✵ Ch 14 TERMINAL RESERVE

❖ METHODS OF CALCULATING THE RESERVE

There are 2 methods:

1-The Retrospective method: we look @ the past.

The Value of the Reserve =

{Collected Prems plus Interest at age x+t}(Amount)

-{Paid Benefits plus Interest at age x+t}(Amount)

or: Reserve =

{Accumulated Value of Paid Prem's @ age x+t

-Accumulated Value of Paid Benefits @ age x+t}

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2-The Prospective Method:

The value of the Reserve =

{PV of Future Benefits at age x+t}

minus: {PV of Future Prems at age x+t}

Ex 1: Find the reserve per survivor using the prospective method at the end of the 5th policy yr for a $100,000, 10-yr endowment policy issued to a 20- yr- old male if the policy issued for:

a)an annual prem.

b)a single prem.

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Solution:

a)an annual prem: *@ the end of the 5th policy yr, the insured is 25 yrs old.*

At that time the value of the reserve =

the PV of the future benefits (NSP for a 5-yr, $100,000 endowment policy issued to a 25-yr-old male)

minus the PV of the future prems (the remaining 5 prems which represent an Annuity).

This value can be calculated as follow:

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$$V = \left\{ \frac{(M_{x+t} - M_{x+n} + D_{x+n}) - P(N_{x+t} - N_{x+n})}{D_{x+t}} \right\}$$

$$V = \left\{ \frac{(M_{25} - M_{30} + D_{30}) - P(N_{25} - N_{30})}{D_{25}} \right\} \times 100{,}000$$

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where: $P = \dfrac{(M_{20} - M_{30} + D_{30})}{(N_{20} - N_{30})}$

$$P = \frac{(9477.262 - 8408.291 + 47548.5)}{(15258554 - 9089224)} = \frac{48617.471}{616933} = 0.0788$$

$$V = \frac{(8859.475 - 8408.291 + 47548.5) - 0.0788(1182196.8 - 908922.4)}{59767.4} \times 100{,}000$$

$$V = \frac{(47999.684 - 21534.027)}{59767.4} \times 100{,}000$$

$$V = \frac{26465.661}{59767.4} \times 100{,}000 = 44{,}281$$

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a)a single prem: *@ the end of the 5th policy yr, the insured is 25 yrs old.*

At that time the value of the reserve =

the value of the future benefits & equal NSP for a 5-yr, $100,000 endowment policy issued to a 25-yr-old male.

From the formula this value is:

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where: $$V = A_{\overline{25:5}|} \times 100{,}000$$

$$V = \frac{M_{25} - M_{30} + D_{30}}{D_{25}} \times 100{,}000$$

$$V = \left(\frac{8859.475 - 8408.291 + 47548.5}{59767.4}\right) \times 100{,}000 = \$80{,}311$$

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Ex 2: Find the reserve per survivor @ the end of the 10th policy yr using the prospective method for a $70,000, whole life policy issued to a 20- yr- old male if the policy issued for:

a)a single prem.

b)an annual prem.

c)a limited annual prem for 15 yrs.

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a)a single prem: @ the end of the 10th policy yr, the insured is 30 yrs old.

At that time, there are future benefits from age 30 & up & there are no future prems from age 30 & up (he paid NSP).

Then, the value of the Reserve =

{PV of Future Benefits @ age 30

- PV of Future Prems @ age 30 which = 0 (he paid NSP)

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***a)a single prem*:**

$$V = \frac{M_{30}}{D_{30}} \times 70{,}000$$

$$V = \frac{8408.291}{47548.5} \times 70{,}000 = 12{,}378.527$$

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b)an annual prem: @ the end of the 10th policy yr, the insured is 30 yrs old.

At that time, there are future benefits from age 30 & up & there are future prems from age 30 & up.

Then, the value of the Reserve =

{PV of Future Benefits @ age 30

- PV of Future Prems @ age 30
(which represent an Annuity).

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b)an annual prem:

$$V = \{\frac{M_{x+t} - P(N_{x+t})}{D_{x+t}}\}$$

$$V = \{\frac{(M_{30} - P(N_{30})}{D_{30}}\} \times 70{,}000$$

where: $P = \frac{M_{20}}{N_{20}}$

$$P = \frac{9477.262}{15258554} == 0.00621$$

$$V = \frac{(8408.291 - (0.00621 \times 9089224)}{47548.5} \times 70{,}000 = 4{,}068.936$$

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c)a limited annual prem: *@ the end of the 10th policy yr, the insured is 30 yrs old.*

At that time, there are future benefits from age 30 & up & there are future prems from age 30 & up to age 35.

Then, the value of the Reserve =

{PV of Future Benefits @ age 30

- PV of Future Prems @ age 30 to 35 (which represent an Annuity for 5 yr)

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c)a limited annual premium for 15 years:

$$V = \{\frac{M_{x+t} \_ P(N_{x+t} \_ P(N_{x+n})}{D_{x+t}}\}$$

$$V = \{\frac{(M_{30} \_ P(N_{30} \_ N_{35})}{D_{30}}\} \times 70{,}000$$

where: $P = \frac{M_{20}}{N_{20} \_ N_{35}}$

$$P = \frac{9477.262}{15258554 \_ 691534} == 0.011359$$

$$V = \frac{(8408.291 \_ 0.011359(9089224 \_ 691534)}{475485} \times 70{,}000 = 8{,}743.249$$

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***Ex 3**: Find the reserve per survivor at the end of the 10th policy yr using the retrospective method for a $70,000, whole life policy issued to a 20- yr- old male if the policy issued for:*

a)a single prem.

b)an annual prem.

c)a limited annual prem for 15 yrs.

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***a)a single prem*: At the end of the 10th policy yr, the insured is 30 yrs old.**

At that time, the insurer collected the whole prems (NSP) & paid 10 yrs benefits.

Then, the value of the Reserve =

{The amount of collected prem@ age 30

- The amount of paid benefits @ age 30

Or: = The net single prem @ age 30

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a)a single prem:

$$V = \frac{M_x - (M_x - M_{x+t})}{D_{x+t}}$$

$$V = \frac{M_{20} - (M_{20} - M_{30})}{D_{30}} \times 70{,}000$$

$$V = \frac{M_{30}}{D_{30}} \times 70{,}000 = \frac{840\&291}{475485} \times 70{,}000 = 12{,}378\&527$$

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b)an annual prem: *@t the end of the 10th policy yr, the insured is 30 yrs old.*

At that time, the insurer collected 10 prems & paid 10 yr benefits.

Then, the value of the Reserve =

{The amount of collected prem@ age 30

- The amount of paid benefits @ age 30

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b)an annual prem:

$$V = \frac{P(N_{20} \_ N_{30}) \_ (M_{20} \_ M_{30})}{D_{30}}$$

where: $P = \frac{M_{20}}{N_{20}}$

$$P = \frac{9477.262}{15258554} == 0.00621$$

$$V = \frac{0.00621(15258554 - 9089224) \_ (9477.262 \_ 8408.291)}{47548.5} \times 70{,}000$$

$$V = \frac{(3831.154 \_ 1068.971)}{47548.5} \times 70{,}000 = 4{,}066.433$$

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c)a limited annual prem: *@ the end of the 10th policy yr, the insured is 30 yrs old.*

At that time, the insurer collected 10 prems & there are 5 remaining prems & paid 10 yr benefits.

Then, the value of the Reserve =

{The amount of collected prem@ age 30

- The amount of paid benefits @ age 30

(which represent an Annuity for 10 yr)

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c)a limited annual prem:

$$V = \frac{P(N_{20} - N_{30}) - (M_{20} - M_{30})}{D_{30}}$$

where: $$P = \frac{M_{20}}{N_{20} - N_{35}}$$

$$P = \frac{9477.262}{15258554 - 691534} = 0.011359$$

$$V = \frac{0.011359(15258554 - 9089224) - (9477.262 - 8408291)}{475485} \times 70{,}000$$

$$V = 8{,}743.249$$

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Ex 4: *An ordinary life ins. policy of $70,000 has been issued on the life of a person now aged 30 for the last 10 yrs.*

He now wishes to change this policy to a 15–payment whole life policy as of his original age at issue.

How much must he pays to the ins. Co.

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a)an annual prem: *@t the end of the 10th policy yr, the insured is 30 yrs old.*

At that time, the insurer collected 10 prems & paid 10 yr benefits.

Then, the value of the Reserve =

{The amount of collected prem@ age 30

- The amount of paid benefits @ age 30

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a)an annual prem:

$$V = \frac{P(N_{20} - N_{30}) - (M_{20} - M_{30})}{D_{30}}$$

where: $$P = \frac{M_{20}}{N_{20}}$$

$$P = \frac{9477.262}{15258554} == 0.00621$$

$$V = \frac{0.00621(15258554 - 9089224) - (9477.262 - 8408.291)}{47548.5} \times 70{,}000$$

$$V = \frac{(3831.154 - 1068.971)}{47548.5} \times 70{,}000 = 4{,}066.433$$

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b)a limited annual prem: *@ the end of the 10th policy yr, the insured is 30 yrs old.*

At that time, the insurer collected 10 prems & there are 5 remaining prems & paid 10 yr benefits.

Then, the value of the Reserve =

{The amount of collected prem@ age 30

- The amount of paid benefits @ age 30

(which represent an Annuity for 10 yr)

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b)a limited annual prem:

$$V = \frac{P(N_{20} - N_{30}) - (M_{20} - M_{30})}{D_{30}}$$

where: $$P = \frac{M_{20}}{N_{20} - N_{35}}$$

$$P = \frac{9477.262}{15258554 - 691534} = 0.011359$$

$$V = \frac{0.011359(15258554 - 9089224) - (9477.262 - 8408291)}{475485} \times 70{,}000$$

$$V = 8{,}743.249$$

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Then the insured should pays the difference between the two reserve, i.e.:

8743,249 – 4066.433 = 4676.816

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Ex 5: *An ordinary life ins policy of $70,000 issued to a person aged 20 is discontinued at age 30.*

He now wishes to use the reserve for the same policy without paying any more prems.

How much would be the amount of ins of the new policy.

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The reserve of the first policy after 10 yrs:

@t the end of the 10th policy yr, the insured is 30 yrs old.

At that time, the insurer collected 10 prems & paid 10 yr benefits.

Then, the value of the Reserve =

{The amount of collected prem@ age 30

- The amount of paid benefits @ age 30

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a)The reserve of the whole life policy after 10 yrs:

$$V = \frac{P(N_{20} - N_{30}) - (M_{20} - M_{30})}{D_{30}}$$

where: $$P = \frac{M_{20}}{N_{20}}$$

$$P = \frac{9477.262}{15258554} == 0.00621$$

$$V = \frac{0.00621(15258554 - 9089224) - (9477.262 - 8408.291)}{47548.5} \times 70{,}000$$

$$V = \frac{(3831.154 - 1068.971)}{47548.5} \times 70{,}000 = 4{,}066.433$$

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This reserve represents the net single prem for a whole life policy issued at age 30:

$$A_{30} = \frac{M_{30}}{D_{30}} \times Y$$

$$4066.433 = \frac{8408.291}{47548.5} \times Y$$

4066.433 = 0.1768361 Y

Y = 22995.491

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Ex 6: *An ordinary life ins policy of $70,000 issued to a person aged 20 is discontinued at age 30.*

He now wishes to use the reserve to buy a 20 yr term insurance at age 30.

How much would be the amount of ins?

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The reserve of the first policy after 10 yrs:

@t the end of the 10th policy yr, the insured is 30 yrs old.

At that time, the insurer collected 10 prems & paid 10 yr benefits.

Then, the value of the Reserve =

{The amount of collected prem@ age 30

- The amount of paid benefits @ age 30

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a)The reserve of the whole life policy after 10 yrs:

$$V = \frac{P(N_{20} - N_{30}) - (M_{20} - M_{30})}{D_{30}}$$

where: $$P = \frac{M_{20}}{N_{20}}$$

$$P = \frac{9477.262}{15258554} == 0.00621$$

$$V = \frac{0.00621(15258554 - 9089224) - (9477.262 - 8408.291)}{47548.5} \times 70{,}000$$

$$V = \frac{(3831.154 - 1068.971)}{47548.5} \times 70{,}000 = 4{,}066.433$$

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This reserve represents the net single prem for a 20 yr term ins policy issued at age 30:

$$A^{1}_{30:\overline{20}|} = \frac{M_{30} - M_{50}}{D_{30}}$$

$$4{,}066.433 = \frac{8408.291 - 6616.417}{47548.5} \times Y$$

$$4066.433 = \frac{8408.291}{47548.5} \times Y$$

4066.433 = 0.037685 Y

Y = 107,905.878