E. Profit Measures

PROFIT VECTOR

$\Pr_t$ is the profit for year t at the end of year t given the contract is in force at the beginning of year t.

$\Pr_0 = -\left(E_0 + {}_0V\right)$

E_0 expenses are called *pre-contract expenses*

For $t > 0$, the profit of a life insurance contract on (x) is:

$$\Pr_t = \left({}_{t-1}V + G_t - E_t\right)(1+i) - q_{x+t-1}\left(DB_t\right) - p_{x+t-1}\left({}_tV\right)$$

Understand the above formula because you need to be able to adjust it for different types of contracts

Change in reserve method:

$$\Pr_t = \left(G_t - E_t\right)(1+i) + \Delta\,{}_tV - EDB_t$$

$$\Delta\,{}_tV = {}_{t-1}V \times (1+i) - p_{x+t-1} \times {}_tV$$

PROFIT SIGNATURE

Π_t is the profit for year t at the end of year t given the contract is in force at issue.

$$\Pi_t = \begin{cases} \Pr_0 & t = 0 \\ {}_{t-1}p_x \cdot \Pr_t & t > 0 \end{cases}$$

where ${}_{t-1}p_x$ is the probability that policy is in force at beginning of year t.

PROFIT MEASURES

Risk discount rate (a.k.a. hurdle rate) $= r$

$$\text{NPV} = \sum_{t=0}^{n} \Pi_t\, v_r^t$$

Partial NPV at time t :

$$\text{NPV}(t) = \sum_{k=0}^{t} \Pi_k\, v_r^k$$

IRR is j such that:

$$\sum_{t=0}^{n} \Pi_t\, v_j^t = 0$$

Discount Payback Period:

$$\text{DPP} = \min\{t : \text{NPV}(t) \geq 0\}$$

$$\text{profit margin} = \frac{\text{NPV}}{P\ddot{a}_{x:\overline{n}|}}$$

ZEROIZATION

1. Start with the last year and solve for the reserve such that the profit for the year is zero.

2. Working backwards continue this process for each year.

3. If a reserve is negative, then set the reserve to zero.

4. Perform profit test using these new **zeroized** reserves.

MULTIPLE STATE MODELS

1. For each in-force state i, calculate the profit vector $\Pr^{(i)}$.

2. The profit signature now multiplies by the probability of being in the in-force state

$$\Pi_t = \begin{cases} \Pr_t & t = 0, 1 \\ \sum\limits_{\text{all } i} {}_{t-1}p_x^{0i}\, \Pr_t^{(i)} & t = 2, 3, \ldots \end{cases}$$