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Subject: Pricing and Reserving for Life Insurance products - 2

Chapter: Unit 4

Category: Practice Questions

1. 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]

2. 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]

3. 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:

Policy Year	*Premium Payable* £	*Allocation Rate* %
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]

4. 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]

5. 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]

6. 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]

7. 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, *NUCFt* (*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]

8. CT5 April 2009 Q12

(i) Explain the terms "unit fund" and "non-unit fund" in the context of a unit linked life assurance contract. [4]

(ii) Explain why a life insurance company might need to set up reserves in order to zeroise future expected negative cashflows in respect of a unit-linked life assurance contract. [2]

(iii) A life insurance company issues 4-year unit-linked contracts to a male lives aged 50 exact. The following non-unit fund cash flows, *NUCFt*, (t = 1, 2, 3, 4) are obtained at the end of each year t per contract in force at the start of the year t:

Year t	*1*	*2*	*3*	*4*
$NUCF_t$	375.4	−152.0	−136.2	−118.0

The rate of interest earned on non-unit reserves is 5.5% per annum and mortality follows the AM92 Select table.

Calculate the reserves required at times t = 1, 2 and 3 in order to zeroise future negative cash flows. [4]
[Total 10]

9. CT5 September 2008 Q2

The profit signature of a 3-year assurance contract issued to a life aged 57 exact, with a premium payable at the start of each year of £500 is (–250, 150, 200).

Calculate the profit margin of the contract.

Basis:
Mortality AM92 Ultimate
Lapses None
Risk discount rate 12% per annum [3]

10. CT5 April 2007 Q11

A five-year unit-linked policy issued to a life aged 50 exact has the following pattern of end of year cashflows per policy in force at the start of each year:
(-95.21, -30.18, -20.15, 77.15, 120.29)

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

(ii) Calculate the non-unit reserves required for the policy in order to zeroise negative cashflows assuming AM92 Ultimate mortality and that reserves earn interest at the rate of 5% per annum. [2]

(iii) Determine the net present value of the profits before and after zeroisation assuming the risk discount rate used is 8% per annum and state with reasons which of these figures you would expect to be higher. [6]
[Total 10]