recent performance has not been reasonably stable because of the effect of property revaluations, then a procedure for the investment manager to notify you of significant property revaluations will be required.

Commercial mortgages:

Commercial mortgages constitute a very small part of the UWP fund, so we do not have to do anything too complicated to estimate the values on daily basis.

[12]

Total Marks 100