

Stat 444  
Advanced Long-term Actuarial Math

Lecture 6: Universal Life Insurance

# Universal Life (UL) Insurance Design Features

UL policies are very popular in the United States:

- UL is purchased with a specified face amount.
- Premiums (net of a percent-of-premium charge) are deposited into a notional account (fund).
  - Timing and amount of premium deposits are flexible, subject to certain guidelines.
- The fund earns an interest rate declared by the insurer, subject to a contractual minimum rate.
  - The credited interest rate is often determined as the rate earned in the LIC general fund, minus a spread.
  - The credited interest rate may be **tiered** by account size.
- The death benefit consists of <sup>1</sup>:
  - the specified amount (Option A or Type A)
  - the specified amount plus the account value (Option B or Type B)

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<sup>1</sup> “Corridor factors” complicate the matter a bit; more on these later.

# Universal Life (UL) Insurance Design Features (cont'd)

- Periodic (typically monthly) deductions are taken from the account to cover the cost of insurance and expenses.
- Expense charges are specified in the contract.
  - It's typical for the charge in the first year to be larger than those in renewal years.
- COI rates are typically per unit (\$1000) of NAR, and are based on rating factors such as gender, age, and rate class.
  - They may also be **banded or tiered** by size.
  - LIC can change their COI rates, subject to contractually specified maximum rates.
- The account value (AV) can be used in various ways:
  - Loans
  - (Partial) Withdrawals
  - (Full) Surrender
- The cash surrender value (CSV) consists of the AV minus a surrender charge (subject to a minimum of 0)
  - Surrender charge may be a flat amount or a percent of the AV, and typically decreases (often to 0) over some number of years.

# Some Basic Account Value Mechanics

In practice, there are various ways that UL mechanics may work. In the following examples we'll assume (mostly for simplicity):

- All calculations are done on an annual basis.
- Premiums are payable at the beginning of the year.
- COI charges are discounted with interest back to the beginning of the year.
- All COI and expense charges happen at the beginning of the year.
- COI rates are not banded by policy size.

# More Account Value Mechanics

Using the following notation:

- $AV_t$ : Account value at time  $t$
- $MC_t$ : Maintenance expense charge deducted at the beginning of year  $t$
- $COI_t$ : Cost of insurance deducted at the beginning of year  $t$
- $i_t^c$ : Credited interest rate during year  $t$
- $P_t$ : Premium paid at the start of year  $t$
- $e_t$ : Percent of premium charge in year  $t$

We can calculate account values recursively:

$$(AV_{t-1} + P_t(1 - e_t) - MC_t - COI_t)(1 + i_t^c) = AV_t$$

# More Account Value Mechanics

More notation:

- $r_c$ : COI rate per \$1,000 of NAR
- $i^q$ : Interest rate for discounting the COI charge
- $SA_t$ : Specified amount in year  $t$

The NAR (called ADB in AMLCR) at time  $t$  is the difference between the death benefit and the account value (both at time  $t$ ):

- For an Option A policy, this is  $SA_t - AV_t$
- For an Option B policy, this is  $SA_t$

Then we can calculate the COI charge as

$$COI_t = \frac{(NAR/1000) \times r_c}{1 + i^q}$$

# Type B Universal Life Example

Consider a 40-year-old, Female, Non-smoker, purchasing a \$500,000 Type B UL policy with annual premiums of \$2,500. Product information is given on the UL Product Specification Sheet.

- ① Calculate the Surrender Value at the end of years 1 and 2.
- ② Paying \$2,500 per year, how long will her policy last?
- ③ What annual premium should she pay to make the policy last until age 95? to age 100?
- ④ Repeat the last two parts assuming that she only wants to pay premiums while working, i.e., making the last payment at age 64. What if she wants to increase her premiums by 3% per year (to match anticipated salary increases)?

# Corridor Factors

The insurance element of a UL policy consists of the NAR; if the  $AV$  is large relative to the specified amount, the NAR could be rather small (especially in a Type A policy), meaning that there's not really any insurance happening.

**Corridor factors** assure that UL policies have a sufficient insurance element.

- Corridor factors are specified by the (U.S.) government, and are a function only of attained age.
- We'll denote the applicable corridor factor by  $\gamma$ .
- The death benefit must be at least  $\gamma \times AV$ .

Then, with corridor factors, the death benefit for a UL policy is:

- Type A:  $\max(\gamma \times AV_t, SA_t)$
- Type B:  $\max(\gamma \times AV_t, SA_t + AV_t)$



# Type A Account Values

After doing some algebra, we can calculate the account value assuming both that the corridor factors apply ( $AV_t^c$ ) and that they don't ( $AV_t^f$ ) and the account value is  $AV_t = \min(AV_t^c, AV_t^f)$ .

$$AV_t^f = (AV_{t-1} + P_t - EC_t - q_{x+t-1}v_q(SA_t - AV_t^f))(1 + i_t^c)$$

$$\rightarrow AV_t^f = \frac{(AV_{t-1} + P_t - EC_t - q_{x+t-1}v_qSA_t)(1 + i_t^c)}{1 - q_{x+t-1}v_q(1 + i_t^c)}$$

$$AV_t^c = (AV_{t-1} + P_t - EC_t - q_{x+t-1}v_q(\gamma_t - 1)AV_t^c)(1 + i_t^c)$$

$$\rightarrow AV_t^c = \frac{(AV_{t-1} + P_t - EC_t)(1 + i_t^c)}{1 + q_{x+t-1}v_q(\gamma_t - 1)(1 + i_t^c)}$$

# Universal Life Example

Continuing the previous example, now suppose that the face amount is \$100,000 and that premiums are \$11,000 per year. At what age does the corridor requirement first become applicable?

Now suppose that the above UL policy is type A. Repeat the entire example.

# Profit Testing for UL Products

The general principles of profit testing are the same for UL products as they were for term products, but there are some complications:

- Before doing a profit test, we must first calculate the set of account values for a policy; these function as the reserves in the term profit test.
- All of the values are very sensitive to the premium / contribution level; usually want to run multiple scenarios with different premium levels.
- Since there are usually surrender values, need to explicitly account for surrenders.

Once we have the profit vector, though, it's essentially the same as the profit test for traditional products.

## (U.S. Regulatory) Definition of Life Insurance

Various tests are done to assure that a policy meets the definition of life insurance, as specified by IRS regulations (IRC 7702).

For every policy, one of the two following methods is chosen (at policy issue, and cannot be subsequently changed) to ensure compliance:

- Cash Value Accumulation Test (CVAT)
- Guideline Level Premium / Guideline Single Premium / Corridor Factor Tests

In the event that a contract does not meet the definition of life insurance, it is treated as an investment rather than a life insurance product.

- The implication of this is that the death benefit is no longer tax-free, as it would be in a life insurance product.
- This would almost certainly be detrimental to the policyholder, so the LIC will typically not allow it to happen (e.g., by refusing premiums that would cause the policy to fall out of compliance).

# Cash Value Accumulation Test (CVAT)

The account value (cash value) of a policy cannot, at any point in time, exceed the net single premium (NSP, EPV) that would be required to fund the policy.

- The idea is that there shouldn't ever be any circumstances where we need to have more than this quantity as an account value, so the account value is capped at this amount.

**Example:** For a 100,000 Option A issued to (40):

- The AV at time 1 cannot exceed 100,000  $A_{41}$ .
- The AV at time 10 cannot exceed 100,000  $A_{50}$ .

The basis for this calculation is:

- Mortality uses guaranteed maximum COI charges.
- The interest rate used is the maximum of 4% and the guaranteed minimum credited interest rate for the contract.

Under this option, a policy must meet both the GLP / GSP (Guideline Premium) test **and** the corridor factor test.

- Typically, if the corridor factor test would be failed, the face amount of the policy can be increased to compensate.

Guideline Premium Test: Aggregate total of premiums paid into the contract cannot at any time exceed the greater of: (a) the GSP (Guideline Single Premium), and (b) the sum of the GLPs (Guideline Level Premiums, sometimes called Guideline Annual Premiums).

The GSP is the net single premium that funds the contract, while the GLP is the level annual premium that funds the contract.

# Basis for Guideline Premium Calculations

Guideline premiums are calculated once at policy issue and don't change for the life of the contract. They're calculated on the following basis:

- Mortality: Guaranteed maximum COI charges
- Interest:
  - GSP:  $\max(6\%, \text{guaranteed minimum int. rate})$
  - GLP:  $\max(4\%, \text{guaranteed minimum int. rate})$
- Death Benefit:
  - GSP: use Option A DB, regardless of contract DB option
  - GLP: use actual contract DB option

**Example:** Suppose a policy has a GSP of \$50,000 and a GLP of \$4,000. The policyholder wants to pay premiums of \$5,000 per year. At what point, if ever, is the Guideline Premium Test failed?

# Modified Endowment Contracts

Even if a contract meets the definition of a life insurance product, it may still be deemed a **Modified Endowment Contract (MEC)** if it doesn't meet the (TAMRA) 7-pay test (IRC 7702A).

A MEC still has a tax free death benefit, like other life insurance products.

However, MEC status affects the tax treatment of policy loans and withdrawals:

- When money is withdrawn from a MEC, all gain is deemed to be withdrawn first, before any of the cost basis is withdrawn (LIFO).
- This is the opposite of the treatment of other life insurance contracts (FIFO).

Thus, policyholders will typically want to avoid having their policies enter MEC status; it's also not possible to "un-MEC".



## Basis for 7-Pay Calculations

The TAMRA premiums are calculated once at policy issue and don't change for the life of the contract. They are the net level premium required to pay up the contract in 7 years, and are calculated on the following basis:

- Mortality: Guaranteed maximum COI charges
- Interest:  $\max(4\%, \text{guaranteed minimum int. rate})$
- Death Benefit: Use Option A, regardless of actual DB option

The TAMRA 7-pay test is failed if, at any point within the first 7 years of the contract, the sum of the premiums paid exceeds the sum of the 7-pay premiums.

**Example:** Continuing the previous example, suppose a policy has a 7-pay premium of \$6,000. At what point, if ever, does the contract become a MEC?

# IRC 7702 / 7702A Summary

## Summary:<sup>2</sup>

To be considered life insurance (and get a tax-exempt death benefit), the product must meet either:

- Cash Value Accumulation Test (CVAT), or
- All of the Guideline Level Premium / Guideline Single Premium / Corridor Factor Tests

A product that qualifies as a life insurance product, but fails the TAMRA 7-pay test is considered a MEC for tax purposes:

- The death benefit is still taxable, and the “inside buildup”, i.e., cash value accumulation is still tax-deferred.
- Any distributions such as loans or withdrawals over the life of the contract are taxed as “income first” rather than “basis first”, so that they are taxable to the extent that the withdrawals exceed premium contributions. Additional taxes or penalties may apply to these distributions.

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<sup>2</sup>This is a summary of what you need to know for this class; the actual details are considerably more complicated.

## Waiver of Monthly Deduction (WMD)

- Monthly COI and expense charges are waived in the event that the policyholder becomes disabled.
- This rider is paid for through an additional monthly expense charge.

## Spouse / Child / Family Riders

- Provides some insurance protection on the death of the insured's spouse and/or child(ren).
- One charge may cover all children in the family.
- These other insureds aren't typically underwritten.
- Usually these riders are restricted to small face amounts.

Some other UL designs / features include:

- Fixed Premium UL
- Survivorship (last to die) UL
- Level COI UL
- Option C UL

# Variable Universal Life (VUL)

VUL products became very popular in the United States in the 1990s and early 2000s:

- VUL was dominant form of UL for a while (up to maybe 2005 - 2010 or so).
  - Interest rates had been low for a while, making UL less attractive. Stock market mostly booming.
- In most ways, VUL is very similar to UL.
- Premiums are flexible, subject to all the same 7702 / 7702a rules.
- LIC deducts monthly charges for COI and expenses.
- Death benefits have Option A and Option B.

# Variable Universal Life (VUL)

The key feature of VUL is that it lets the policyholder direct their investments:

- Instead of the nominal account being invested in the LIC's general fund, the money is invested in a separate fund or separate account.
  - These funds are distinct from the LIC's other monies.
  - They show up distinctly in financial statements and are not subject to creditors.
- A typical VUL product will offer 5 - 50 investment fund options for policyholders.
  - Policyholders allocate their premiums among these options however they wish.
  - These fund options behave similarly to mutual funds, and span a large range of investment options. (Large cap stocks, international, index funds, precious metals, etc.)

Premiums are converted to **units** of the various funds:

- These units are redeemed (typically monthly) to pay expense and COI charges.
- The unit values rise and fall with the financial markets. (There's no interest credited, per se.)
- The policyholder can change the allocation among funds at any point.

## Secondary Guarantees

In addition to the primary guarantees (min credited int. rate for UL and max COI rates for UL/VUL), some UL / VUL products offer **secondary guarantees**. (They're even more important for VA products; more on this later.)

In return for making (at least) a minimum series of premium contributions, the LIC provides guarantees regarding the account value, surrender value, or death benefit amounts, regardless of the policyholder's investment allocations or fund performances.



The most commonly offered secondary guarantee for VUL products is a **no-lapse guarantee**. Two possible basic designs for the no-lapse guarantee include:

- Specified premium
- Shadow account

More complex designs now exist, and these plan designs are ever-evolving.

Similar to UL, the account value is periodically credited with interest. For IUL, the credited rate is determined by a formula specified in the contract:

- Usually tied to a stock market or other index.
- Involves a “participation rate” that may be between 25% and 100%.
- Offers downside protection: if the index decreases in value, the account is typically credited with some minimum interest rate (typically 0% - 1%).
- There may also be a cap on the credited rate.

## Indexed UL (IUL or EIUL)

Note that, unlike VUL, the policyholder is not investing directly in the stock market or mutual funds; a particular market index is simply used to calculate the credited rate.

The designs vary widely, so each type of plan has its own calculations, but generically:

$$i^c = \max(\min(r \cdot P, c), f)$$

$r$  = rate of return for index

$P$  = participation rate

$c$  and  $f$  = cap and floor

Actuarial Mathematics for Life Contingent Risks, Second Edition,  
by Dickson, Hardy, and Waters.

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