Actuarial Society of India

Examinations

November 2006

SA6 – Investment

Indicative Solution

[1]

(i) MWRR

$$1,000(1+i) + 50(1+i)^{7/8} + 80(1+i)^{5/8} - 40(1+i)^{3/8} + 50(1+i)^{1/8} = 1,110$$

Using $(1+i)^t \approx 1+i\,t$ gives $1,085\,I = 30$ *i.e.*, $i = -2.76\%$ *pa*

LIRR

Q1 $1,000(1+i_1) = 50(1+i_1)^{0.5} = 1,014 \Rightarrow$ $i_1 = -3,512\%$

Q2 $1,014(1+i_2) = 80(1+i_2)^{0.5} = 1,046 \Rightarrow$ $i_2 = -4,554\%$

Q3 $1,046(1+i_3) = 40(1+i_3)^{0.5} = 1,045 \Rightarrow$ $i_3 = +3,801\%$

Q4 $1,045(1+i_4) = 50(1+i_4)^{0.5} = 1,110 \Rightarrow$ $i_4 = +1,402\%$

LIBR = 0.96488 x 0.95446 x 1.03801 x 1.01402 − 1 = -3.07%

(ii) Attribution analysis

(1) Equities benchmark performance

Arithmetic total return: - 5.00%
Geometric total return: 0.944 x 0.945 x 1.044 x 1.017 – 1 = -5.28%

(2) Cash benchmark performance

Arithmetic total return: - 5.00%
Geometric total return: 1.012 x 1.013 x 1.012 x 1.013 – 1 = +5.09%

(3) Benchmark sector allocation (75/25) with benchmark stock performance

Q1   0.75 x -5.6% + 0.25 x 1.2%   =   -3.9%

Q2   0.75 x -5.5% + 0.25 x 1.3%   =   -3.8%

Q3   0.75 x -4.4% + 0.25 x 1.2%   =   +3.6%

Q4   0.75 x 1.7% + 0.25 x 1.3%   =   +1.6%

Arithmetic total return: - 2.50%
Geometric total return: 1.961 x 0.962 x 1.036 x 1.016 – 1 = -2.69%

(The geometric return is calculated assuming rebalancing back to 75%/25% each quarter)

(4) Actual sector allocation (85/15) with benchmark stock performance

Q1   0.85 x -5.6% + 0.15 x 1.2%   =   -4.58%

Q2   0.85 x -5.5% + 0.15 x 1.3%   =   -4.48%

Q3   0.85 x 4.4% + 0.15 x 1.2%   =   +3.92%

Q4   0.85 x 1.7% + 0.15 x 1.3%   =   +1.64%

Arithmetic total return: - 3.50%
Geometric total return: 0.9542 x 0.9552 x 1.0392 x 1.0164 – 1 = -3.73%

(5) Actual equity performance

Q1 $850(1+i_1) + 0.85 + 50 \times (1+i_1)^{0.5}$ =854 $\Rightarrow$ $i_1 = -4.419\%$

Q2 $0.85(1{,}014)(1+i_2) + 0.85 + 80 \times (1+i_2)^{0.5} = 880$ $\Rightarrow$ $i_2 = -5.570\%$

Q3 $0.85(1{,}046)(1+i_3) + 0.85 + 40 \times (1+i_3)^{0.5} = 892$ $\Rightarrow$ $i_3 = +4.231\%$

Q4 $0.85(1{,}045)(1+i_4) + 0.85 + 50 \times (1+i_4)^{0.5} = 892$ $\Rightarrow$ $i_3 = +4.231\%$

Arithmetic total return: - 4.30%
Geometric total return: 0.95581 x 0.9443 x 1.04231 x 1.01457 – 1 = -4.55%

(6) Actual cash performance

Q1 $150(1+i_1) + 0.15 + 50 \times (1+i_1)^{0.5}$ =160 $\Rightarrow$ $i_1 = -1.626\%$

Q2 $0.15(1{,}014)(1+i_2) + 0.15 + 80 \times (1+i_2)^{0.5} = 166$ $\Rightarrow$ $i_2 = -1.202\%$

Q3 $0.15(1{,}046)(1+i_3) + 0.15 + 40 \times (1+i_3)^{0.5} = 153$ $\Rightarrow$ $i_3 = +1.365\%$

Q4 $0.15(1{,}045)(1+i_4) + 0.15 + 50 \times (1+i_4)^{0.5} = 166$ $\Rightarrow$ $i_3 = +1.090\%$

Arithmetic total return: - 5.28%
Geometric total return: 1.01626 x 1.01202 x 1.01365 x 1.01090 – 1 = -5.39%

Summary of attribution

% effective return	Equity stock From	Cash stock Form (6)	Total stock Form (4)	Sector (4)-(3)	Total From (3) against

	(5) against data in question	against data in question	against calculation for LIRR		calculation for LIRR
Q1	+1.18	+0.43	+1.07	-0.68	+0.30
Q2	-0.07	-0.10	-0.07	-0.68	-0.75
Q3	-0.17	+0.17	-0.12	+0.32	+0.20
Q4	-0.24	-0.21	-0.24	+0.04	-0.20
Arithmetic total for year	+0.70	+0.28	+0.64	-1.00	-0.36

(iii) Discussion of performance *v* objectives

- The overall performance is a loss relative to the benchmark of -0.38% (geometric basis).

- This resulted from poor sector selection. Equities under-performed cash by about 10% over the year, so the manager's 10% overweight equity position gave a 1% loss on sector selection.

- Note that the manager was only supposed to deviate from the benchmark allocation if he or she was "very confident". Yet the sector selection was negative in two successive periods.

- This was partly offset by good equity selection performance (and slightly positive cash instrument selection.

- In particular, the manager's 0.73% *pa* equity selection profit did achieve the objective of out-performing the equity index by 0.5% *pa*.

- Good equity selection against a falling market is surprising given that the manager was presumably expecting equities to do well and was trying to out-perform by 0.5% so would have been tempted by high beta stocks.

Deficiencies in analysis

- The calculations are based on the assumptions specified in the question and solution (*e.g.* timing of cash flows, rebalancing of actual portfolio and of benchmark, no allowance for expenses.)

- Ideally we would want to analyse the manager over a longer time period, and assess the risk run within the cash and equity portfolios (*e.g.,* share betas and credit rating of the institutions where cash was held).

(b)
Why hold only 5% in US equities?

As mentioned earlier, the proportion of investments in assets denominated in foreign currencies is limited due to liability considerations. The US market in particular has not fallen by as much as the Indian equity market, and this may be the reason for your comments.

The US market has not fallen by as much as the Indian since the start of this century – even in the face of the September 11th disaster, the market has held up relatively well.

The US market has withstood the uncertainty caused by the Enron and WorldCom accounting scandals and the Iraq war.

This strong performance has not been all due to underlying economic performance. Equities in the US market are much higher priced, offering a dividend yield of around 1.7% *pa*. This suggests that US equities may be more expensive and hence more likely to fall in the future. Our fund manager believes that future returns from US equities will be poor even though past returns have been good.

For this reason the fund is happy to hold less in the US market than the average fund, but still a little to obtain the benefits of diversification.

Why hold 4% of the fund in Japanese equities?

It is true that the Japanese economy has undergone difficult times, and in particular over the year from 1990 to 2004, has only grown at 1% *pa*. The country also records very large government deficits, which is seen by some as a negative indicator.

The banking sector in particular has some serious problems, many of which have been caused by the collapse in property prices, which left the banks with large portfolios of bad debt.

Despite these facts, and the strength of the Yen over the last few decades, the Japanese economy still records a large surplus in its trade with other countries.

On the back of this difficult environment, and the fact that asset prices in general rose to unsustainable levels in the late 1980s, Japanese equities have fallen a long way during the 1990s. In this respect their prices already reflect much of the bad news that you mention on the economy.

The government continues to try to stimulate the economy using government-funded initiatives, which may lead to a more stable and higher-growth environment for equities. Growth prospects for the coming year are good.

Japanese equities till offer low yields in comparison with other major markets – typically around 1% *pa*, which may seem low, but which are considerably better than in the past. Economic growth is estimated to be in exc3es of 3% in the coming year.

Also, many commentators believe that the accounting policies used in Japan mean that published earnings (and hence declared dividends) from companies are underestimated, which will not be the case for companies in the UK or US.

The pension fund portfolio has been structured with future performance in mind-although Japan has real problems, the portfolio has taken a small positive position relative to other funds because of the potential recovery prospects.

(ii) Information explanation

5-year information ratio

The information ratio is defined as $\dfrac{relative return}{relative risk}$

Where relative return means the annualise difference between the return generated by her fund and the returns generated by the benchmark set by the trustee (usually a major index, less charges and tax).

Relative risk is the volatility of the relative return

The above returns and volatility of returns would be calculated using the 5-year performance statistics on an annualised basis.

The ratio describes how much the fund managed to outperform the benchmark that it was set, but also distinguishes between those funds that achieved positive relative performance through accepting high risk. Such funds would see their relative risk increase and hence their information ratio decrease.

A figure of 0.7 would be considered quite good because it means that the manager has achieved a performance better than the benchmark, and done so with relatively little risk (relative to the benchmark).

The provisions year figure of -0.3 is poor as it implies an under-performance relative to the index. A negative number cannot be produced through negative relative risk as this has a minimum value of zero.

Such a sharp improvement in the 5-year data suggests excellent relative performance in the last year. I would want to know why the improvement was so sharp.

A contrarian style means that the manager aims to buy equities that are currently "out of favour" with the market. In general, these are companies whose shares have fallen considerably in recent times due to some financial or business problems.

If these companies can find solutions to their problems, then they can survive and prospect. Any fund that has purchased the shares while they are out of favour should see a good performance as the shares become accepted by the market again.

A value style is considered to be one where certain traditional measures of value are considered when buying a share. These are normally.

- price/earnings ratio (a low ratio indicates good value)

- dividend yield (a high value indicates good value)

- cashflow and earnings yield (a high ratio indicates good value)

- price to book value (a low value indicates good value)

- sales to book value (a high ratio indicates good value)

Such investment ratios would be considered before buying a share

Switch to Passive Management

Types of passive fund available

Passive funds aim to replicate the performance of a specified index or benchmark, and do not try to add value or out-perform the chosen benchmark.

Passive funds are normally management in one of four ways:

- full replication

- stratified sampling

- optimization

- synthetic funds.

Full replication involves buying every stock or share in the benchmark in the same proportion s it is included in the benchmark, thereby assuring the same performance as the benchmark.

Stratified sampling involves investing the same proportion of the fund in each sector or sub-sector of the index (for example the financial sector, or perhaps at a more detailed level the banking sub-sector), but holding only a few stocks or share in each of those sectors or sub-sectors.

Optimisation involves selecting a range of shares that match the index in certain key ways. For example, the portfolio should have the same average PE ratio as the benchmark and the same average gearing ratio. This should ensure a similar performance.

Synthetic funds buy derivatives based on the chosen benchmark in order to match the performance.

Advantages and disadvantages of having a large proportion in passive funds

In general, passive fund management reduced the need for active management expertise and as a result offers lower management fees.

It can also be argued that passive funds are more diversified because they invest in a similar manner to a diversified index. This should be more efficient and less volatile than an active fund.

If markets are efficient, then there it is impossible to out-perform over the long-term, therefore, employing active managers is a waster of money. Historical evidence can be shown to support this view.

Index funds cannot be made to fit the needs of a particular fund and can only be based on an established index. As such there is a loss of control involved.

Full replication has the advantage of having the lowest tracking error, but suffers from the fact that there are a larger number of holdings and transactions, and hence the costs can be too great for anything other than a very large fund. This method may be suitable for the pension fund's domestic equity and perhaps domestic bond portfolio, but is unlikely to be suitable for overseas equities, overseas bonds and property portfolios.

It is particularly difficult to have a passive property portfolio as there are few appropriate indices around, property prices are subjective and not frequently published and there is no recognized market.

Stratified sampling will involve greater tracking error risk, but should save on costs. It has the advantage that the manager does not have to buy every stock that enters the index at the exact time it enters the index. Often in such situations, the price of the share can be published to unjustifiable levels in difficult trading conditions, which is generally the wrong time to buy the stock. However, full replication managers must buy the stock.

Optimisation has been shown to work well, particularly where a good multi-factor model is used to select the portfolio. This may well be a suitable way forward.

Synthetic methods suffer from the fact that the manager will need to roll-over the position in the derivative market on a regular basis. Each roll-over will involve costs and basis risk if the market is not perfectly efficiently priced, and these costs can add up, leading to a tracing error.

In general, passive fund management is popular in the US but not as developed in India.

Advantages and disadvantages of the structure of passive plus active

The main advantages (other than those listed above) would be that the active funds remaining would be considerably smaller than the original portfolio and therefore could

be managed actively without many of the disadvantages mentioned earlier in connection with large funds.

In addition, the active management mandate could involve a much grater degree of risk because the funds represent only a small proportion of the total fund. This will allow the active manager to back his "bets" without worrying about commercial matching or risk relative to a benchmark or liabilities. This should lead to more efficiency and success.

On the other hand, having yet more managers will lead to greater administration and costs. It may be difficult to obtain overall performance data on a regular basis and to attribute the profits and losses to the correct sources.

It may also involve some structural risk in that the combination of all of the passive managers' benchmarks plus the active managers' mandates will not exactly equal the overall benchmark set by the actuaries for the scheme.

There will also be significant restructuring costs as such a policy is implemented.

[50]

[2]

a)

(i) Reserves

Non profit term assurance	~	20 + 45 – 50~Rs. 15
With profit endowments	~	40 + 900 – 500~Rs.440
Non profit annuities	~	30 + 1,200 - 0~1,230
Total	~	Rs.1,685

(ii) Features of Liabilities

Nature

Term assurance

The claim-outgo on the term assurance is likely to be fixed in monetary terms. However, this outgo is covered by he premium income (also fixed in monetary terms.)

There may also be some decreasing term assurances, but these are also likely to be fixed in monetary terms (although some policies may provide an RPI link).

The future expenses are likely to be largely real (*e.g.*, staff salaries, which would grow in line with earnings less productivity savings – approximately RPI inflation).

The reserve of Rs.15 should therefore be considered as being needed to match the real nature of the expenses (which are not matched by the premium income).

With profit endowments

We are not told the split of the claim-outgo between guaranteed benefits (basis sum assured plus past bonus additions) and future bonuses on the endowments.

However, we do know that the company is well established. Provided that the sale of each type of policy is also well-established, this suggests that the balance between past and future liabilities ought to be broadly stable.

The guaranteed benefits are a form fixed liability. The future benefits are, arguably, determined by "policyholders" reasonable expectations" (PRE).

PRE may include an expectation that:

- the investment policy follows that stated in the company's with profit guide and marketing literature
- the average investment return should be higher than under a non-profit policy
- that the return is largely real (*i.e.,* higher when inflation is higher)
- payouts are comparable with those from other life offices
- smoothing is applied as stated.

If, for example, Rs.500, of the claim outgo represents guaranteed benefits then we may be able to consider the future premiums as largely matching the guaranteed benefits.

In this case the reserve of Rs.440 could be considered as largely real (again treating expenses as real).

Such guarantees are rate in the UK, and it seems unlikely that they would be a problem here.

Annuities

The annuity payments are likely to be fixed in nature. This will be the case if the annuities are either level or escalate at a fixed rate.

It would not be the case if the annuities were index-linked.

The expenses will again be real.

Overall

Overall we may have about Rs.400 real, Rs.1,200 fixed. Further information would enable us to be more certain about the split here.

Tern

The term of the liabilities under all three policy types will be long.

The office is "well established", so there will be a mixture of mature and new policies with maturities spread over the next 20 or 30 yeas. The average may be, say, 10 to 15 years.

The typical term of the annuities may be a little shorter than the typical term of the endowments, particularly where the annuitants are elderly.

Currency

The liabilities outgo should be reasonably predictable.

Surrender levels may be fairly uncertain, since they are often a function of overall economic conditions. However, provided that surrender values are not guaranteed (and not over generous), we need not allow for this uncertainty.

On such a large portfolio uncertainty in the rate of mortality should not be a major factor.

(iii) Appropriate asset distribution

fixed interest:	50%	(see below)
Cash:	3%	Some needed for short-term liquidity
Index-linked:	7%	Matches future expenses (and RPI linked annuities, if any)
equities:	25%	Investment backing with profit non-guaranteed liability plus part of free reserves for realness and high expected return. Assumes that terminal bonus is used to cope with fluctuations in market values.
Overseas equities:	5%	Investment backing small part of with profit non-guaranteed liability plus part of free reserves for high expected return, realness and diversification from equities.
Property:	10%	Own office plus some other properties for realness, high expected return, stable day-to-day market value and diversification from equities. Also provides a high running yield.

The 50% in fixed interest reflects the fact that:

1. 60% *i.e.,* $\left(\dfrac{1,200}{2,000} \right)$ would be needed to match the fixed liabilities.

2. The free reserves (2,000-1,685) allow some degree of mismatching.

3. The free reserves will be invested in other assets that give higher potential returns.

4. The company has some ability to mismatch and will probably choose to investment less than the matching amount in fixed interest.

(iv) Asset distribution with free assets Rs.500 higher

The Rs.500 itself would be invested mainly in equities (UK and Overseas) and property. This would change the % allocation to each category.

It would also be possible to mismatch to a greater extent. For example, a further Rs.500 could be moved from fixed interest into the higher expected return categories. (Based on an assumption that equities *etc.* won't fall by more than 50% relative to the price of the matching fixed interest stocks).

Alternatively, greater mismatching by term, or greater use of non-government stocks within the fixed interest portfolio would be acceptable.

The company could also increase the proportion of assets investment overseas.

The result might be:

Fixed interest:	30%
Cash:	2%
Index-linked equities:	6%
	35%
Overseas equities:	15%
Property:	12%

(v) Additional reserves that might need to be held

The office might need to hold any or all of the following additional reserves:

a) A resilience test reserve. A life office needs to be able to demonstrate statutory solvency in the fact of variable investment conditions. The office has to show that, under various changes in yields and equity levels, it is still statutorily solvent. The additional reserve that it needs to hold in order to demonstrate this is the resilience test reserve.

b) A reserve for the required margin of solvency. Life offices need to hold assets in excess of their liabilities by a certain margin. This margin is broadly equal to 4% of the reserves, as calculated on the statutory basis. This additional sum may be held in the form of a separate solvency margin reserve.

c) Reserves for other known liabilities that are not included in the basis. For example, an AIDs reserve – this is often held as a separate reserve, in case subsequent AIDs experience turns out to be worse than anticipated.

b)

How are asset-backed securities structured?

There are a wide variety of structures for asset-backed securities.

Most asset-backed securities are structured using a "pass through" security whereby the retail bank creates a portfolio into which the loans from the retail bank are transferred. This can then be securitised and sold to investors. The payments of interest and capital from this security to investors are normally guaranteed by an institution (such s Ginnie Mae) so that the credit risk is removed.

The responsibility for collection of payments on the debt normally remains with the issuing retail bank.

The retail bank may take a certain proportion of the income from the mortgage payments in order to cover its costs.

The default risk may or may not be passed to the investors. It is normally the case that a guaranteeing institution such as Ginnie Mae will guarantee the payments of interest and capital.

Such securities are called Mortgage Backed Securities and expose the investor to prepayment risk. In order to reduce the pre-payment risk to investors which occurs when mortgages in the portfolio are repaid early, there are often different classes of liability – the first class accepting the first layer of early repayments, the second class accepting the next layer of repayments and so on. Such securities re called Collateralised Mortgage Obligations.

(ii) (a) The main concerns and risks from the institution's viewpoint

Mismatching risk

This investment is a medium-term fixed interest investment that will provide a suitable match for the fixed liabilities of the institution. You will therefore have to consider carefully the current extent of the mismatching risk and how it would be affected by this investment.

As part of the consideration of mismatching risk you will have to look t the term or the expected "weighted average maturity" of the investment, which are not told. Mortgage backed securities have "pre-payment risk", which means that the term of the debt will not be know. Mortgages are repayable at any time by the bank's customers. If they repay, what happens to the investment? If the fund received part of its investment back each time a customer repaid (or at regular 6-monthly intervals for example) then the bond might turn out to have a very short average term.

The institution has a risk with respect to the interest rate charged to mortgage customers. If the rate falls due to competitive pressures or due to the level of short-term interest rates, the yield on the investment will fall.

Default risk

What happens in the event of default by the retail bank's customers? This will normally be insured as part of the conditions of the "pass-through security", but if the guarantor is not a government agency, there will still e some risk remaining.

What happens in the event of default by the retail bank itself?

What happens in the event of default by the retail bank itself?

Liquidity may also be a concern for the institution, as it will require a certain amount of cashflow to meet claims and expenses. If the company is expanding it may be short of cash because of new business expenses on setting up the new policies. If it is contracting it will perhaps be paying out more in claims than it received as premiums. The need for regular income from the investment will be determined by such factors.

In addition the fund may require a certain proportion of marketable investments. This security is unlikely to be marketable on the basis that it is a privately negotiated over-the-counter deal. It is also large and invisible.

Tax may be a concern to the institution. The tax efficiency of this security would need to be carefully examined.

The transaction costs of such a deal would be a concern. It is complex and requires a complicated legal framework to make it work. This will cost money that may be deducted from the fund itself or paid directly by the retail bank up front.

(ii) (b) Safeguards

It would be necessary to limit the pre-payment risk involved. This can be done in a number of ways:

5. The securitised portfolio could be divided into various different classes of unit. For example, the first layer of units would take the first third of all capital repayments. The second would take the next third and so on. Whereas the first type of units would appeal to investors looking for short-term investments, the last tranche would perhaps appeal to the institution, which may be looking for a medium-term fixed interest investment.

6. It would be possible to arrange for the replacement of repaid mortgages by the retail bank. It is possible to have a mechanism whereby the repaid loan is replaced with another equivalent debt by the retail bank. The investor could then determine the term of the investment.

It would be preferable to have the guarantor of the pass-through security retain the customer default risk. This presents the institution having to bear this risk.

(ii) (c) Evaluating the bond

As with the all investments, the first step will be to compare the expected return with other similar investments offering an equivalent level of risk, the risks being those mentioned in (ii)(a) after the measures described in (ii)(b) has been taken into account.

The interest rate on the bond would be compared with those offered by medium-term government bonds and corporate bonds. The rate would have to exceed this amount to compensate for the value of the all option that the institution has written to the mortgage owners.

The risks of such a collateralised loan will be greater than government bonds, but less than unsecured corporate debt, and so the interest rate would be expected to lie somewhere between these two.

[50]

****