FRM Part 1

Book 3 - Financial Markets and Products

Chapter 2

INSURANCE COMPANIES AND PENSION PLANS

Learning Objectives

After completing this reading you should be able to:

- ✓ Describe the **key features** of the various categories of **insurance companies** and identify the **risks facing insurance companies**.
- ✓ Describe the use of **mortality tables** and **calculate the premium payment** for a policyholder.
- ✓ Calculate and interpret **loss ratio**, **expense ratio**, **combined ratio**, and **operating ratio** for a property-casualty insurance company.
- ✓ Describe **moral hazard** and **adverse selection** risks facing insurance companies, provide examples of each, and describe how to overcome the problems.
- ✓ Distinguish between **mortality risk** and **longevity risk** and describe how to hedge these risks.
- ✓ Evaluate the **capital requirements** for life insurance and property-casualty insurance companies.
- ✓ Compare the **guaranty system** and the **regulatory requirements** for insurance companies with those for banks.
- ✓ Describe a **defined benefit plan** and a **defined contribution plan** for a pension fund and explain the differences between them.

Categories of Insurance

An insurance contact is:

- An **agreement** between an **insurer** and a **policyholder**, where the latter receives **protection in exchange for premiums**.

- Insurance takes two main forms:

Life assurance

Nonlife (property) insurance

- Notes: Since we cannot put a price/value tag on human life, the word “insurance” is replaced with assurance.

Types of Life Assurance
1. Term life assurance

- A term life assurance contract is a contract to pay the beneficiary a **predetermined amount of benefit**, also called the sum assured, in case the **policyholder dies** within the term of the contract.
  - If the contract starts today and remains in force for the next 10 years, the sum assured will only be payable if the policyholder dies within the next 10-year period.
  - If the policyholder survives to the end of the term, the contract **comes to an end without any form of compensation**.

Types of Life Assurance
2. Whole life assurance

- Under a whole life contact, the sum assured is payable when the policyholder dies, **regardless of when that happens**.
  - It provides protection for the life of the policyholder.
  - Premiums are paid throughout the life of the policyholder.
  - Unlike in a term life contract **the sum assured is certain to be paid at some point in the future**, provided the policyholder continues to make the required premium payments up to the point of their death.

Types of Life Assurance
3. Variable life assurance

- A variable life assurance policy is a type of whole life assurance with an **investment component**.
  - A portion of the **premium payable is invested** in a number of sub-accounts available in the policy.
    - ✓ For example, let's say John buys a variable life assurance policy where he pays an annual premium amounting to $10,000.
    - ✓ The contract could be designed in such a way that **$5,000 goes toward the sum assured** (death benefit), say, $1 million, and the other **$5,000 is invested in various instruments**.
  - Thus, the **total benefit** received on the death of the policyholder will be the **sum assured plus a variable amount generated from the investment account**.

Types of Life Assurance
4.Universal life

- Just like variable life assurance, a universal life contract is a type of whole life assurance **with an investment component**.
  - However, a universal contract gives the policyholder a lot more **flexibility in terms of the premium payable**.
  - The **premium can even be reduced** to a pre-specified minimum without the policy lapsing.
  - The policyholder is also **assured of a minimum return** from the investment account.

Types of Life Assurance
5. Endowment life assurance

- Under an endowment contract, the sum assured is **payable either when the policyholder dies** or **at the end of the specified period**, whichever comes first.
  - There are many variants of endowment life contracts in the market today.
  - Some may even have an investment component.
  - Others may precondition payment of the sum assured **on survival of the policyholder** to the end of the period.

Types of Life Assurance
6. Group life assurance

- A group life assurance contract **covers multiple persons**, usually employees in a company.
  - The policy could be **contributory**, in which case the premium payable is **shared between the employer and the employee**.
  - In other cases, it could be **non-contributory**, meaning that the **employee is obliged to pay the full premium amount**.

Types of Life Assurance
7. Annuity contract

- An annuity is a contract that requires the **policyholder to pay a lump sum**. In return, the policyholder receives a **regular series of payments** at specified points in the future.
  - This regular stream of payments is called an annuity. The annuity starts at a particular date and **lasts for the rest of the policyholder's life**.
  - The annuity could start immediately after the lump sum has been paid. In other cases, it could start, say, 5 years after payment of the lump sum.
    - ✓ Such a contract is called a deferred annuity.
  - The insurance company funds the annuity by **investing the lump sum** in an investment vehicle of their choice, including **secured bonds** and **mutual funds**.
  - An annuity helps the policyholder to **defer the tax payable** until they receive each scheduled annuity payment.

Mortality Tables

- For each age, a mortality table gives the probability of a person at that age **dying before their next birthday**.
  - In other words, it gives the **survivorship** of people from a given population.
- The mortality rate among men is different (and usually higher) from that of women.
  - Thus, mortality tables are constructed **separately for men and women**.
- Insurance companies use mortality tables to **price insurance products** and **project future insured events**.

Illustration >>

Period Life Table - 2015

		Male			Female	
Exact age	Probability of death within 1 year	Male number of lives	Life expectancy	Probability of death within 1 year	Female number of lives	Life expectancy
0	0.006383	100,000	76.15	0.005374	100,000	80.97
1	0.000453	99,362	74.63	0.000353	99,463	80.41
2	0.000282	99,317	74.67	0.000231	99,427	79.44
3	0.000230	99,289	73.69	0.000165	99,405	78.45
4	0.000169	99,266	72.71	0.000129	99,388	77.47
5	0.000155	99,249	71.72	0.000116	99,375	76.48
. . .	. . .	. . .	. . .	. . .	. . .	. . .
30	0.001626	97,393	47.75	0.000740	98,588	51.95
31	0.001669	97,235	46.82	0.000792	98,515	50.99
32	0.001712	97,072	45.90	0.000841	98,437	50.03
33	0.001755	96,906	44.98	0.000886	98,354	49.07
34	0.001800	96,736	44.06	0.000929	98,267	48.11
35	0.001855	96,562	43.14	0.000977	98,175	47.16

Mortality Tables

Interpreting the table:

- Consider the row corresponding to age 3.

		Male			Female	
Exact age	Probability of death within 1 year	Male number of lives	Life expectancy	Probability of death within 1 year	Female number of lives	Life expectancy
3	0.000230	99,289	73.69	0.000165	99,405	78.45

- The second column gives the probability of a male aged **exactly 3** dying within the next year (0.000230).
- The third column gives the number of male lives, out of a cohort of 100,000 lives **that attain age 3** (99,289).
- The forth column shows that a male aged 3 has a remaining life expectancy of 73.69 years. Interpreted, that means on average, 3-year-old males will live to age **76.69 (= 73.69 + 3) .**
- We can interpret the rest of the data for females in a similar manner.

Calculating the Premium Payable

Example:

- Robert Myer **aged 30**, buys a **2-year term** assurance contract with a sum assured of **$100,000**.
- Interest rates for all maturities are **6% per annum** (with **semiannual compounding**), and **premiums are paid annually in advance** (at the beginning of the year).
- Calculate the **break-even premium**.

Calculating the Premium Payable

Solution

		Male			Female	
Exact age	Probability of death within 1 year	Male number of lives	Life expectancy	Probability of death within 1 year	Female number of lives	Life expectancy
30	0.001626	97,393	47.75	0.000740	98,588	51.95
31	0.001669	97,235	46.82	0.000792	98,515	50.99
32	0.001712	97,072	45.90	0.000841	98,437	50.03

- Present value of income = Present value of outgo
- Working out the left side of the equation, let the annual premium payable be X. Since the **first premium is paid immediately** the contract is signed, its **present value is still X**.
- The probability of the second premium payment being made at the beginning of the second year is the probability that the man does not die during the first year **(= 1 – 0.001626 = 0.998374).** Discounted at time 0:

$$PV\ of\ income = X + \frac{0.998374X}{1.03^2} = 1.94106X$$

Calculating the Premium Payable

Solution

		Male			Female	
Exact age	Probability of death within 1 year	Male number of lives	Life expectancy	Probability of death within 1 year	Female number of lives	Life expectancy
30	0.001626	97,393	47.75	0.000740	98,588	51.95
31	0.001669	97,235	46.82	0.000792	98,515	50.99
32	0.001712	97,072	45.90	0.000841	98,437	50.03

- The expected payout if Robert **dies in the first year is $162.60** (= 0.001626 × $ 100,000) .
- The expected payout if Robert **dies in the second year is $166.63** [= (1 – 0.001626) × 0.001669 × $ 100,000] .
  - We must the **discount these to time 0.**
- Note: In most cases, the assumption is that death occurs **midway through the year**, and the benefit is payable immediately on death.

Calculating the Premium Payable

- We discount the first expected payout for 6 months and the expected payout in year 2 for 18 months.

$$PV\ of\ outgo = \frac{\$162.6}{1.03} + \frac{\$166.63}{1.03^3} = \$310.35$$

- Remember that we have the equation from the beginning:

$$Present\ value\ of\ income = Present\ value\ of\ outgo$$
$$1.94106X = \$310.35$$
$$X = \$159.90$$

- Therefore, the **break-even premium** has to be $159.90.

Ratios in Property/ Casualty Insurance

- The ratio of **payouts made** to **premiums earned** in a year.
  - A high loss ratio indicates poor financial health.
    - ✓ The insurer **may not be collecting enough premium** to pay claims, expenses, and still make a sizeable profit.
- The expense ratio is the ratio of **expenses** to **premiums earned** in a year.
  - It shows how efficient the insurer is in terms of cash management before factoring in claims and investment gains or losses.
  - Expenses comprise of:
    - ✓ Ad fees,
    - ✓ employee wages,
    - ✓ commissions for sales agents, etc.
- The **combined ratio** is the **sum of the loss ratio** and **the expense ratio.**
- The **operating ratio** is defined as the combined ratio **after dividends less investment income**.

Illustration >>

Ratios in Property/ Casualty Insurance

Illustration of the different ratios

Loss ratio	65%
Expense ratio	30%
Combined ratio	65% + 30% = 95%
Dividends	2%
Combined ratio after dividends	95% + 2% = 97%
Investment income	2%
Operating ratio	97% - 2% = 95%

Moral Hazard in Insurance

- Moral Hazard describes the risk that once an individual signs up for an insurance contract, **they will behave differently than they would without the insurance**.
  - They will have an incentive to take risks they would otherwise not dare take.
- Moral hazard **increases the expected payout** of the insurer.
- The strategies adopted to mitigate moral hazard include:
  - Use of deductibles such that the first part of a loss is covered by the insured.
  - Use of co-insurance provisions where the insurer can only cover a certain percentage (less than 100%) of losses after taking deductibles into account.
  - Use of policy limits so that there's a cap on the maximum payout.

Adverse Selection in Insurance

- Adverse selection is the risk that a company **may attract bad risks** more than it attracts good risks.
  - If the insurer sells a product at the **same price to everyone**, it might inadvertently **attract more of the bad risks**.
- Just like moral hazard, adverse selection **increases the chances of claims** overwhelming the insurer, something that can lead to insolvency.
- The best way to **mitigate the risk of adverse selection** has much to do with making sure that the **insurer gathers as much information** about prospective policyholders as possible.
  - That way, they will be more likely to unearth certain facts that will help them to price the policy appropriately.

Mortality Risk and Longevity Risk

Mortality Risk

- The risk that wars and a host of **diseases** such as cancer and the HIV/AIDS epidemic will lead to people not living as long as expected.
- It has the potential to negatively impact insurance payouts because there will be **more deaths than initially anticipated**.
- Increased mortality risk **increases the profitability of annuity contracts** because the policyholders end up receiving fewer scheduled payments.

Longevity Risk

- The risk that a person will **live longer than initially expected** thanks to rapid advancement in **medical science** and **improved lifestyle** among people.
- Increased longevity risk **adversely affects annuity contracts** because the sponsor ends up parting with more payments than initially anticipated.
- Increased longevity will **improve the profitability of life insurance contracts** because the insureds will end up paying more and more premiums.

Mortality Risk and Longevity Risk

- Insurance companies hedge mortality risk through a combination of **careful pricing** and **reinsurance**, where they share the pooled risks with a **third party insurer**.

- Longevity risk can be **hedged** using **longevity derivatives**.
  - A typical derivative here is the longevity bond.
    - ✓ A population is defined.
    - ✓ The coupon payable as of a particular date is a function of the number of people still alive at that point.

Main Risks Facing Insurance Companies

- In readiness for claims, insurance companies **set aside funds generated from the premiums paid** as well as from various investments (reserves).
- **The number one risk** facing insurers is the risk that **policy reserves are not sufficient** to cover the forwarded claims.
  - Actuaries tend to be fairly **conservative** when calculating the reserves needed.
- Insurers have to contend with the risk that their investments will perform poorly.
- An **increase in default rates** spells doom for insurers.
  - This risk can be mitigated by diversifying investments over a range of industries or sectors in an economy.
- Insurers are constantly **faced with liquidity risk**. Bonds can be quite illiquid, especially those offered via private placement.
- Insurance companies face **credit risk** thanks to their transactions with **banks** and **reinsurance companies**.

Defined Benefit Plans vs Defined Contribution Plans

In a defined benefit plan:

- The **amount paid to the employee** at retirement is **specified by the plan**.
- It's the **employer** who **sponsors the plan** in its entirety.
- The benefit payable is a **function of the years** the employee has **worked** and their **salary**.
  - The benefit may be equal to the average earnings of the employee in the final three years of employment multiplied by the number of years worked.
- The employee has little control over the funds until they are received at retirement.
- **The employer bears investment risk** – they have to ensure that there are sufficient funds to pay the employee at retirement.
- In a defined benefit plan, all funds are **pooled by the employer**.
  - Payments to retirees are made from the pool.

Defined Benefit Plans vs Defined Contribution Plans

In a defined contribution plan:

- Both the **employee** and the **employer contribute toward the plan**, and the total amount is invested in a range of stable, secure investments, usually mutual funds, and money market funds.
- The **amount paid** to the employee at retirement **depends on the performance** of the investment.
- Since the employer has little control over the funds' performance, defined contributions are considered **low-risk to the employer**.
- In a defined contribution plan **each employee has their own account** and the pension payable is determined by the performance of that account.

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NEXT

MUTUAL FUNDS AND HEDGE FUNDS