## Solutions for End-of-Chapter Questions and Problems: Chapter Six

1. What is the primary function of an insurance company? How does this function compare with the primary function of a depository institution?

The primary function of an insurance company is to provide protection from adverse events. Insurance companies accept premium payments in exchange for compensation in the event that certain specified, but undesirable, events occur.

The primary function of depository institutions is to provide financial intermediation for individual and corporate savers. By accepting deposits and making loans, depository institutions allow savers with predominantly small, short-term financial assets to benefit from investments in larger, longer-term assets. These long-term assets typically yield a higher rate of return than short-term assets.

2. What is the adverse selection problem? How does adverse selection affect the profitable management of an insurance company?

The adverse selection problem occurs because customers who are most in need of insurance are most likely to acquire insurance. However, the premium structure for various types of insurance typically is based on an average population proportionately representing all categories of risk. Thus, the existence of a proportionately larger share of high-risk customers may cause the premium revenue received by the insurance provider to underestimate the revenue needed to cover the insured liabilities and to provide a reasonable profit for the insurance company.

3. What are the similarities and differences among the four basic lines of life insurance products?

The four basic lines of life insurance products are (1) ordinary life, (2) group life, (3) industrial life, and (4) credit life. Ordinary life is sold on an individual basis and represents the largest segment (~80%) of the life insurance market. The insurance policy can be structured as pure life insurance (term life) or may contain a savings component (whole life or universal life). Group policies (~19%) are similar to ordinary life insurance policies except that they are centrally administered, providing cost economies in evaluating, screening, selling, and servicing the policies. Industrial life (<1%) has largely been replaced by group life since cost economies have made group life more affordable. Industrial life was historically marketed to individuals who would make small, very frequent payments and would require personal collection services. Credit life (<1%) typically is term life sold in conjunction with some debt contract

4. Explain how annuity activities represent the reverse of life insurance activities.

A typical life insurance contract requires a periodic payment by one party for a promised payment of either a lump sum or an annuity if a particular event occurs, such as death or an accident. An annuity represents a reverse contract where the party purchases the right to receive periodic payments depending on the market conditions. The contract may be initiated by investing a lump sum or by making periodic payments before the annuity payments begin.

5. Explain how life insurance and annuity products can be used to create a steady stream of cash disbursements and payments to avoid paying or receiving a single-lump sum cash amount.

A life insurance policy (whole life or universal life) requires regular premium payments that entitle the beneficiary to the receipt of a single lump sum payment. Upon receipt of such a lump sum, a single annuity could be obtained which would generate regular cash payments until the value of the insurance policy is depleted.

6. a. Calculate the annual cash flows from a $1 million, 20-year fixed-payment annuity earning a guaranteed 10 percent per year if payments are to begin at the end of the current year.

The annual cash flows are given by X:



where PVA is obtained from a financial calculator with i = 10 percent and n = 20 years. The value for X is $117,459.62.

b. Calculate the annual cash flows from a $1 million, 20-year fixed-payment annuity earning a guaranteed 10 percent per year if payments are to begin at the end of year 5.

In this case, the first annuity is to be received five years from today. The initial sum today will have to be compounded by four periods to estimate the annuities: *X* = $171,972.64



c. What is the amount of the annuity purchase required if you wish to receive a fixed payment of $200,000 for 20 years? Assume that the annuity will earn 10 percent per year.

The required payment is the present value of $200,000 per year for 20 years at 10 percent.



7. You deposit $10,000 annually into a life insurance fund for the next 10 years, after which time you plan to retire.

a. If the deposits are made at the beginning of the year and earn an interest rate of 8 percent, what will be the amount of retirement funds at the end of year 10?



b. Instead of a lump sum, you wish to receive annuities for the next 20 years (years 11 through 30). What is the constant annual payment you expect to receive at the beginning of each year if you assume an interest rate of 8 percent during the distribution period?

In this case, the first annuity is to be received ten years from today. The amount of retirement funds at the end of year ten (the answer to part (a) of $156,454.87) will be paid out over twenty years with the first payment to be received immediately.

*X* = $14,754,88



c. Repeat parts (a) and (b) above assuming earning rates of 7 percent and 9 percent during the deposit period and earning rates of 7 percent and 9 percent during the distribution period. During which period does the change in the earning rate have the greatest impact?

##### Deposit Value at Distribution Annual

Period 10 Years Period Payment

7 percent $147,835.99 7 percent $13,041.75

9 percent $14,857.72

9 percent $165,602.93 7 percent $14,609.11

9 percent $16,643.32

If you earn only 7 percent during the deposit period, earning 9 percent during the distribution period will barely allow you to better the distribution of the 8 percent/8 percent pattern in parts (a) and (b). But if you earn 9 percent during the deposit period, the distribution amount at 7 percent will almost match the 8 percent/8 percent pattern.

8. You deposit $12,000 annually into a life insurance fund for the next 10 years, at which time you plan to retire. Instead of a lump sum, you wish to receive annuities for the next 20 years. What is the annual payment you expect to receive beginning in year 11 if you assume an interest rate of 6 percent for the whole time period?

The value of $12,000 deposited annually in a fund will amount to the following in ten years:



The annuities per year over the next twenty years at 6% will be:



Solving for X, annual cash flows, X= $13,789.94

9. a. Suppose a 65-year-old person wants to purchase an annuity from an insurance company that would pay $20,000 per year until the end of that person’s life. The insurance company expects this person to live for 15 more years and would be willing to pay 6 percent on the annuity. How much should the insurance company ask this person to pay for the annuity?



b. A second 65-year-old person wants the same $20,000 annuity, but this person is much healthier and is expected to live for 20 years. If the same 6 percent interest rate applies, how much should this healthier person be charged for the annuity?



c. In each case, what is the difference in the purchase price of the annuity if the distribution payments are made at the beginning of the year?

For 15 years, the lump sum value is $205,899.68. So, the difference in the purchase price is $11,654.70. For 20 years, the lump sum value is $243,162.33. So, the difference in the purchase price is $13,763.91.

10. Contrast the balance sheet of a life insurance company (Table 6-3) with the balance sheet of a commercial bank (Table 2-6) and that of a savings institution (Table 2-10). Explain the balance sheet differences in terms of the differences in the primary functions of the three organizations.

Life insurance companies have long-term liabilities because of the life insurance products that they sell. As a result, the asset side of the balance sheet predominantly includes long-term government and corporate bonds, corporate equities, and a declining amount of mortgage products. The asset side of a commercial bank’s balance sheet is comprised primarily of short- and medium-term loans to corporations and individuals and some liquid investment securities (e.g., Treasury securities). The principal asset category for a savings institution is long-term mortgages.

In effect, all three companies use large degrees of financial leverage to fund assets that primarily consist of debt securities. While the face value of deposits is fixed for banks and savings institutions, the composition of liabilities for insurance companies is stochastic. The primary liability category for a life insurance company is policy reserves that reflect the expected payment commitments on existing policy contracts. Insurance companies also sell short- and medium-term debt instruments called GICs that are used to fund their pension plan business. The liabilities of savings institutions are primarily short-term deposit accounts, while banks utilize short-term deposits and short-term borrowed funds, depending on the size of the bank.

11. Using the data in Table 6-2, how has the composition of assets of U.S. life insurance companies changed over time?

Table 6-2 indicates that life insurance companies have increased their holdings of bonds and stocks and decreased their holdings of mortgages and policy loans since the 1920s and 1930s. Government securities comprise the second largest component, although the proportion has been decreasing in recent years as the yields have decreased.

12. How do life insurance companies earn a profit?

Insurance companies earn profits by taking in more premium income than they pay out in policy payments. Firms can increase their spread between premium income and policy payouts in two ways. The first way is to decrease future required payouts for any given level of premium payments. This can be accomplished by reducing the risk of the insured pool (provided the policyholders do not demand premium rebates that fully reflect lower expected future payouts). The second way is to increase the profitability of interest income on net policy reserves. Since insurance liabilities typically are long term, the insurance company has long periods of time to invest premium payments in interest earning asset portfolios. The higher is the yield on the insurance company's investments, the greater is the difference between the premium income stream and the policy payouts (except in the case of variable life insurance) and the greater is the insurance company's profitability.

13. How would the balance sheet of a life insurance company change if it offered to run a private pension fund for another company?

The primary change in the balance sheet of a life insurance company would be an increase in the liability accounts that reflect these pension plans. Guaranteed investment contracts (GICs) and separate account categories likely would increase, depending on the type of pension plans provided to the customers. The premiums and contributions would be invested in the normal asset categories of the insurance company, except in cases where the pension fund requires aggressive investment strategies. In this case, the funds may be invested in specific equity mutual funds.

14. How does the regulation of insurance companies differ from the regulation of depository institutions? What are the major pieces of life insurance regulatory legislation?

Insurance companies are more exclusively subject to state regulations compared to banks and savings institutions. Although there are national insurance organizations such as the National Association of Insurance Commissioners, the companies are chartered and regulated at the state level. Banks and thrifts are typically subject to both national and state oversight. While both banks and insurance companies receive regulatory scrutiny as to the quality of their assets and liabilities, bank regulations also dictate minimum reserve and capital requirements. Both insurance companies and banks are limited in the products that they can offer. The primary legislation is the McCarran-Ferguson Act of 1945. This legislation provides that federal regulation is subordinate to state regulation.

In 2009, the U.S. Congress considered establishing an optional federal insurance charter. The move behind such a charter picked up steam following the failure of the existing state by state regulatory system to act in preventing the problems at insurance giant AIG from becoming a systemic risk to the national economy. Those in favor of an optional federal insurance charter noted that under the current state by state system, insurers face obstacles such as inconsistent regulations, barriers to innovation, conflicting agent licensing, and education requirements. While the House version of the 2010 Financial Services Regulatory Overhaul Bill (approved in December 2009) contained no provision for federal regulation of insurance companies, Financial Services Chairman Barney Frank stated that this would still be a possibility as the bill moved through the regulatory process towards final passage.

The final version of the overhaul bill, the Wall Street Reform and Consumer Protection Act of 2010 established the Federal Insurance Office (FIO) that reports to Congress and the President on matters pertaining to the insurance industry. While the industry’s main regulator continues to be the states in which firms operate, the FIO has the authority to monitor the insurance industry, identify regulatory gaps or systemic risk, deal with international insurance matters and monitor the extent to which underserved communities have access to affordable insurance products. The Wall Street Reform and Consumer Protection Act also called for the establishment of the Financial Stability Oversight Council (FSOC), which is charged with designating any financial institution (including insurance companies) that presents a systemic risk to the economy and subjecting them to greater regulation.

15. How do state guarantee funds for life insurance companies compare with deposit insurance for depository institutions?

State guarantee funds are different from deposit insurance in several ways. First, the insurance guarantee funds are administered by the life insurance companies as opposed to a separate company like the FDIC for deposit institutions. Second, insurance companies do not generally pay premiums into the guarantee fund until after the failure of an insurance company. The FDIC requires annual premium payments from all depository institutions. Third, while the FDIC requires premium payments to be based on the amount of deposits and the risk of the assets of the depository institutions, the contributions by insurance companies typically are based on the relative amount of premium income received by the surviving insurance companies. Finally, because contributions to the insurance guarantee funds are requested only after the failure of a company, the transmission of the benefits to the policyholders occurs only after a reasonable delay. In contrast, the FDIC normally pays depositors within a few days after the failure of a depository institution.

16. What are the two major activity lines of property-casualty insurance firms?

The two major lines of property-casualty insurance are:

a) Property insurance: Insurance compensating the insured, fully or partially, for personal or commercial property damage as a result of accidents and other events; and

b) Liability insurance: Insurance compensating a third party, fully or partially, because its personal or commercial property was damaged as a result of the accidental actions of the insured.

In many cases, property and liability insurance is sold together, such as personal or commercial multiple peril and auto insurance. Fire and allied lines usually are sold as property insurance only. Liability insurance is sold separately for coverage such as malpractice or product liability hazards. In addition, reinsurance provides a means for primary insurers to pool their risk by transferring some of the risk and premium to a reinsurer.

17. How have the product lines of property-casualty insurance companies changed over time?

Product lines based on net premiums typically are included in the property-casualty insurance arena. The largest decreases have been in the fire and allied categories, while the multiple peril (or umbrella) and liability policies have shown the largest increases. The changes are related in that much of the decreased coverage has been subsumed into the multiple peril policies.

18. Contrast the balance sheet of a property-casualty insurance company (Table 6-5) with the balance sheet of a commercial bank (Table 2-6). Explain the balance sheet differences in terms of the differences in the primary functions of the two organizations.

The balance sheet of a PC company is similar to that of a life insurance company. Long-term financial assets such as bonds, common equities, and preferred stock comprise the majority of the assets, while loss reserves, loss adjustment expenses, and unearned premiums dominate the liabilities. In contrast, short- and medium-term financial assets dominate the asset side of the balance sheets of most banks and borrowed funds in the form of deposits are the primary liability for commercial banks. Whereas banks provide time and size intermediation for depositors, PC insurance companies use premium payments to provide assurance against certain types of risk for customers. For a bank the deposits represent borrowed funds, while the premiums to an insurance company represent the actual price for the risk coverage.

19. What are the three sources of underwriting risk in the property-casualty insurance industry?

The three sources of underwriting risk in the PC industry are (a) unexpected increases in loss rates, (b) unexpected increases in expenses, and (c) unexpected decreases in investment yields. Loss rates are influenced by whether the product lines are property or liability (with the latter being less predictable), whether they are low-severity high-frequency lines or high-severity low-frequency lines (with the latter being more difficult to estimate), and whether they are long-tail or short-tail lines (with the former being more difficult to estimate). Loss rates also are affected by product and social inflation. Unexpected increases in expenses are a result of increases in commission costs to brokers, general expenses, taxes, and other expenses related to acquisitions. Finally, investment yields depend on the stock and bond markets as well as on the asset allocations of the portfolios.

20. How do unexpected increases in inflation affect property-casualty insurers?

Inflation generally has an adverse effect on the cost of providing benefits that have been purchased by the insured, particularly if the policy is written in terms of the replacement cost of the asset and the premiums are not adjusted for inflation. In addition, the investment value of bonds and other fixed-rate assets of insurers from which claims proceeds are derived may decrease in value from unexpected inflation.

21. Identify the four characteristics or features of the perils insured against by property-casualty insurance. Rank the features in terms of actuarial predictability and total loss potential.

* **Property versus liability:** Maximum levels of losses are more predictable for property lines than for liability lines.
* **Severity versus frequency:** Loss rates are more predictable on low-severity, high-frequency lines than they are on high-severity, low-frequency lines.
* **Time of exposure:** The extent of expected losses is more difficult for long-tail risk exposure phenomenon than for short-tail exposures.
* **Inflation:** The inflation risk of property lines is likely to reflect the underlying inflation of the economy, while the inflation risk of liability lines may be subject to the changing values or social risk of the society.

22. Insurance companies will charge a higher premium for which of the insurance lines listed below? Why?

a. Low-severity, high-frequency lines versus high-severity, low-frequency lines.

Insurance companies have a more difficult time predicting the severity of losses for high- severity, low-frequency lines of business, such as earthquakes and hurricanes. In addition, these catastrophic events cause severe damage, meaning the individual risks in the insured pool are not independent. As a result, premiums for high-severity, low-frequency lines will be higher than premiums for low-severity, high-frequency lines.

b. Long-tail versus short-tail lines.

Losses in long-tail lines of business are harder to predict than in short-tail lines, because claims can be made years after the premiums have been made. Thus, premiums in this category of business will be higher. Modern day examples of such lines include coverage for product liabilities, such as exposure to asbestos.

23. What does the loss ratio measure? What has been the long-term trend of the loss ratio? Why?

The loss ratio measures the actual losses incurred on a line of insurance relative to the premiums earned on the line. A ratio greater than 100 implies that the premiums earned did not cover the losses on the product line. The loss ratio has increased from the 60 percent range in the early 1950s to the 70 and 80 percent range in the 1990s into the 2010s. Increases in social inflation and the long-tail risk exposure phenomenon have caused some insurance companies to invest in shorter-term assets that have lower yields and thus generate lower premium earnings. In addition, increased coverage in areas with higher uncertainty of losses has occurred within the industry.

24. What does the expense ratio measure? Identify and explain the two major sources of expense risk to a property-casualty insurer. Why has the long-term trend in this ratio been decreasing?

The expense ratio measures the expenses incurred relative to premiums written. Expense risk is comprised primarily of loss adjustment expenses, which relate to the cost surrounding the loss settlement process, and commission costs paid to insurance brokers and sales agents in an effort to attract business. Large insurance companies have found expense efficiencies in using their own brokers rather than using independent brokers to sell insurance.

25. How is the combined ratio defined? What does it measure?

The combined ratio is equal to the loss ratio plus the expense ratio. The ratio may be stated before or after dividends paid to policyholders. The ratio basically measures the underwiting profitability of an insurance line. If the combined ratio is less than 100, the premiums on the insurance have been sufficient to cover both losses and expenses on line.

26. What is the investment yield on premiums earned? Why has this ratio become so important to property-casualty insurers?

In cases where the combined ratio is greater than 100, the insurer must rely on investment income from premiums to achieve profitability. Since the 1980s, the combined ratio consistently has been greater than 100. That is, the loss ratio and the expense ratio have exceeded the amount of premiums received on the insurance lines. Thus, the yield on invested premiums has become critical to the overall profitability of the property-casualty insurance industry.

27. Consider the data in Table 6-6. Since 1980, what has been the necessary investment yield for the industry to enable the operating ratio to be less than 100 in each year? How is this requirement related to the interest rate risk and credit risk faced by a property-casualty insurer?

The minimum investment yield required to achieve an operating ratio of 100 or less ranged from a low of -7.6 percent in 2006 to a high of 16.2 percent in 1985. The average yield over this period (for the years reported) was 4.39 percent. In effect, PC insurers required an average annual yield of 4.39 percent on invested premiums during a time when interest rates were seldom this high and operating losses were significant. Year-by-year values are given below based on data given in Table 6-6.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | Combined | Required | Minimum |
|  |  | Ratio after | Combined | Investment |
|  | Year | Dividends | Ratio | Yield |
|  | 1980 | 103.1% | 100.0% | 3.1% |
|  | 1985 | 116.2% | 100.0% | 16.2% |
|  | 1990 | 109.6% | 100.0% | 9.6% |
|  | 1995 | 106.4% | 100.0% | 6.4% |
|  | 1997 | 101.6% | 100.0% | 1.6% |
|  | 2000 | 110.5% | 100.0% | 10.5% |
|  | 2001 | 116.0% | 100.0% | 16.0% |
|  | 2002 | 107.2% | 100.0% | 7.2% |
|  | 2003 | 100.1% | 100.0% | 0.1% |
|  | 2004 | 98.7% | 100.0% | -1.3% |
|  | 2005 | 100.9% | 100.0% | 0.9% |
|  | 2006 | 92.4% | 100.0% | -7.6% |
|  | 2007 | 95.6% | 100.0% | -4.4% |
|  | 2008 | 105.1% | 100.0% | 5.1% |
|  | 2009 | 101.0% | 100.0% | 1.1% |
|  | 2010 | 102.4% | 100.0% | 2.4% |
|  | 2011 | 108.2% | 100.0% | 8.2% |
|  | 2012 | 104.0% | 100.0% | 4.0% |
|  |  |  |  |  |
|  |  | Arithmetic Average = | | 4.39% |
|  |  |  | Minimum = | -7.6% |
|  |  |  | Maximum = | 16.2% |

28. a. What is the combined ratio for a property insurer that has a loss ratio of 73 percent, a loss adjustment expense of 12.5 percent, and a ratio of commissions and other acquisition expenses of 18 percent?

The combined ratio is 73% + 12.5% + 18% = 103.5%.

b. What is the combined ratio adjusted for investment yield if the company earns an investment yield of 8 percent?

The combined ratio adjusted for investment yield is 103.5% - 8% = 95.5%.

29. An insurance company’s projected loss ratio is 77.5 percent and its loss adjustment expense ratio is 12.9 percent. The company estimates that commission payments and dividends to policyholders will be 16 percent. What must be the minimum yield on investments to achieve a positive operating ratio?

The combined ratio = 77.5% + 12.9% + 16.0% = 106.4%. In order to be profitable, the yield on investments has to be greater than 6.4%.

30. An insurance company collected $3.6 million in premiums and disbursed $1.96 million in losses. Loss adjustment expenses amounted to 6.6 percent and dividends paid to policyholders totaled 1.2 percent. The total income generated from the company’s investments was $170,000 after all expenses were paid. What is the net profitability in dollars?

Pure loss = $3.6 million - $1.96 million = $1,640,000

Expenses = 0.066 x $3,600,000 = $237,600

Dividends = 0.012 x $3,600,000 = $43,200

Investment returns = $170,000

Net profits = $1,640,000 - $237,600 - $43,200 + $170,000 = $1,529,200

31. A property–casualty insurer brings in $6.25 million in premiums on its homeowners multiple line of insurance. The line’s losses amount to $4,343,750, expenses are $1,593,750, and dividends are $156,250. The insurer earns $218,750 in the investment of its premiums. Calculate the line’s loss ratio, expense ratio, dividend ratio, combined ratio, investment ratio, operating ratio, and overall profitability.

Loss ratio = $4,343,750/$6,250,000 = 69.5%

Expense ratio = $1,593,750/$6,250,000 = 25.5%  
Dividend ratio = $156,250/$6,250,000 = 2.5%

Combined ratio = 69.5% + 25.5% + 2.5% = 97.5%

Investment ratio = $218,750/$6,250,000 = 3.5%

Operating ratio = 97.5% - 3.5% = 94.0%

Overall profitability = 100.0% - 94.0% = 6.0%