



Subject: PRLI 2

Chapter: Unit-4

Category: Practice Question

1. CT5 September 2010 Q11

A life insurance company issues a four-year unit-linked policy to a male life. The following non-unit cash flows, $NUCF_t$ ($t = 1, 2, 3, 4$), are obtained at the end of each year t per policy in force at the start of the year t :

Year t	1	2	3	4
$NUCF_t$	-50.2	-43.1	-32.1	145.5

Assume that the annual mortality rate for the male life is constant at 1% at all ages.

(i) Show that the annual internal rate of return is 6%. [3]

The company sets up reserves in order to zeroise future negative cash flows. The rate of interest earned on non-unit reserves is 2.5% per annum.

(ii) Calculate the net present value of the profits after zeroisation using a risk discount rate of 6% per annum. [3]

(iii) Comment on the results obtained in (i) and (ii) above. [1]

2. CT5 September 2011 Q12

(i) List the main features of a unit-linked policy. [4]

A four-year unit-linked policy issued by a life insurance company to a life aged 56 exact has the following profit vector:

(1525.89, -334.08, -292.05, -933.82)

(ii) Determine the net present value of the profits of this policy, assuming that the company sets up reserves in order to zeroise future negative expected cash flows on the policy.

Basis:

Mortality AM92 Ultimate

Rate of interest on non-unit fund cash flows 4.5% per annum

Risk discount rate 7.5% per annum [5]

[Total 9]

3. CT5 April 2013 Q14

A life insurance company issues a three-year unit-linked endowment assurance policy to a life aged 67 exact. Level premiums are payable yearly in advance throughout the term of the policy or until earlier death.

In the first year, 50% of the premium is allocated to units and 110% in the second and third years. The units are subject to a bid-offer spread of 5% and an annual management charge of 0.75% of the bid value of units is deducted at the end of each policy year.

Management charges are deducted from the unit fund before death and surrender benefits are paid.

If the policyholder dies during the term of the policy, the death benefit of the bid value of the units is payable at the end of the year of death. The policyholder may surrender the policy only at the end of each year immediately before a premium is paid. On surrender or on survival to the end of the term, the bid value of the units is payable at the end of the year of exit.

The company uses the following assumptions in carrying out profit tests of this contract:

Rate of growth on assets in the unit fund 4% per annum

Rate of interest on non-unit fund cash flows 3% per annum

Mortality 90% AM92 Ultimate

Surrenders 8% at end of first year, 4% at end of second year based on policies in force at that time.

Initial expenses £235

Renewal expenses 45 per annum on the second and third premium dates

Initial commission 12.5% of first premium

Renewal commission 2.5% of the second and third years' premiums

Claim expense £75 on deaths and surrenders only

The company sets premiums so that the net present value of the profit for the policy is 10% of the annual premium, using a risk discount rate of 6% per annum.

(i) Calculate the premium for the policy on the assumption that the company **does not** zeroise future expected negative cash flows. [12]

(ii) Calculate the net present value of the profit on the policy on the assumption that the company **does** set up reserves in order to zeroise future expected negative cash flows. [5]

[Total 17]

4. CT5 September 2013 Q15

A three-year unit-linked endowment assurance policy is sold to a male life aged 40 exact. The profit signature for this policy, calculated using AM92 Select mortality and making no allowance for surrenders, is:

(−209.80, 253.55, 109.85)

It is now assumed for the cash flows for this policy that 15% of all policies in force at the end of the first policy year are surrendered at that time. The surrender value payable at that time is the bid value of units at the end of the policy year less a surrender penalty of £500. There are no other changes to the policy.

- (a) Calculate the revised profit signature in the first policy year.
- (b) Comment on the impact on the profit signature in the second and third policy years.
- [4]

5. CT5 September 2014 Q14

A life insurance company, is proposing to launch a “Low Start” unit-linked endowment policy for a term of 3 years under which premiums increase by a fixed monetary amount each year and are payable yearly in advance throughout the term of the policy or until earlier death. The premium payable and the amount of premium allocated to units in each policy year are as follows:

<i>Policy Year</i>	<i>Premium Payable</i> £	<i>Allocation Rate</i> %
1	1500	50
2	2250	105
3	3000	115

If the policyholder dies during the term of the policy, the death benefit of £6,750 (i.e. the total amount of premiums due to be paid on the policy if held to maturity) or the bid value of the units, whichever is higher, is payable at the end of the policy year of death. The policyholder may surrender the policy only at the end of each policy year. On surrender or on survival to the end of the term, the bid value of the units is payable at the end of the policy year of exit.

The units are subject to a bid-offer spread of 6% and an annual management charge of 1% of the bid value of units is deducted at the end of each policy year. Management charges are deducted from the unit fund before death, surrender and maturity benefits are paid.

You should use the following assumptions in carrying out profit tests of this policy:

Rate of growth on assets in the unit fund 4.5% per annum

Rate of interest on non-unit fund cash flows 2.5% per annum

Mortality 90% AM92 Ultimate

Surrender 7.5% of policies in force at the end of year 1 and 2.5% of policies in force at the end of year 2 then surrender

Initial expenses £200

Renewal expenses £55 per annum on the second and third premium dates

Initial commission 5% of first premium

Renewal commission 2.5% of the second- and third-years' premiums

Claim expense £75 (payable only on death and surrender)

Risk discount rate 6.5% per annum

(i) Calculate the profit margin for the policy issued to a life aged 61 exact on the assumption that the company does not set up sterling reserves for this policy.

[13]

(ii) Explain why a life insurance company might need to set up non-unit reserves in respect of a unit-linked life assurance policy. [2]

(iii) Calculate the profit margin for the policy on the assumption that the company does set up reserves for this policy. [4]

[Total 19]

6. CT5 April 2016 Q7

A five-year unit-linked policy issued by an insurance company to a life aged 60 exact has the following profit vector:

(751.25, -321.06, -267.57, -192.05, 201.75)

(i) Define the meaning of zeroisation in the context of this unit linked policy. [1]

(ii) Explain why an insurance company might choose to zeroise the above profit vector. [1]

(iii) Calculate, showing all your workings, the net present value of the profits of this policy after zeroisation.

Basis:

Mortality AM92 Ultimate

Rate of interest on non-unit fund cash flows 3.5% per annum

Risk discount rate 6.0% per annum

[5]

[Total 7]

7. CT5 September 2016 Q2

A 10-year unit-linked policy has the following profit vector:

$(-50, -10, -10, 5, 5, 5, -3, 15, 40, 60)$

Reserves are set up to zeroise future negative cash flows on the following basis:

Basis:

Mortality The probability of death at each age is a constant 0.25% per annum

Rate of interest 1.5% per annum

Determine the revised profit vector. [4]

8. CT5 September 2017 Q11

A life insurance company issues a large number of 4-year unit-linked endowment assurance policies to lives aged 65 exact. Level premiums are payable annually in advance until maturity or earlier death.

The company has performed a profit test on these policies and the profit vector per policy sold, ignoring surrenders, is as follows:

$(185.21, -121.52, -5.28, 12.95)$

(i) Calculate the profit signature per policy sold if negative non-unit fund cash flows are zeroised. [3]

The company now wishes to allow for surrenders in its calculations. It assumes that at the end of the first and second policy years only, 3% of the surviving policyholders will surrender. Surrender values are equal to the bid value of units held (after deduction of the fund management charge) less a surrender penalty of 50.

(ii) Calculate the revised profit signature per policy sold after allowing for surrenders if negative non-unit cash flows are zeroised. [6]

(iii) Calculate the net present value of the revised profit signature in part (ii), using a risk discount rate of 8% per annum. [1]

Basis: Mortality AM92 Ultimate

Interest earned on non-unit cash flows 5% per annum fund

Expenses Ignore

[Total 10]

9. CT5 April 2018 Q13

A life insurance company issues a three-year unit-linked endowment assurance contract to a male life aged 62 exact under which level annual premiums of 6,000 are payable in advance throughout the term of the policy or until earlier death. 90% of each year's premium is invested in units at the offer price.

There is a bid-offer spread in unit values, with the bid price being 95% of the offer price.

There is an annual management charge of 1% of the bid value of units. Management charges are deducted at the end of each year, before death or maturity benefits are paid.

On the death of the policyholder during the term of the policy, the benefit, payable at the end of the year of death, is 12,000, or the bid value of the units if greater. The policyholder may surrender the policy only at the end of each year immediately before a premium is payable. On surrender, the bid value of the units is payable at the end of the year of exit. On maturity, 110% of the bid value of the units is payable.

The company holds unit reserves equal to the full bid value of the units. It sets up non-unit reserves to zeroise any negative non-unit fund cash flows, other than those occurring in the first year.

The company uses the following assumptions in carrying out profit tests of this contract:

Rate of growth on assets in the unit fund 5% per annum

Rate of interest on non-unit fund cash flows 3% per annum

Mortality AM92 Ultimate

Surrenders 10% at the end of the first policy year, 5% at the end of the second policy year based on policies in force at that time

Initial expenses 225 plus 5% of the first premium (all incurred on policy commencement)

Renewal expenses 65 at the start of each of the second and third policy years plus 2.5% of the second and third premiums

Risk discount rate 7% per annum

Calculate the profit margin on the contract. [15]

10. CT5 September 2018 Q8

(i) State the main features of a unit-linked policy. [4]

A life insurance company issues a four-year unit-linked policy to a life aged 51 exact.

The policy has the following profit vector:

(1798.01, -401.56, -355.10, -1075.23)

(ii) Determine the net present value of the profits of this policy, assuming that the company sets up reserves in order to zeroise future negative expected cash flows on the policy.

Basis: Mortality AM92 Ultimate

Rate of interest on non-unit fund cash flows 2.5% per annum

Risk discount rate 4.5% per annum [5]

[Total 9]

11. CT5 September 2018 Q9

A life insurance company issues a three-year policy to a life that offers the following benefits:

- On death during the term of the policy, a sum of 37,500.
- On redundancy during the term of the policy, a return of 105% of total premiums paid.
- On surrender during the term of the policy, a return of 33% of total premiums paid.
- On survival to the end of the term, a sum of 39,000.

Premiums of 12,500 are payable annually in advance throughout the term of the policy or until earlier claim. The death, redundancy and surrender benefits are payable immediately on claim. The policy ceases on payment of any claim.

The company uses the following basis to profit test this policy:

Independent force of mortality 1.5%

Independent force of redundancy 2%

Independent force of surrender 5% in years 1 and 2 only

Interest earned on cash flows 2.5% per annum

Expenses 2.5% of each premium paid

Reserves Ignore

The company assumes that each force of decrement is constant over each year of age.

- (i) Calculate the dependent rates of mortality, redundancy and surrender for each policy year. [3]
- (ii) Calculate the expected profit margin to the company on this policy using a risk discount rate of 4% per annum. [7]
- [Total 10]

12. CM1A September 2022 Q9

A unit-linked policy has the following profit vector:

<i>Year</i>	<i>In-force profit</i>
1	-22
2	-25
3	-39
4	55
5	70

- (i) Calculate, showing all working, the reserves required to zeroise the expected negative future cashflows at the end of years 2 and 3, assuming the non-unit fund accumulates at 3% p.a. effective and that $q_x = 0.02$ for all ages. [3]
- (ii) Determine the net present value of the profits, assuming a risk discount rate of 8% p.a.:
- (a) before zeroisation.
- (b) after zeroisation. [6]
- (iii) Comment on the results you obtained in part (ii). [2]
- [Total 11]